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The Commonwealth of Learning (COL) Open Schools Initiative launched an Open Educational Resources (OER) Project to provide materials under the Creative Commons license agreement to support independent study in 17 specially selected secondary school subjects. Funded by the William and Flora Hewlett Foundation its aim is to broaden access to secondary education through the development of high quality Open Distance Learning (ODL) or self-study materials.

These specially selected OER subjects include:

1. Commerce 11
2. Coordinated Science 10 (Biology, Chemistry and Physics)
3. English 12
4. English Second Language 10
5. Entrepreneurship 10
6. Food & Nutrition
7. Geography 10
8. Geography 12
9. Human Social Biology 12
10. Life Science 10
11. Life Skills
12. Mathematics 11
13. Mathematics 12
14. Physical Science 10
15. Physical Science 12
16. Principles of Business
17. Spanish

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The *OER for Open Schooling Teachers' Guide* has been developed to guide teachers/instructors on how to use the Open Educational Resources (OER) in five of these courses.

1. English
2. Entrepreneurship
3. Geography
4. Life Science
5. Physical Science

The aim of this teachers' guide is to help all teachers/instructors make best use of the OER materials. This guide is generic, but focuses on Namibian examples.

Print-based versions are available on CD-ROM and can be downloaded from www.col.org/CourseMaterials. The CD-ROM contains the module and folders with additional resources, multimedia resources and/or teacher resources. Note that not all subjects have multimedia resources.

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Unit 1

Structure of the Earth

Introduction

Welcome to the first unit of the Grade 12 Geography programme which deals with the structure of the earth. You would probably realise that what you are going to learn in this first unit is not entirely new to you. You studied the Physical Environment when you were doing Social Studies at junior schools. This unit builds on the foundation laid by the Social Studies course.

In all there are 16 units in this Geography programme. The subject Geography deals more with the physical environment and how these influence human activities. It is important to start the Geography programme with a closer look at the processes responsible for the formation of the physical features. This unit therefore is the foundation upon which all other units are built. For example in the next unit or Unit 2, you will do map reading which will help you locate these physical features on maps.

In this unit, you will learn about the earth as part of the physical world. The term “physical” means natural. A scientific field called geophysics studies the physics of the earth. Through geophysics many significant discoveries about the nature of the earth have been made. In this unit you will study the earth’s surface and the natural behaviour of the earth below the surface. Besides the structure of the earth you will learn about the formation of different landforms associated with the movement of the earth.

The topics addressed by this unit are:

Topic One: The Structure of the Earth

In this topic we will be looking at the different layers that make up the inside of the earth. These are the earth crust, the mantle and the core. We will move on to learn about the internal movements that take place inside the earth that causes earth movements called plate tectonics and the various types of plate boundaries.

Topic Two: Faulting and Folding

The first topic describes various types of earth movements and the landforms associated with them. We will be looking specifically at folding and the formation of Fold Mountains. We will move on to faulting and the formation of rift valleys and block mountains.

Topic Three: Earthquakes

The topic deals with earthquakes, what causes them and the various types of shock waves. We will also look at how earthquakes are measured, the distribution of earthquakes and their effects.

Topic Four: Volcanicity

In this topic we are going to discuss volcanicity. We are going to look at how volcanoes occur, internal and external volcanic features and the various types of volcanoes. We will also look at the distribution of volcanoes and their effects on humans.

Upon completion of this unit you will be able to:



Outcomes

- List and describe the three layers that comprise the earth's structure.
- Describe the proportion of land and water
- Describe rock types (igneous, sedimentary and metamorphic) and their formation
- Explain the forces of compression and tension in relation to the theory of plate tectonics.
- Describe the distribution of earthquakes and volcanoes in relation to plate margins.
- Explain how volcanoes and earthquakes are formed and their impact on humans and the environment.
- Interpret the Richter scale to determine the magnitude of earthquakes.
- Describe the formation of related landforms for example, fold mountains and lakes, rift valleys and block mountains.
- Discuss the impact of the above landforms on human activities



Time

Time

You will need 2 hours to study each topic. You will therefore need to dedicate 8 hours for you to cover the entire whole unit sufficiently. You might finish studying each topic in less than 2 hours or exceed your study time as this is determined by your understanding of the topic and reading speed. You will need about an hour to complete the assignments and another to complete the assessment. However, do not be too worried if you take longer.

Learning approaches

In order to ensure smooth learning, this unit has been designed with the following features:

- Unit and Topic objectives: these are meant to focus your attention so that you know exactly what is expected of you.
- Activities or Exercises: they are of two types. The first types are meant for you to recall your previous knowledge. The second type are meant to test your understanding of the content you have just learnt
- Presentation of content: this is done selectively, one at a time to help you focus
- Case Studies: they help you come closer to the concrete experience of the issues being discussed
- Illustrations: they help you visualise the issues being discussed
- Assignments: give you an opportunity to do something on your own and assess what you have learned in each topic

- **Assessment:** help to see if you are able to retrieve and apply the content you have learnt in the unit and help consolidate learning
- **Feedback:** it is always given at the end of assignments, activities and assessment. It helps you identify correct answers to the questions or problems and assess your understanding as you go through the different sections of each topic.

Assessment

Each topic has activities, assignments and assessment. To test your understanding, one or more activities are provided in the course of each topic. At the end of the unit are assignments and assessment questions. Take time to work on the assignments and assessment questions as these will help you consolidate your understanding of the unit. You should first attempt these activities, assignments and assessment questions without looking at the answers provided. After that you can check your answers by referring to the answers that are provided in the unit.

You are encouraged to effectively participate in the questions and discussions in the activities as they foster active learning. If you are registered with any distance education provider, you are advised to make use of their learner support services such as study centres, tutorials, radio programmes and counselling support. Study centres are important because they have relevant information that you need. They also give you the opportunity to meet and discuss with other learners. Notice that tutors are available at the study centres and they will help you where you experience difficulties.

Resources

You will need some materials to study this unit effectively. Besides the pens, pencils and paper that you need for writing and drawing, you will also need maps or atlases to locate places mentioned in this unit. There are also some textbooks (See list of references at the end of the unit) that give information on these lessons. You can find all these from your nearby library or study centre. Internet also provides information on what is discussed in this unit. However, if you do not have these resources, do not worry as the information provided here is adequate to assist you in mastering the topics.

Glossary

The table below is a glossary of words used in the unit. You will find the glossary useful as it helps you to understand these words. If there is any word used that you are not sure of its meaning please refer to a dictionary. You can find dictionaries in your nearby study centres and libraries. Your tutor can also help you.



Terminology

Active volcano:	A volcano with frequent eruptions
Compression:	Force caused by collision and pressure
Dormant volcano:	A volcano that has not erupted in a long time but may erupt in the future

Earth tremors:	Small earthquakes that produce minor shock waves
Extinct volcano:	A volcano that has not erupted for a very long time and shows no signs of ever erupting in future
Intensity:	The strength and effect of an earthquake
Lava:	Molten rocks that reach the earth surface
Magma:	Molten rocks of very high temperatures
Magnitude:	Total amount of energy released by an earthquake
Plate Tectonics:	Movement of large blocks of the earth crust
Pyroclastic flow:	Materials blown into the atmosphere by volcanic activity including cinders, ash, volcanic bombs and burning gases. It appears like a cloud and travels at a fast speed burning everything in its way
Seismic waves:	Energy that travel through the earth or other elastic body as the result of an earthquake
Seismograph:	An instrument used for recording the intensity and duration of an earthquake
Tension:	Force produced by pulling apart
Zone of Subduction:	An area where an oceanic plate collides with a continental one and sinks into the mantle

Topic 1: The Structure of the earth

Introduction

Do you remember that in the unit introduction we said that this is the first of the four topics found in this unit? Have you ever wondered what you would find if you were to dig deep down into the earth's surface? You have also probably wondered how some landforms like mountains and lakes have been formed. In this topic we will begin to address these issues. You are going to learn about the various components that comprise the earth structure and the characteristics of each component. The topic therefore deals with the shape of the earth, its structure and the natural forces that are within the earth and what these forces produce.

Topic Objectives

At the end of this topic you should be able to:

- draw a diagram of the earth identifying the three layers of the earth
- describe the composition of each layer
- Describe rock types (igneous, sedimentary and metamorphic) and their formation
- illustrate with diagrams the natural forces of compression and tension that cause the movement of plate
- identify and name the major plates on a world map
- list and describe the three main types of plate boundaries and the physical features associated with each one of them

Topic Contents List

1.0 Model of the earth

1.1 The earth crust

1.2 The mantle

1.3 The core

2.0 Plate movements

2.1 Convergent plate boundaries

2.2 Divergent plate boundaries

2.3 Transform plate boundaries

3.0 Summary

1.0 Model of the earth

Before you go any further with this topic, let us refresh your memory on what you learnt in junior secondary. Do Activity 1 that follows.



Activity 1

1. List some of the physical features you learnt about in junior secondary level.
2. Explain the importance of these features to human beings.

Feedback

I hope you were able to recall what you have learnt about physical features in your country. Here are answers to the two questions:

1. *Examples of physical features are mountains, rift valleys, craters, lakes and inland deltas*
2. *Some of these features are:*
 - *sources of water, for example lakes and deltas*
 - *attraction to tourists, for example rift valleys, craters and deltas and in fact all the features listed can be tourists attractions and*
 - *influence on climate, for example mountains. You will learn about climate and the role of mountains in a later unit.*

If you travel from one place to another in your country, you might see physical features such as hills, mountains, valleys and lakes. In order to understand fully the features that we find on the earth surface, it is important to know what is inside the earth. What we know of the interior of the earth is related to what we can see at the earth surface. We get information about the interior of the earth from such things as earthquakes, volcanic eruptions and from deep mines. For instance, people who work in deep mines, like the gold mines in South Africa, have noted that temperatures underground are higher than temperatures on the ground surface.

You have probably seen a model of the earth called a globe. The earth is shaped like a sphere, a round shape that is slightly flattened at the poles. As you can observe in Fig 1, a cut through the earth will show three circular layers called the crust, the mantle and the core. The distance from the surface of the earth to its inner most centre is about 6400 kilometres. As we go deeper and deeper into the earth, the temperature and pressure increases.

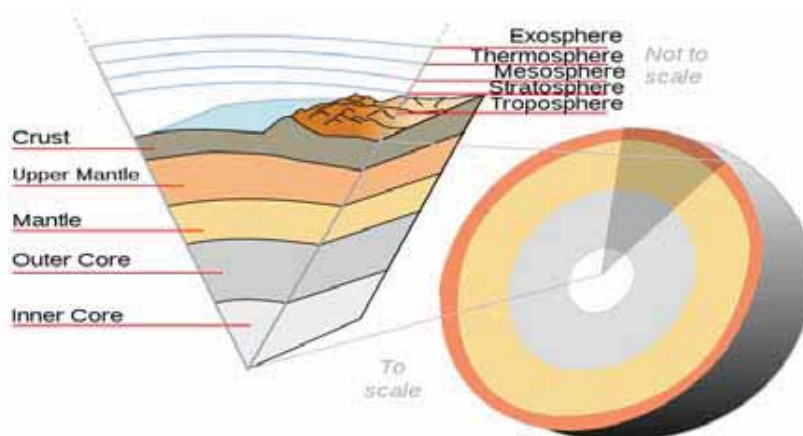


Fig 1: The structure of the earth

Source: <http://upload.wikimedia.org/wikipedia/commons/e/ee/Earth-crust-cutaway-english.svg>


Retrieved: 03/07/11

1.1 The Earth Crust

The outer shell of the earth is called the earth crust. The earth crust is more like the shell of an egg in that it is very thin and brittle compared to the other parts. It ranges in thickness from 10 to 70 kilometres. The thinnest part is under the oceans and goes to a depth of 10 kilometres. The thickest part is the top of the Himalaya Mountains at 70 kilometres.

Before we look at distinct layers of the earth it is very important to understand the rock types that makes up the earth. Geologists classify rocks in three types. These are grouped according to the major earth processes that formed them, their texture, mineral and chemical composition. The three major types of rocks are sedimentary, igneous and metamorphic.

The table below is a brief summary of how each type or group of rocks was formed and their examples.

Type of Rock	Formation	Examples
Igneous	Formed from molten rock (magma) that cooled and solidified. Igneous rocks differ according to the chemical composition and cooling rates of magma. Some igneous rocks were formed from magma which cooled and solidifies within the earth crust e.g granite. Some were formed from magma which cooled and solidified on the earth surface and formed rocks like pumice and basalt.	Granite, basalt, obsidian, quartz, pumice, flint, andesite  Igneous rock- gabbro Source: http://en.wikipedia.org/wiki/Rock_(geology) Retrieved : 03/07/11
Sedimentary	Formed from sediments (rock particles, minerals, plant and animal remains) layers which had accumulated over many years	Shale, sandstones, limestone, chalk



		 <p>Sedimentary rock – sandstone with iron oxide Source: http://en.wikipedia.org/wiki/Rock_(geology) Retrieved : 03/07/11</p>
Metamorphic	Formed when sedimentary and igneous rocks are further compacted by intense pressure and heat.	<p>Slate, marble, quartzite</p>  <p>Metamorphic rock – banded gneiss Source: http://en.wikipedia.org/wiki/Rock_(geology) Retrieved : 03/07/11</p>

Fig 2: Rocks - Types, formation and examples

Now that you know about the three major groups of rocks you should be able to understand the composition of each layer of the earth. You will also learn about some of the elements that we have mentioned in the formation of the rocks, for example, magma and where it comes from.

The earth crust has two distinct layers. The upper layer consists mainly of granitic rocks and forms continents (Continental Crust). Its main mineral constituents are silica and aluminium hence it is also known as SIAL. The lower layer is made of dense basaltic rocks and forms ocean floors (Oceanic Crust). Its main mineral constituents are silica, iron and magnesium hence it is also known as SIMA.

If you look closely at the diagram in Fig 3, you will realise that the ocean lies on top of the oceanic crust whereas above the continental crust is a landmass or a continent. The Continental Crust is much thicker than the Oceanic Crust, as also demonstrated in Figure 3.

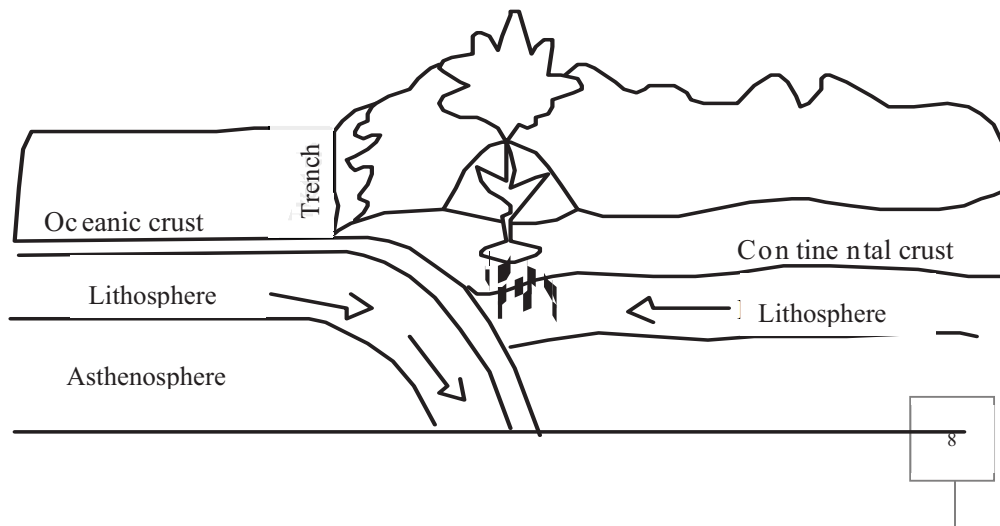


Fig 3: The oceanic and continental crusts

What is on the oceanic crust? You are correct if you said water or ocean water. The water on earth occupies 70% of the earth's total surface. Inclusive of this amount is the 1% of fresh water from rivers, dams, lakes and boreholes.

If you look closely at Fig 3, you will find that the oceanic crust lies lower than the continental crust that covers only 30% of the crust. It therefore makes sense to conclude that oceanic crust lies lower than the continental crust because it carries water, particularly ocean water.

Now that you have learnt about the earth crust, let us now move on to what lies below the earth crust. What kind of rocks do you think are found below the crust?

1.2 The Mantle

If you look closely at Fig 1 again, you will realise that immediately below the Earth's crust is the mantle, which extends to a depth of 2 900 kilometres. The mantle is composed of semi liquid or molten rocks that are subjected to extreme pressure. The rocks are rich in iron and magnesium. The boundary between the Earth's crust and the mantle is called the Moho Discontinuity. The area labelled asthenosphere in Fig 3 is part of the mantle.

Notice the difference in rock type between the earth crust and the mantle. While rocks in the crust are solid those of the mantle are molten or semi liquid. What kind of rocks do you think are found in the next layer of the earth? Reflect on your answer and then read the next section to see how your answer compares with what is said there.

1.3 The Core

As you can observe from Fig 1, the innermost part of the earth is the Core which has a radius of about 3 500 kilometres. It is composed of metallic elements, especially iron and nickel. Rocks are exposed to intense heat and pressure with temperatures as high as 6 000°C. The core consists of two layers. The outer core is in a liquid state whereas the inner core is in a solid state.

Having gone through the different layers of the earth, I think you are now familiar with the structure of the earth and type of rocks found in each. To see how much you have learnt, attempt Activity 2 that follows.



Activity 2

Study the diagram in Fig 4 that shows a section through the earth. Label the features 1 to 6.

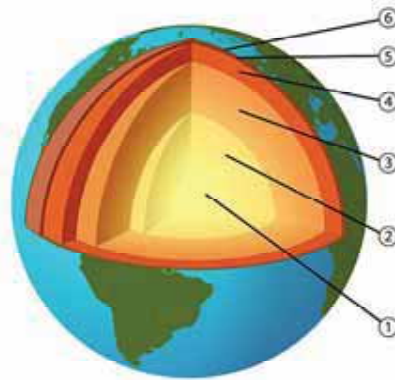


Fig 4: A cross section through the earth.

Image

from

http://commons.wikimedia.org/wiki/File:Jordens_inre_med_siffror.jpg

- | | |
|----------|----------|
| 1. ----- | 2. ----- |
| 3. ----- | 4. ----- |
| 5. ----- | 6. ----- |

Feedback

I hope you have answered as follows:

1.inner core 2.outer core 3. mantle 4.upper mantle 5.oceanic crust 6.continental

There are movements or forces at work inside the earth especially in the mantle and the outer core. It is these movements that results in the formation of landforms at the earth surface and also cause earthquakes. In the next section we are going to look closely at the forces at work inside the earth.

2.0 Plate Movements

The term plate tectonics, as you have noticed under the glossary or terminology section, describes the large scale movement of the earth's lithosphere. The outer most parts of the earth's interior are made up of two layers: the **lithosphere** and the **asthenosphere**. The Lithosphere consists of the Earth Crust and the rigid uppermost part of the mantle. Below the

lithosphere is the asthenosphere made of molten rocks that can flow like liquid. The lithosphere is broken into plates called tectonic plates that ride on the asthenosphere and move in different directions. The earth is broken into several plates as you can see in Fig 5. The main plates include African plate, Antarctic plate, Eurasian plate, Pacific plate, South American plate and North American plate. Minor plates include Arabian plate, Caribbean plate, Cocos plate and Nazca plate. Can you identify these in Figures 5? Study this figure carefully and ensure that you have identified all the plates.

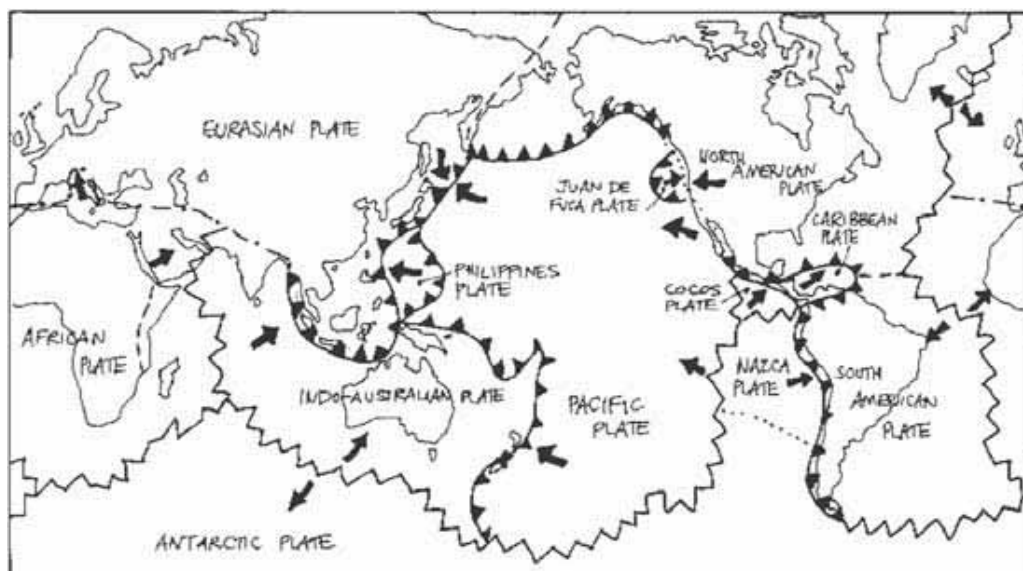


Fig 5: Major tectonic plates

The place where two plates meet is called a plate boundary. These are represented by the thick black lines in Fig 5. Plate boundaries are areas that are prone to earthquakes, volcanic eruptions and formation of landforms. Plates move at a speed of 5 to 10 centimetres a year. Tectonic plates can include the continental crust and oceanic crust. It is believed that the heat from deep inside the earth is the source of the energy driving the plates. The heat produces convectional currents in the mantle. As the currents move they drag the plates lying above them.

Carefully study the diagram in Fig 6. The light arrows in the mantle indicate the convectional currents. The thick arrows indicate the directions in which plates are pulled by convectional currents.

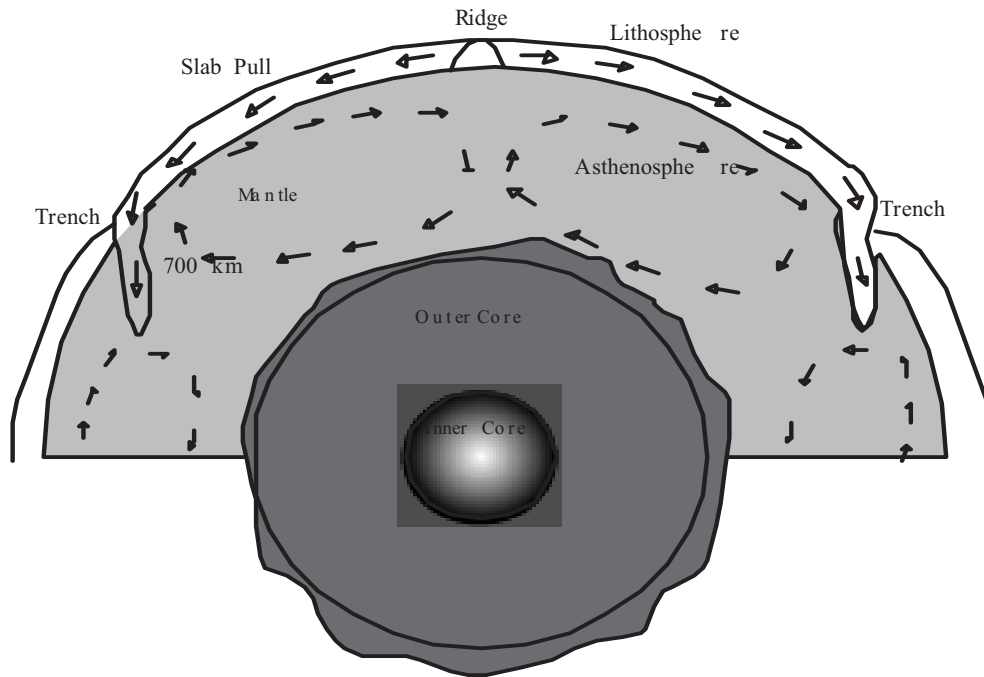


Fig 6: Effects of convectonal currents

Source: Adapted from http://en.wikipedia.org/wiki/File:Oceanic_spreading.svg -

Retrieved: 06/07/11

From what you have learnt, I think you now know what plates are, the boundaries between plates and what causes the movement of plates. In the next section we will look closely at the various types of plate boundaries.

There are three types of plate boundaries as shown in Figure 7. These are convergent, divergent and transform plate boundaries.

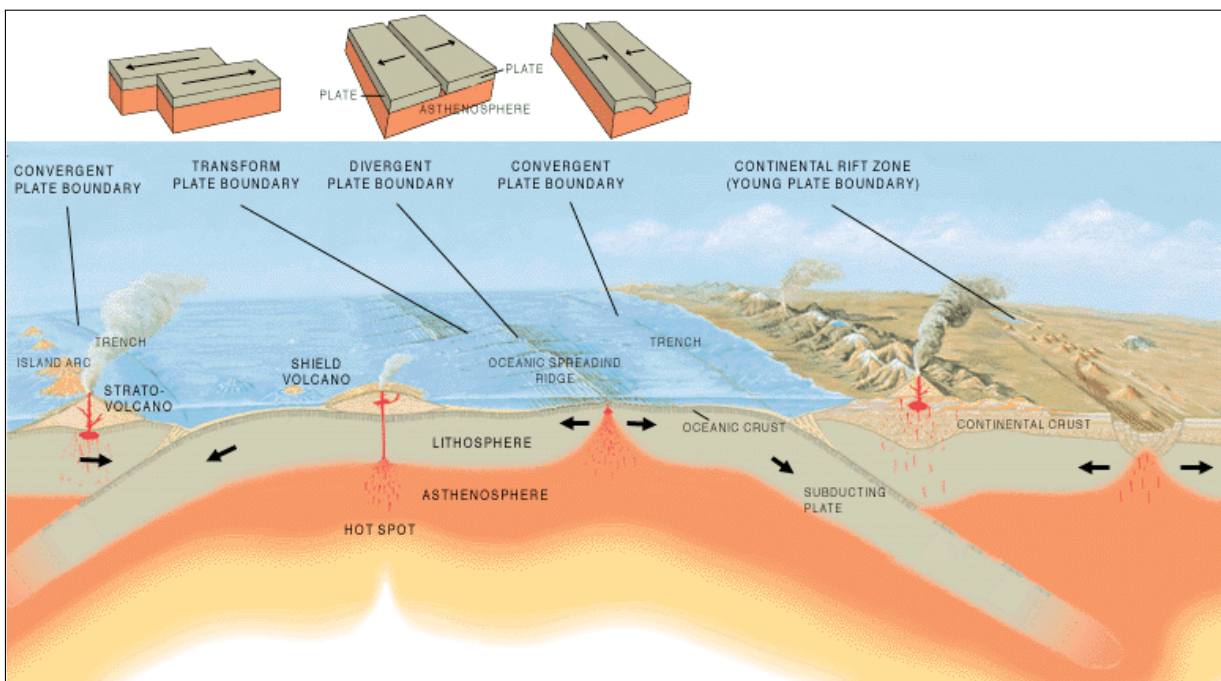


Figure 7: plate boundaries

Source: http://en.wikipedia.org/wiki/File:Tectonic_plate_boundaries.png

Retrieved 03/07/11

2.1 Convergent Plate Boundaries

A convergent plate boundary is also known as a destructive plate boundary. It occurs where two plates moving towards each other collide. The collision can be between two oceanic plates, two continental plates or oceanic and a continental plate.

When a light continental plate meets a heavier oceanic plate, the oceanic plate is forced under the continental plate forming a **subduction zone**. Deep ocean trenches are found at subduction zones.

Study Fig 8 which shows an oceanic plate colliding with a continental plate. Notice that a trench is formed where the oceanic plate is sinking below the continental plate. This boundary is called a destructive plate boundary because it is where the sinking plate is destroyed or lost into the hot mantle below.

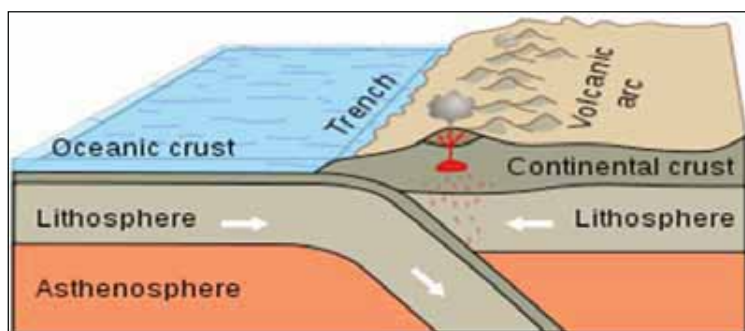


Figure 8: Convergence of Oceanic and continental plates

Source: http://en.wikipedia.org/wiki/File:Active_Margin.svg - Retrieved: 09/08/11

The force that is applied by plates that are moving towards each other is called **compressional force**. It is indicated by arrows pointing towards each other as shown on Fig 9.

When continental plates collide with each other huge mountain ranges are formed. The diagram in Fig 9 shows two continental plates colliding. Notice that a mountain range is formed where the two meet.

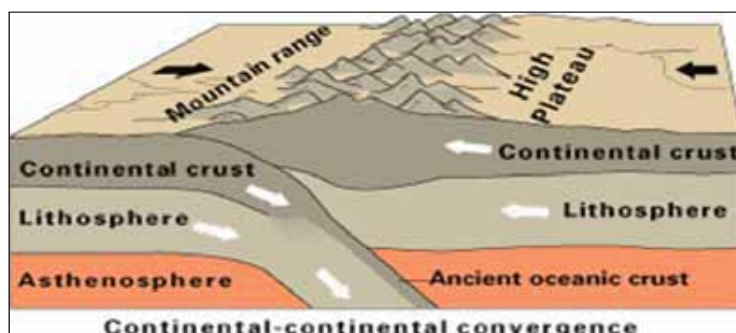


Figure 9: Convergence of two continental plates

http://en.wikipedia.org/wiki/File:Continentalcontinental_convergence_Fig21contcont.gif

Retrieved: 09/08/11

When two oceanic plates collide they create island arcs as one plate is forced under another. The arc is formed by the volcanoes that erupt through the overriding plate. If the volcanic activity continues, the volcano may grow tall enough to reach the surface forming an island. Examples of such islands arcs include, Japan, Mariana Islands, Tonga, Philippines and Indonesia. A deep under sea trench (up to 2000 kilometres deep) is located in front of such arcs. Study Fig 10 showing two oceanic plates colliding. Notice the volcanic eruptions and three islands forming above the water.

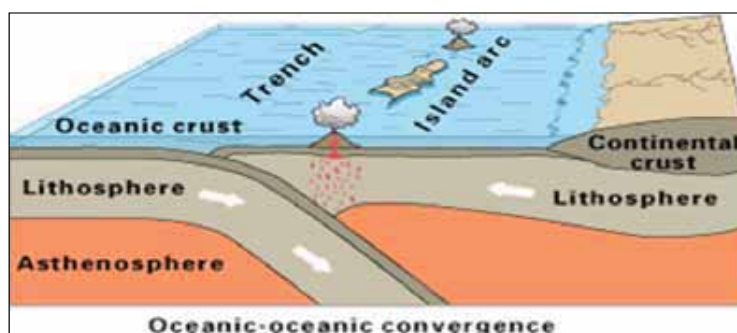


Fig 10: Convergence of two oceanic plates

http://en.wikipedia.org/wiki/File:Oceanic-oceanic_convergence_Fig21oceanoocean.gif

Retrieved: 09/08/11

Having gone through convergent plate boundaries I think you know the features that are formed when plates meet. To refresh your memory, we said these are trenches, mountain ranges and island arcs. What do you think will happen when plates move apart in opposite direction? Think about this. When you are done go on and read the next section.

2.2 Divergent Plate Boundaries

Divergent plate boundary is the opposite of convergent plate boundary that you have just studied. This is where two plates move away from each other. At sea this results in the formation of mid oceanic ridges whilst on land it results in formation of rift valleys. A mid oceanic ridge is a huge underwater mountain that stretches for thousands of kilometres. It is formed when molten rocks from the mantle move in to fill the space left by plates moving apart.

Mid Oceanic Ridge

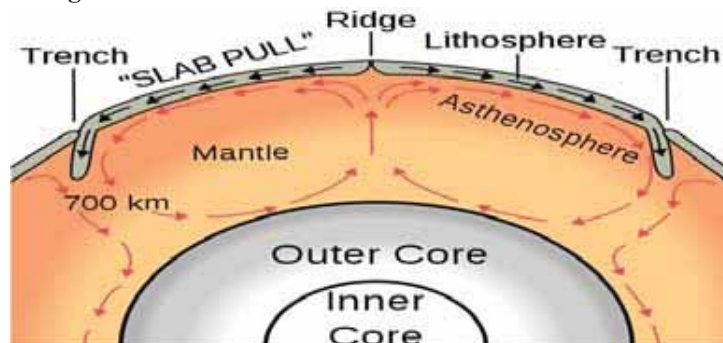


Fig 11: Divergent plate boundary

Source: http://en.wikipedia.org/wiki/File:Oceanic_spreading.svg -Retrieved 06/17/11

Study the diagram in figure 11. The force or the pressure applied by plates that are moving away from each other is called tensional force. It is shown by arrows pointing in opposite direction. Notice that the space left by the two plates is filled by material from the mantle to form a hill like feature under the sea.

We have now realized that plates can move towards each other and away from each other. Now let us look into the other ways in which plates move. This movement occurs at transform plate boundaries.

2.3 Transform Plate Boundaries

Transform boundaries are sometimes called conservative plate boundaries. They occur where plates slide or move past each other. A good example of this type of plate boundary is the San Andreas Fault in the west coast of North America where both the Pacific and North American plates are moving in the same direction but at different speeds creating the impression that they are moving in opposite directions. Fig 12 indicates by arrows the pressure exerted by plates moving past each other.

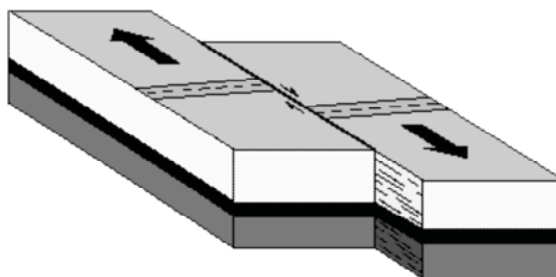


Fig 12: Transform plate boundary

Retrieved from Wikimedia commons

You have now discussed the three different types of plate boundaries. We said these are convergent, divergent and transform plate boundaries. They are sometimes referred to as destructive, constructive and conservative plate boundaries.

To see how much you have learnt so far attempt Activity 3 that follows.



Activity 3

Study the map of the world that shows different plates labelled 1 to 11 in Fig 13

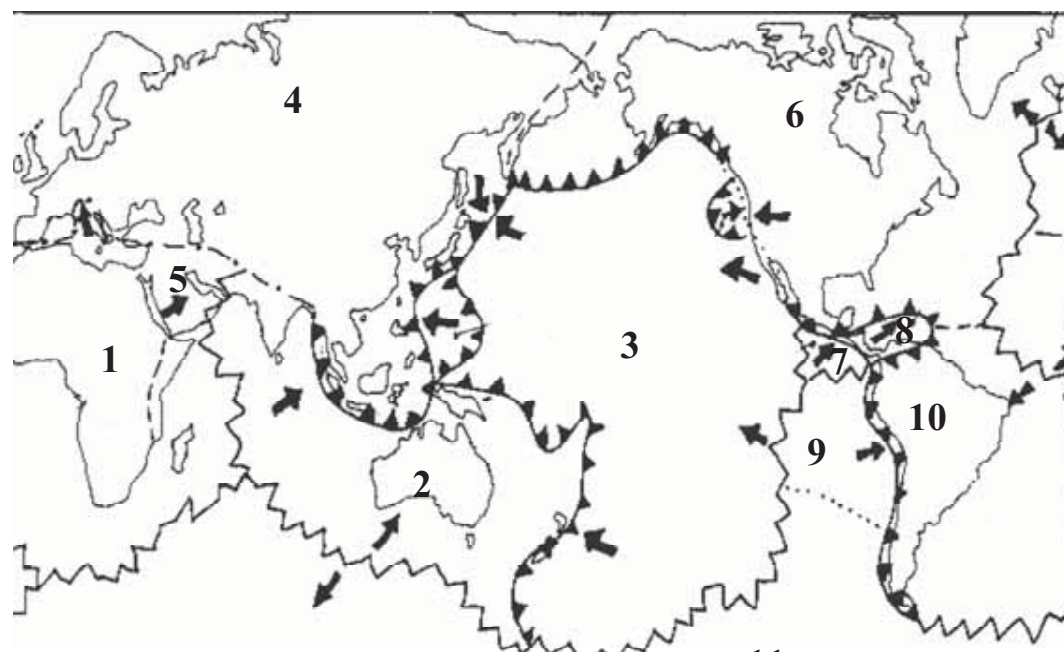


Fig 13: Tectonic Plates

1. List the plates shown on the map [11 marks]
 1.
 2.
 3.
 4.
 5.
 6.
 7.
 8.
 9.
 10.
 11.

2. What features are likely to form at the following places? [3 marks]
 - a) Between the African and South American Plate
.....
 - b) The area around Japan
.....

3. What forces are operating: [2 marks]
 - a) Between African and South American Plate
 - b) The area around Japan

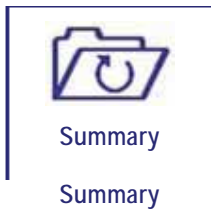
Below are the answers to the above exercise, go through them to see whether you have answered the questions correctly.

Question 1

1 for African Plate, 2 for Indo-Australian Plate, 3 for Pacific Plate, 4 Eurasian Plate, 5 for Arabian Plate, 6 for North American Plate, 7 for Cocos Plate, 8 for Caribbean Plate, 9 for Nazca Plate, 10 for South American plate and 11 for Antarctic Plate

Question 2 a) Mid oceanic ridge b) Trench and volcanic arc

Question 3 a) Tensional force b) Compressional force



3.0 Summary

In this topic you learned about the structure of the earth which comprises the Earth Crust, the Mantle and the Core. The organisational table below summarises the structure of the earth.

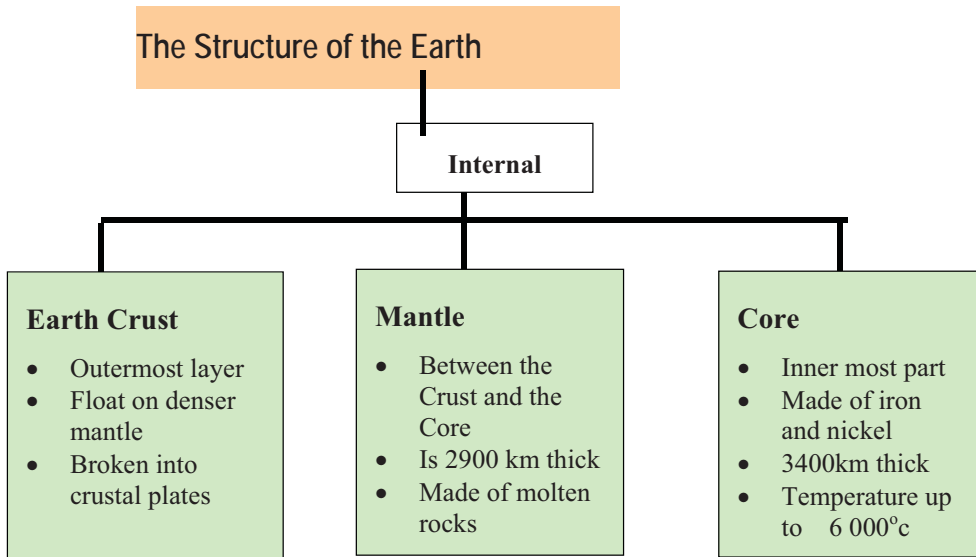


Figure 14: Summary of the structure of the earth.

The Earth Crust is divided into several plates that are moving in different directions. As plates move they exert forces of compression and tension. The boundaries between plates are divided into convergent, divergent and transform plate boundaries.

You will need to use the information you have learnt in this topic to do the first assignment at the end of the topic below. Feedback is also provided to correct you. In the next topic we will be looking at the features that are associated with the movement of plates. This movement of plate results in the formation of landforms or physical features. The first such features are Fold Mountains.

Topic 1: The Structure of the Earth

1. Name the different layers that you will see if you were to cut through the earth. Describe in details the characteristics of each layer. [8 marks]

Feedback

Your answers to the above assignment questions should be more or less similar to the following:

Topic 1

1. (a) Core

- Divided into inner and outer core
- Inner core is said to be solid whilst outer core is said to be liquid
- Rock making the core are said to be rich in nickel and iron
- Temperature range from 3 000°C to 5 000°C
- It is the centre of the earth

(b) Mantle

- Is also divided into two layer; upper mantle (asthenosphere) and lower mantle
- Rocks here are rich in iron and magnesium
- Rocks are in a molten state
- Temperatures are well over 1 000°C
- It is the middle section of the earth

(c) Crust

- A layer on which we live
- It divided into continental and oceanic crust
- Continental crust forms continents whilst oceanic crust forms ocean floor
- Continental crust is also called SIAL because it rich in silica and aluminium
- Oceanic crust is also known as SIMA because it is rich in silica and magnesium

Topic 2: Folding and Faulting

Introduction

In Topic 1, you learnt about the movement of plates. You learned that plates that move towards one another exert compression forces on the earth crust while those that move away from each other exert tensional force on the earth crust. These forces of tension and compression are responsible for folding and faulting of the earth crust which we will be discussing in this topic. There is, thus, a relationship between the two topics.

Topic Objectives

At the end of this topic you should be able to:

- define the terms Faulting and Folding

- draw and explain four types of faults and folds
- draw and explain the formation of landforms associated with faulting and folding.

Topic Contents List

1.0 Folding

1.1 Types of folds

1.2 impacts of fold mountains on people

2.0 Faulting

2.1 Normal fault

2.2 Reverse fault

2.3 Thrust fault

2.4 Tear Fault

3.0 Summary

1.0 Folding

The term Folding refers to the bending and crumbling of sedimentary rocks as a result of compression forces. This bending of rocks is a result of compression force caused by colliding plates at convergent plate boundaries. The colliding plates may either be two continental plates or a continental and oceanic plate. When two continental plates collide and continue to press against each other, the land caught between them has nowhere to go but to rise up. When oceanic and continental plates collide, the oceanic plate is subducted whilst the continental plate is crumpled upwards in a series of folds. In both cases rocks are folded and large layers of the earth crust are raised to form Fold Mountains. Layers of rocks that are folded upwards are called anticlines and form mountain ranges. Layers of rocks folded downwards are called synclines and forms mountain valleys. The sides of folds are called limbs. Figure 1 illustrates these types of folding.

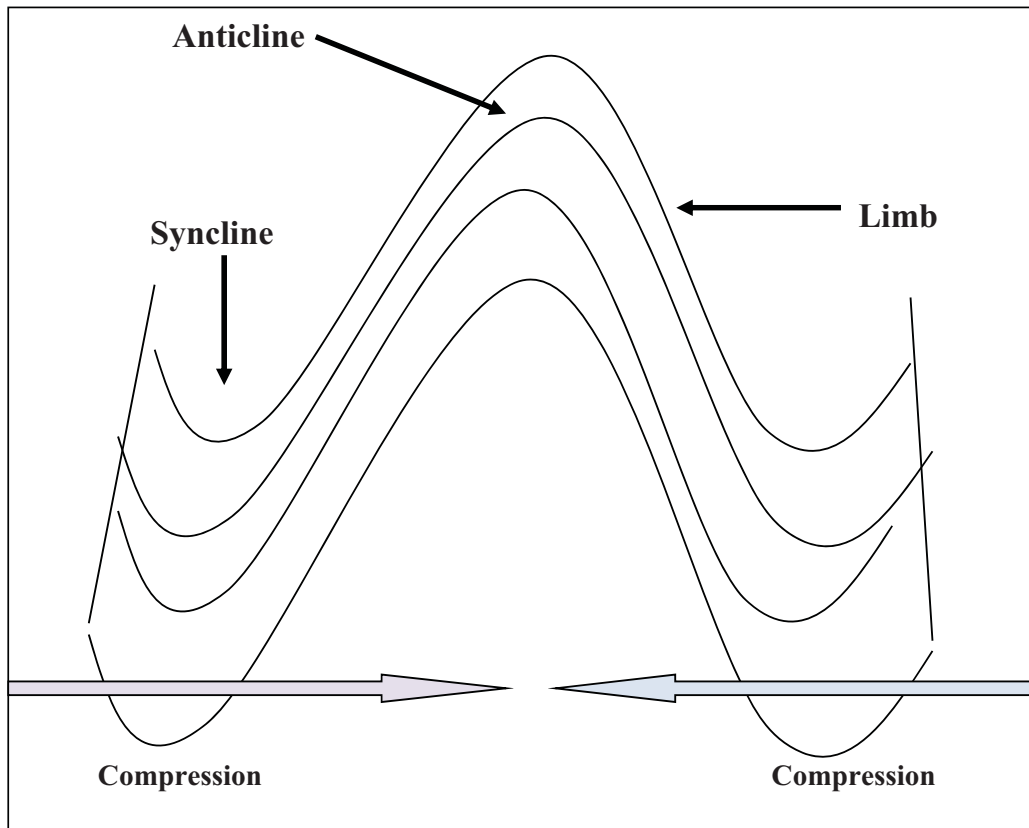


Fig 1: Folding

The folding of rocks as a result of compression force caused by two plates colliding may take various forms.

1.1 Types of folds

You have learned how a fold mountain is formed. The mountain may take different shapes. There are four different types of folds. These are simple, asymmetrical, overfold and overthrust folds. The difference is determined by the amount of compression exerted. The limbs of a simple fold are more or less the same. An asymmetrical fold has one limb steeper than the other. Further compression produces an overfold where one limb is pushed over another. Intense pressure produced by more compression leads to an overthrust where a fracture develops and one limb rides over another

As the rocks get bent and crumpled, massive layers of Earth's crust are uplifted to form fold mountains. Fold mountains are the world's largest mountain ranges. Well-known examples of fold mountains are the Himalayas in Asia, the Andes in South America, the Alps in Europe, the Rockies in North America and the Atlas in North Africa.



Fig 2: The Himalayan Mountain

Source: http://en.wikipedia.org/wiki/File:Crows_Lake_in_North_Sikkim.jpg

Retrieved: 05/07/11

The Himalayan Mountains shown in figure 2 were formed when India plate crashed into Eurasia plate producing the tallest mountain range in the world. In South America, the Andes Mountains were formed by the collision of the South American continental plate and the oceanic Nazca plate.

Fold mountains that are formed in this way may have impact on the lives of people living around them. What do you think are the impacts of fold mountains on people? Think about the answers and when you are done proceed to read about them in the next section.

1.2 Impacts of Fold Mountains on People

Mountains affect the lives of the people near them. What do you think these effects are? Fold Mountains affect human lives in a number of ways. Many of the Fold Mountains around the world are renowned tourist spots. Mountain ranges like the Himalayas in Asia are popular with tourists who come to see these magnificent natural wonders. Tourists generate income for the host country by spending money on such things as transport and lodging. Other impacts of fold mountains include:

- They can be used as recreation centres for such sports as skiing and mountain climbing. Many climbers have tried to conquer Mount Everest, the tallest mountain in the world.
- Fold Mountains may stand on the way of warm and moist air coming from the sea forcing it to rise. As the warm air rises, it produces torrential rain. The mountain may also have snow at the top. This rain and snow may provide water for rivers that bring this valuable resource to the lowlands.
- Some mountains may contain valuable minerals such as copper, tin and iron.
- Mountains are barriers to communication and make the construction of communication lines difficult, for this reason communities living in mountainous areas are often isolated from the rest of the world.

- Mountainous regions are prone to natural hazards such as rock falls, landslides and avalanches.

This brings us to the end of our discussion on folding. The next discussion is on faulting, which we said in the introduction, is also formed as a result of the forces of tension and compression.

2.0 Faulting

Unlike folding, faulting is the fracturing or cracking of the earth crust as a result of both tension and compression. Tensional force is a result of plates pulling away from each other whilst compression is a result of colliding plates. There are four types of faults. These faults can be observed from figure 3 to figure 6. Look at them carefully and try to identify the differences.

2.1 A Normal Fault

A normal fault as you can see in figure 3 is caused by tension force operating on the Earth's crust. A fault develops between the two blocks of land, one block slips downward relative to the other. The exposed upward block forms a cliff-like feature known as a fault scarp which may be hundreds of meters in height and hundreds of kilometers in length.

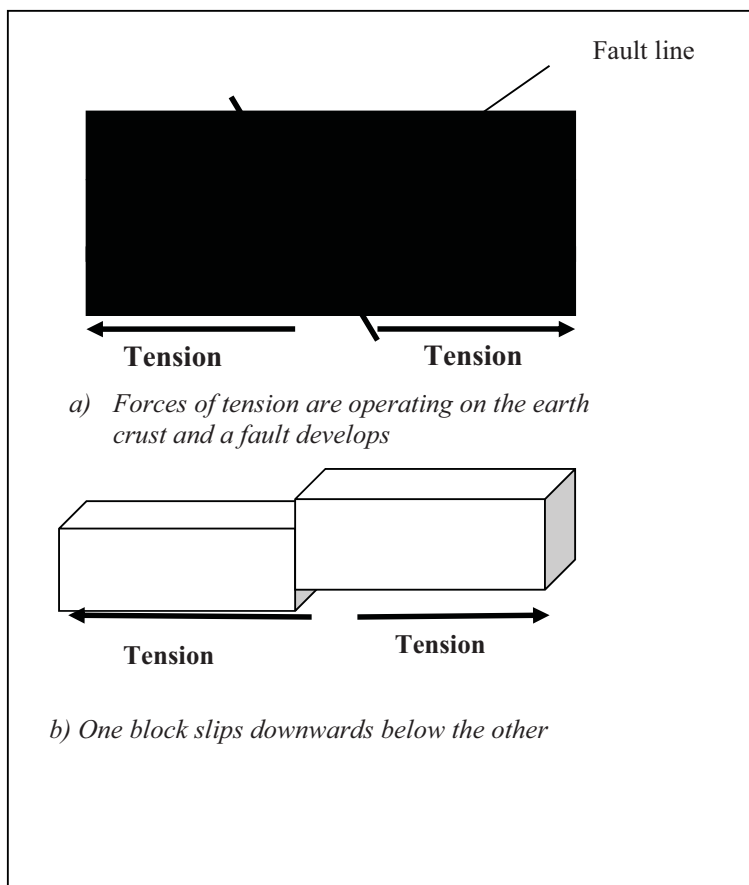


Fig 3: A normal fault

2.2 A Reverse Fault

A reverse fault is the opposite of a normal fault. It is a result of compression force operating on the crust. A fault develops and one block of land moves up relative to the other.

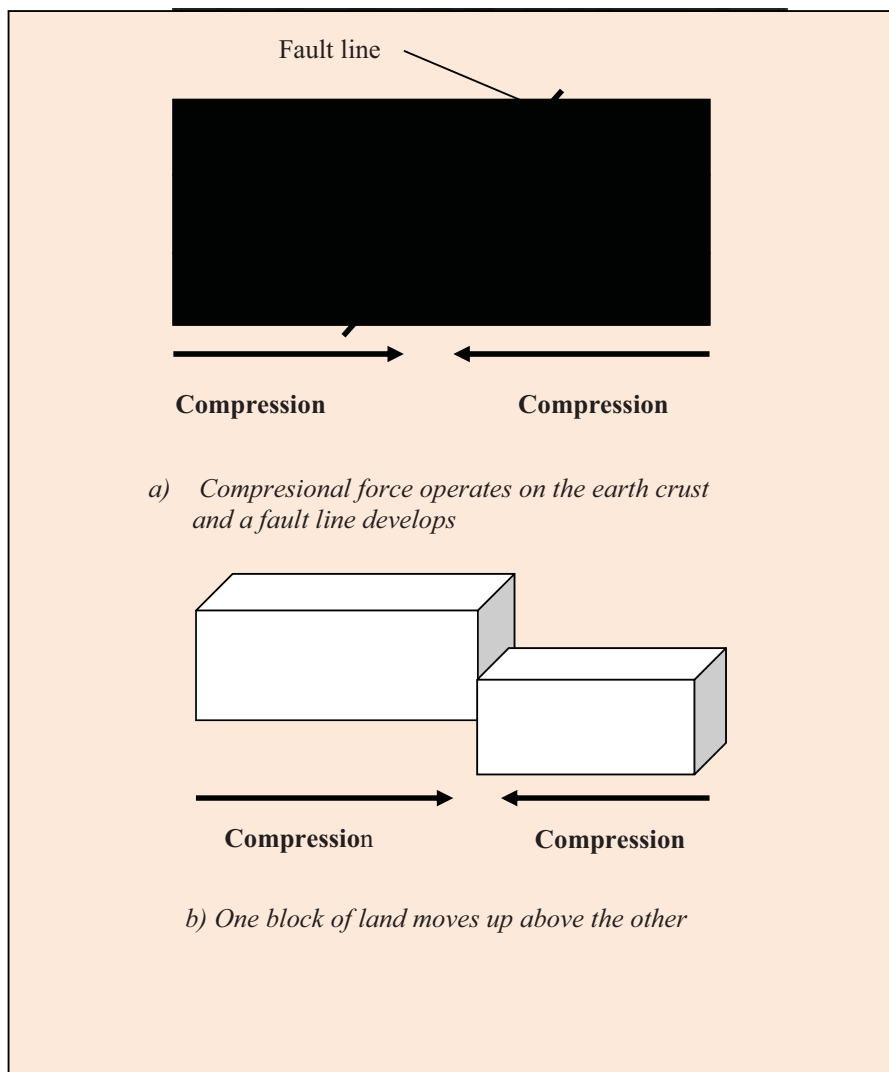


Figure 4: Reverse fault

A thrust fault, on the other hand, is a result of intense compression. A crack develops and one block of the crust is pushed up and over the other block.

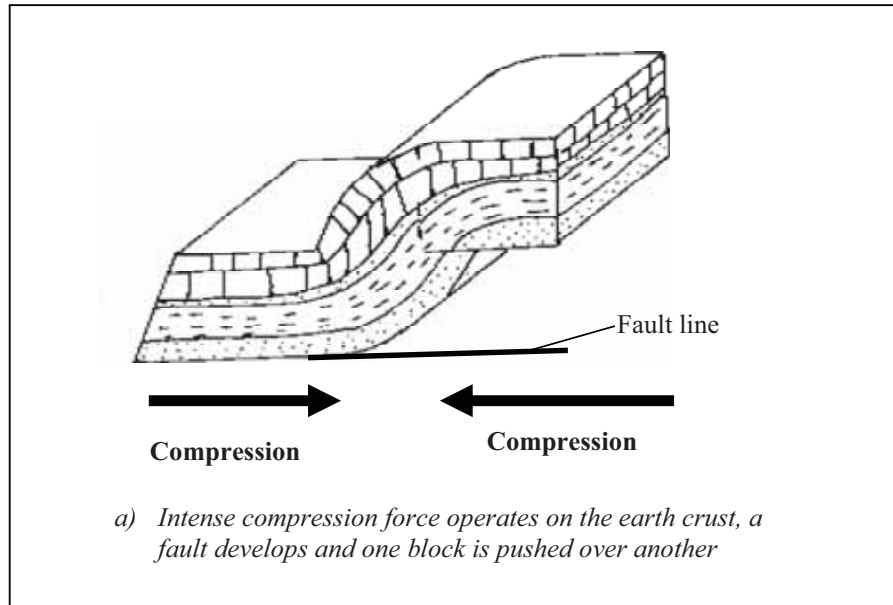


Fig 5: A thrust fault

2.4 Tear fault

A tear fault is a fault on which the two blocks slide past one another. It is caused by plates passing next to each other in opposite directions. The San Andreas Fault in California is an example of a tear fault.

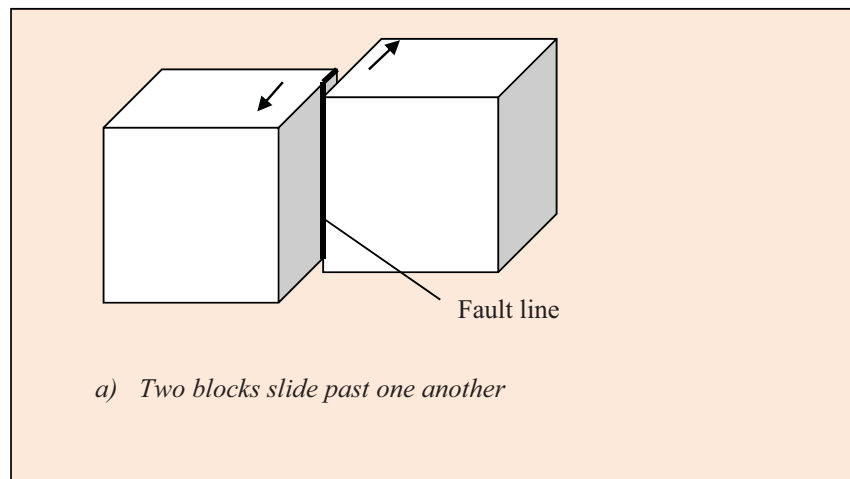


Fig 6: A tear fault

Now that you have covered both folding and faulting, I think you realize that the two concepts are related in that they both involve the movement of plates. The major difference is that with

faulting a crack develops while land folds without cracking in folding. To see how much you have learnt, attempt Activity 1 that follows.



Activity 1

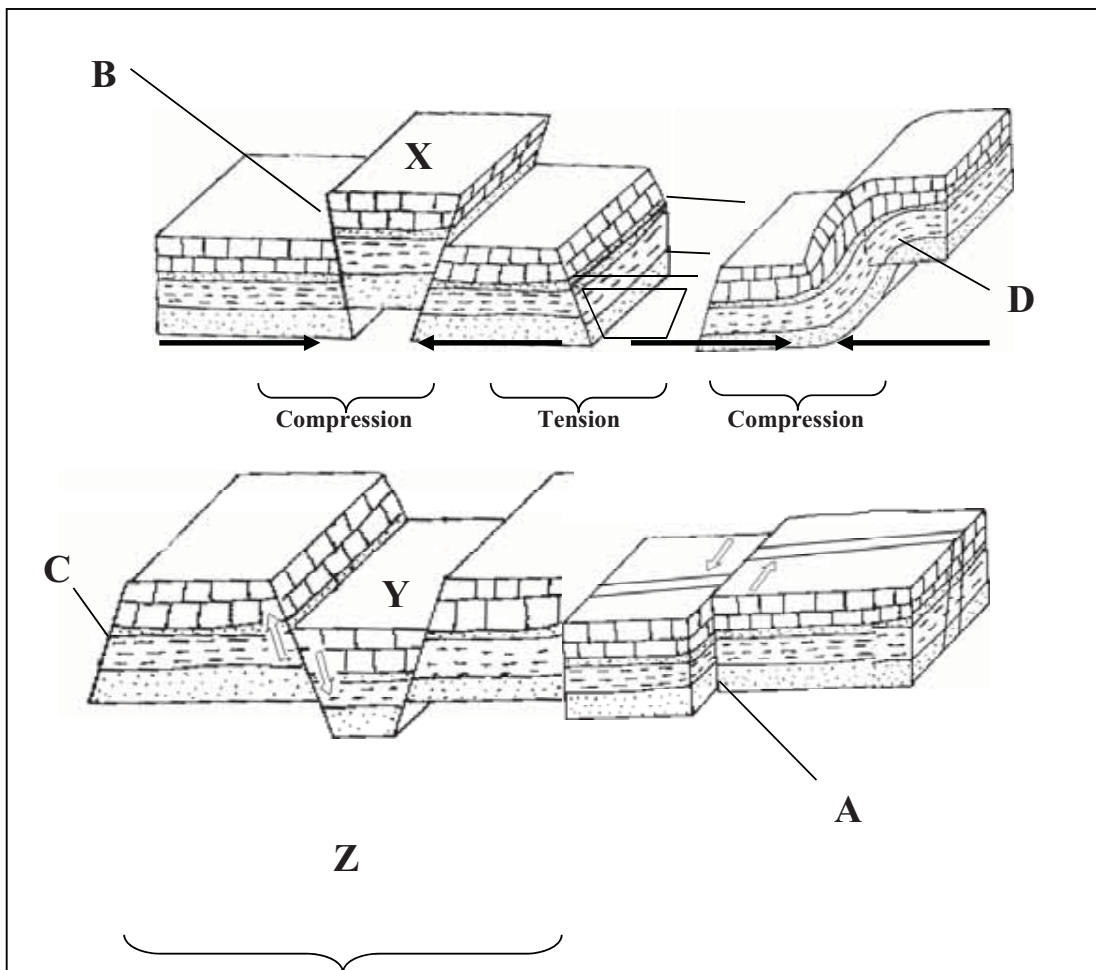


Fig 7: Different types of faults and their associated features

Study Fig 7 and answer the questions that follow

i. List the different types of faults labelled [4 marks]

A

B.....

C.....

D.....

ii. Name the features labelled [2 marks]

X.....

Y.....

iii. Name the forces at work at the place labelled [1 Mark]

Z.....

Total [7 marks]

Feedback

Below are the answers to the above exercise, study them to see whether you have answered the questions correctly

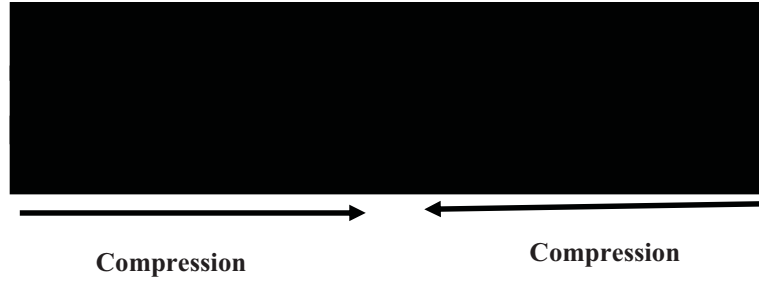
A is a Tear fault. B is a Reverse fault. C is a Normal fault and D is a Thrust fault.

X is Horst and Y Rift valley. Z Tension

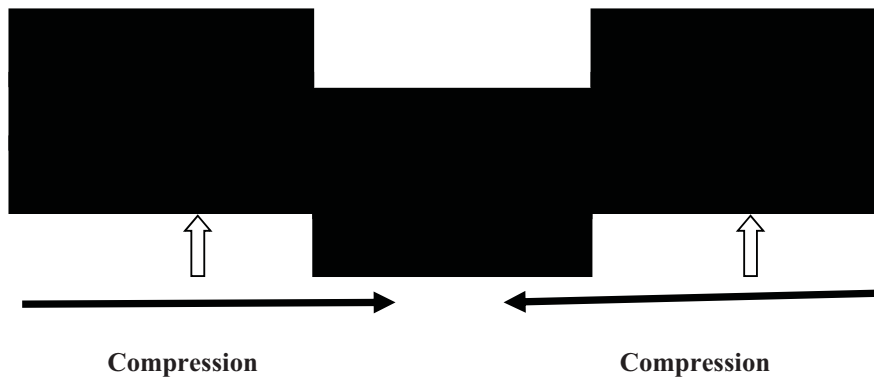
Remember we said that both folding and faulting results in the formation of physical features. Features that are formed as a result of faulting are rift valleys and block mountains.

A Rift Valley sometimes called graben is a long and deep depression that is bounded on both sides by normal faults and occurs on continents or under the oceans. Rift valleys occur in divergent plate boundaries where two plates are moving away from each other. The tensional force as can be seen in figure 8 (b) causes two faults to develop and a block of the Earth's crust between two parallel faults sinks creating a large and relatively flat bottomed valleys. The development of a rift valley in a continent is believed to be a beginning of the breakup of the continent and the development of a new ocean basin.

A. A Rift Valley Formed by Compression



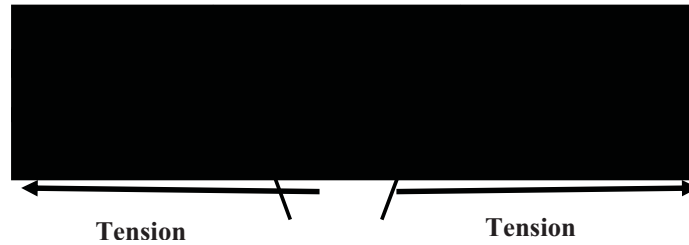
a) Compressional forces are operating on the earth crust, two parallel faults develop



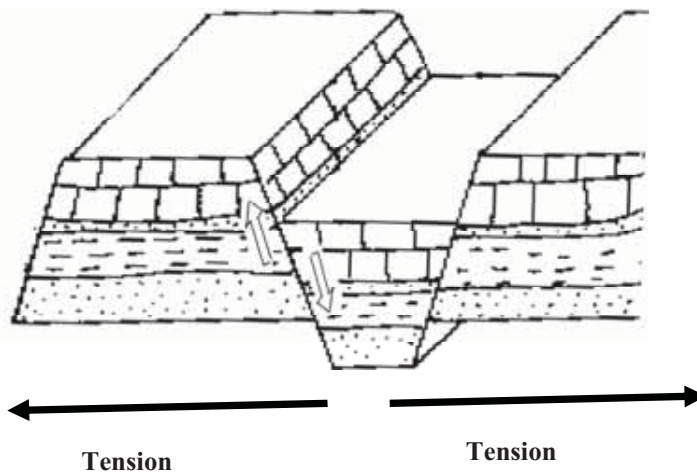
b) The outside blocks are pushed upwards above the middle block

Fig 8: A Rift Valley formed by compression

B. Rift Valley Formed by Depression



- a) Tensional forces are operating on the earth crust, two parallel faults develop

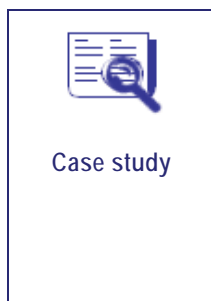


- b) The block of land between two faults sinks, leaving behind a huge depression called a rift valley

Fig 9: The formation of a rift valley by (a) compression and (b) Tension

Rift valleys are usually narrow and long, some measuring hundreds of kilometres in length. They may also be formed by compression caused by colliding plates as can be seen in figure 9 (a). Two parallel faults develop and the other blocks are raised over the middle block creating a depression. Rift valleys many contain deep lakes. The most extensive of the continental rift valleys are those of the East African Rift Valley, which extends from Syria in the Middle East to the Zambezi River in East Africa. This belt has lakes in it such as Lake Malawi, Lake Tanganyika and Lake Turkana. Other notable examples include the Baikal Rift Valley (Russia) and the Rhine Rift Valley (Germany).

Study the case study and map below to strengthen your understanding of the African rift valley system.



Case Study: The East African Rift Valley System

The East African Rift is one of the geologic wonders of the world; a place where the earth's tectonic forces are presently trying to create new plates by splitting apart old ones. In simple terms, a rift can be thought of as a fracture in the earth's surface that widens over time, or more technically, as a long basin bounded by opposed steeply dipping normal faults. The process of rifting is so well displayed in East Africa (Ethiopia-Kenya-Uganda-Tanzania) that geologists have attached a name to the new plate-to-be as the Nubian Plate, which makes up most of Africa, while the smaller plate that is pulling away has been named the Somalian Plate. These two plates are moving away from each other and also away from the Arabian plate to the north. The point where these three plates meet in the Afar region of Ethiopia forms what is called a triple-junction. However, all the rifting in East Africa is not confined to the Horn of Africa. There is a lot of rifting activity further south as well, extending into Kenya, and Tanzania and Great Lakes region of Africa.

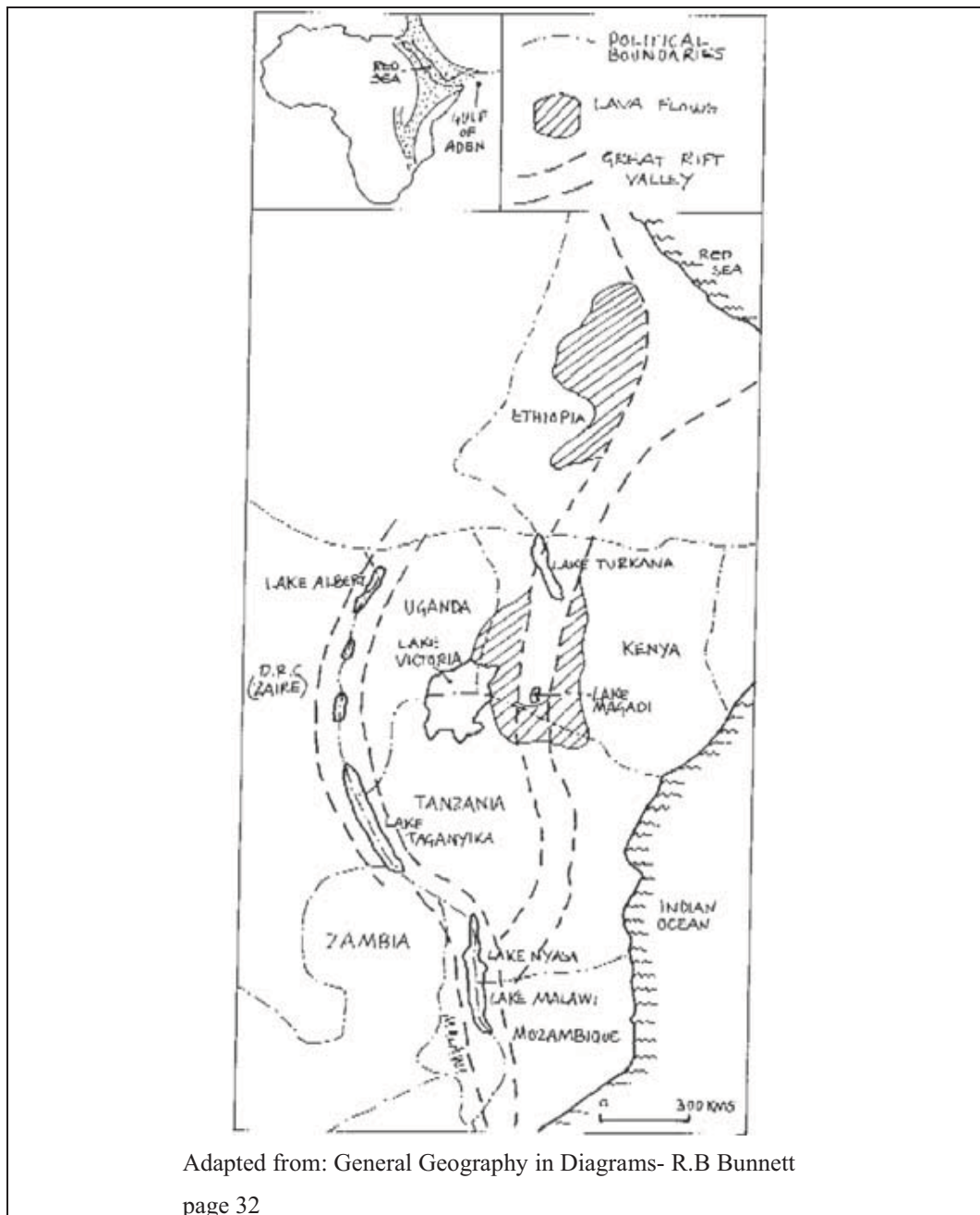


Fig 10: East African Rift Valley system

Source: Story adapted from <http://geology.com/articles/eastafrica-rift.shtml/> in August 2009

We hope that you found the earlier discussion on rift valleys and the case study of the East African Rift Valley system interesting and informative. The next section discusses Block Mountains.

Another feature caused by faulting is a block mountain. A **Block Mountain** which is sometimes called **A Horst** is a raised fault block between two normal faults. A horst is formed from either tension or compression. Tensional forces operating on the earth crust causes the development of parallel faults. The block of land between parallel faults may remain stationery

while blocks on either side sink. The middle block that is left standing becomes a block mountain. Figure 11 shows how a block mountain is formed through tension.

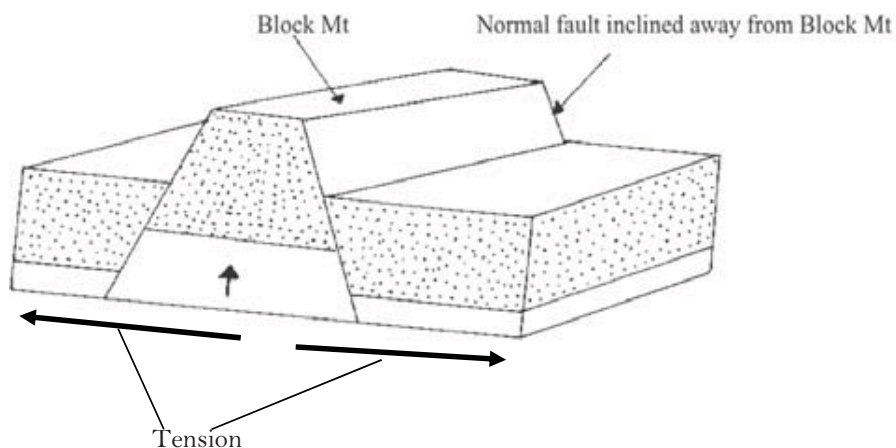


Fig 11: A Block mountain caused by tension

A block mountain may also be formed when compressional forces causes the fracturing of the crust and the upward movement or lifting of rectangular shaped block caught between two parallel faults. Figure 12 shows how a block mountain is formed through compression. Note the difference between the two types of block mountains as illustrated in figures 11 and 12.

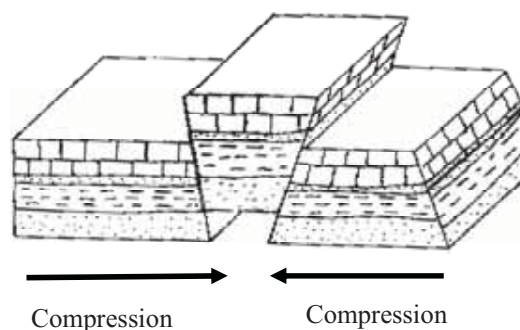


Fig 12: Block mountain caused by compression

Examples of block mountains include the Sierra Nevada Mountains in North America, the Black Forest in Germany and Mount Sinai in Egypt.

Like folding, faulting also impacts on human activities. What do you think are the effects of faulting on people? Faulting has both negative and positive impact on people. Rift valleys and block mountains are centres for tourist attraction. Rift valleys often give rise to important lakes whose water could be used for fishing, irrigation and water transport.



Summary

3.0 Summary

In this topic you learnt about the land forming processes of faulting and folding. We learnt that there are four types of folds which are simple, asymmetrical, overfold and overthrust folds. Folding results in the formation of fold mountains. Faulting on the other hand results in the formation of rift valleys and block mountains. Types of faults include normal, reverse, thrust and tear faults. Landforms caused by faulting and folding may have both negative and positive impacts on people.

You have also realised that there is a relationship between this topic and the first topic. The first topic made us aware of what is inside the earth and the movements that takes place there that cause the plates to move. In this topic we have realised how these movements of plates forms features such as fold and block mountains.

You will need to use the information you have learnt in this topic to do the second assignment at the end of the topic below. Feedback is also provided to correct you. If after checking your answers, you find that there are sections of this topic that you did not understand, review these sections. Thereafter you may proceed to Topic 3 which deals with earthquakes.

Topic 2: Folding and Faulting

1. With the aid of well labelled diagrams, describe two ways in which a rift valley may form. [6 marks]

Feedback

Your answers to the above assignment questions should be more or less similar to the following:

Topic 2

1. (a) By Tension
 - Tensional forces operate on the earth crust
 - Two parallel faults develop
 - The block of land between the faults subsides/sinks
 - A depression (rift valley) forms(b) By Compression
 - Compressional forces operate on the earth crust
 - Two parallel faults develop
 - The two outer block are uplifted above the middle block
 - A depression (rift valley) forms

(refer to Fig 9 of Topic 2 to see the diagrams for the formation of rift valleys)

Topic 3: Earthquakes

Introduction

You have already learnt about the structure of the earth, plate tectonics and the various land forms on the earth surface. In this topic you will learn about the nature of earthquakes, how they are measured and their impact on humans and the environment. You will realise that earthquakes are closely associated with the movement of plates that we have been discussing in the last two topics.

Topic Objectives

On completion of this topic you should be able to:

- explain what earthquakes are
- explain the causes of earthquakes
- describe the measurement of earthquakes
- explain the technical terms used in describing earthquakes
- list regions where earthquakes occur
- describe the impact of earthquakes on people and the environment

Topic Contents List

1.0 What is an earthquake?

2.0 Causes of earthquakes

3.0 Recording earthquakes

4.0 Distribution of earthquakes

5.0 Effects of earthquakes

1.0 What is an Earthquake?

The first question one can ask is “What is an earthquake?” We are very lucky in Botswana and Southern Africa as a whole because earthquakes are not common. The term earthquake comes from two words “earth’ and “quake”. The earth is what we learnt about in Topic 1 and the word “quake” means to vibrate or shake. So the word earthquake is used to describe the sudden vibration of the earth.

Once in a while, we may experience the slight shaking of the earth in Botswana. Unless someone tells you may not even realise it because the earthquake magnitude is very low in this part of the world. Parts of Africa that sometimes experience significant earthquakes are those in the East African Rift Valley and in West Africa. Thousands of earthquakes are recorded around the world every year. Most of them are too small to be felt and few are strong enough to cause damage. Earthquakes can be felt over large areas although they usually last less than one minute.

Earthquakes have been in the news recently and I am sure most of you have heard or read about some of them. One of the most prominent earthquakes that took place recently is the one that

struck the island of Haiti in January 2010 or the one that hit Japan in 2011. In the next section we are going to look closely at what causes earthquakes.

2.0 Causes of Earthquakes

In Topic 1 you learnt about movement of plates and plate boundaries. Earthquakes are a series of vibrations or shock waves caused by earth's movements along plate boundaries. As plates move, pressure builds up due to friction. This pressure will eventually be released along a line of weakness called a fault line. Energy released travels outward as seismic or shock waves causing the earth crust to shake up and down and from side to side. The place where the earthquake originates is called the focus. The place at the earth surface directly above the focus is called the epicentre. This is the place closest to the focus and it is here where most damage will occur. Shock waves lose their energy as they move further away from the epicentre and cause less damage. Study the diagram in figure 1. Notice the position of the focus in relation to the epicentre. See how waves radiate from the focus to the surface.

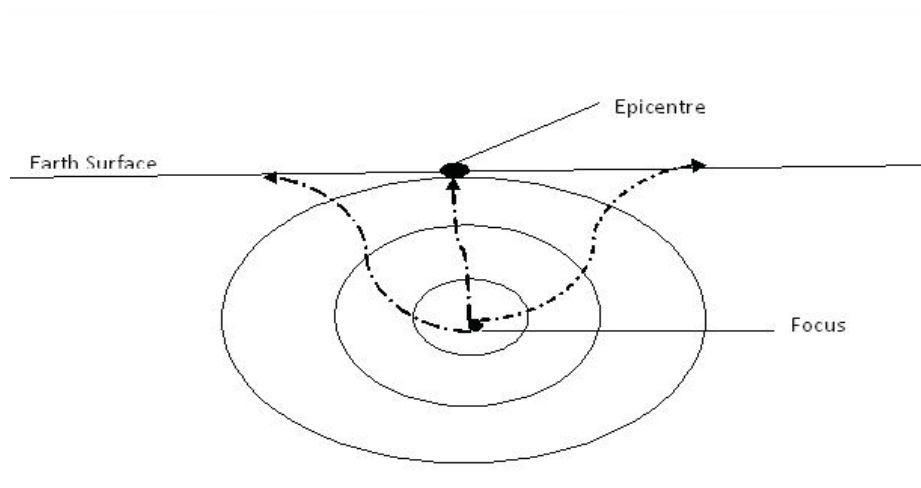


Fig 1: Origin of an earthquake

Sometimes an earthquake has *foreshocks*. These are smaller earthquakes that may happen in the same place before the larger earthquake that follows. The largest, main earthquake is called the *mainshock*. Main earthquakes are always followed by *aftershocks*, which are smaller earthquakes that occur afterwards.

You now know that earthquakes are caused by shock waves. Now let us look closely at these shock waves.

2.1 Shock/Seismic Waves

There are two types of shock waves; these are body and surface waves. Body waves travel through the interior of the earth crust and are of two types, Primary or P waves and Secondary or S waves. P waves cause the rocks to move back and forth in the direction of wave movement. S waves cause rocks to move from side to side at right angles to the direction of wave movement. P waves are faster than S waves and shake the ground first. The time between the two waves is used to locate the position of the earthquake.

Surface waves travel through surface rocks and move more slowly than body waves. They are therefore the most destructive seismic waves. There are two types of surface waves Love and

Rayleigh waves. Love waves are waves that cause surface rocks to move from side to side at right angles to the direction of wave movement. Rayleigh waves cause the surface rocks to move in a way that is similar to those of waves on a water surface.

These shock waves that are responsible for earthquakes are summarised in the table below;

Body Waves	Surface Waves
<ul style="list-style-type: none"> - Are of two types: Primary and Secondary - Travel through the interior of the earth 	<ul style="list-style-type: none"> - Are of two types: love and Rayleigh - Travel through surface rocks

In the next section we will be looking at recording earthquakes. Do you know that it is possible to measure earthquakes? It is even possible to locate where it all started. The shock waves that we have just discussed help us to do this.

3.0 Recording Earthquakes

Earthquakes are recorded by instruments called seismographs, also known as seismometers. The recording they make is called a seismogram. The seismograph as can be seen in figure 2 has a base that sets firmly in the ground, and a heavy weight that hangs free. When an earthquake causes the ground to shake, the base of the seismograph shakes too, but the hanging weight does not. Instead the spring or string that it is hanging from absorbs all the movement.

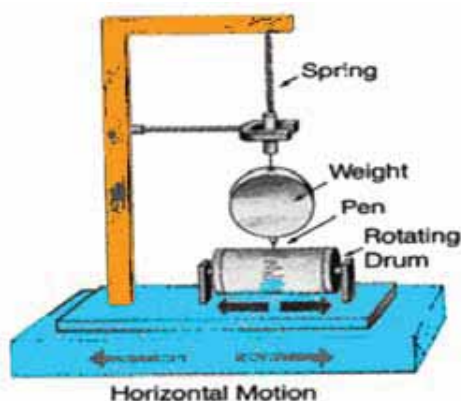


Fig 2: A Seismograph

The difference in position between the shaking part of the seismograph and the motionless part is what is recorded. A short wiggly line that doesn't wiggle very much means a small

earthquake, and a long wiggly line that wiggles a lot means a large earthquake. Figure 3 is an example of the recordings of an earthquake.

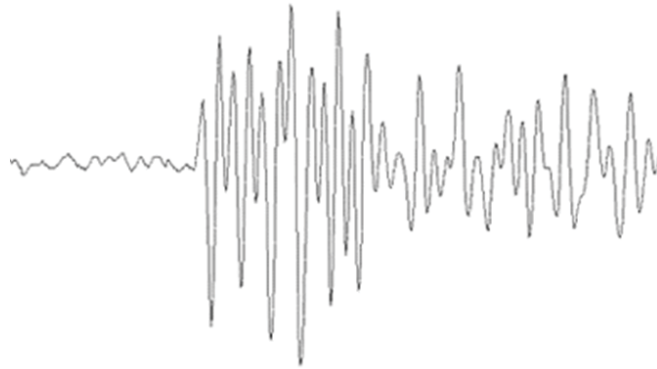


Fig 3: Recordings from a seismograph

Sensitive seismographs can detect strong earthquakes from sources anywhere in the world. The time, locations, and magnitude of an earthquake can be determined from the data recorded by seismograph stations. In the next section you will learn about the scale used for measuring the magnitude of earthquakes including the effects and frequency of the occurrence of earthquakes.

3.1 A Richter Scale

The Richter scale is the best known scale for measuring the magnitude of earthquakes. The magnitude of an earthquake is determined from the logarithm recorded by seismographs. The scale ranges from 0 to 10. Each one-point increase on the scale indicates ten times the amount of shaking and 33 times the amount of energy. For instance an earthquake at Richter scale 6 has a magnitude ten times that at scale 5. Study figure 4 that shows the magnitude, effects and frequency of earthquakes.

Richter Magnitudes	Description	Earthquake Effects	Frequency of Occurrence
Less than 2.0	Micro	Very small earthquakes which are not felt.	About 8,000 per day
2.0-2.9	Minor	Detected only by seismometers.	About 1,000 per day
3.0-3.9		Just about noticeable indoors.	About 49,000 per year

4.0-4.9	Light	Everyone notice them e.g. shaking of indoor items, no significant damage.	About 6,200 per year
5.0-5.9	Moderate	Slight damage to well-designed buildings but can cause major damage to poorly constructed buildings.	800 per year
6.0-6.9	Strong	Significant damage to buildings.	120 per year
7.0-7.9	Major	Can cause serious damage, houses may collapse.	18 per year
8.0-8.9	Great	Cause serious damage, most buildings collapse.	1 per year
9.0-9.9		Total devastation, ground seen to shake, objects thrown into the air	1 per 20 years
10.0+	Epic	Never recorded	Unknown

Fig 4: Magnitude of earthquakes

The effects will however, vary from one area to another depending on such things as the nature of the rocks and whether an area is populated or not.

With the content that you have covered so far, attempt Activity 1 and see how much you have learnt.



Activity 1

1. What are aftershocks?	[1 mark]
----- ----- -----	
2. Which waves are the first to arrive at a seismograph?	[1 mark]

3. What natural processes are triggered by earthquakes?	[2 marks]
----- ----- -----	
4. Why do some earthquakes cause more deaths than others?	[2 marks]
----- ----- -----	

Feedback

Below are the answers to the above exercise, go through them to see whether you have answered the questions correctly

1. *Small earth shakes that occur after the main earthquake*
2. *Primary or P waves*
3. *Landslides and earthquakes*
4. *Earthquakes that occur in populated areas cause more death than those taking place where there are few people*

You have already learnt that earthquakes are less common in Southern African countries like Botswana, Namibia and South Africa. In the next section you will learn of parts of the world where earthquakes are common.

4.0 Distribution of Earthquakes

You have already learnt that earthquakes are caused by movement of plates. Earthquakes are therefore common along active plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. The map in Fig 5 shows the distribution of earthquakes around the world. The well-known belt of earthquakes and volcanoes is the area around the Pacific Ocean popularly known as the Pacific Ring of Fire. On the map in figure 5, this area stretches from the west coasts of North and South America to

the east coasts of Asia and Australia. In Africa earthquakes are common in East and North Africa.

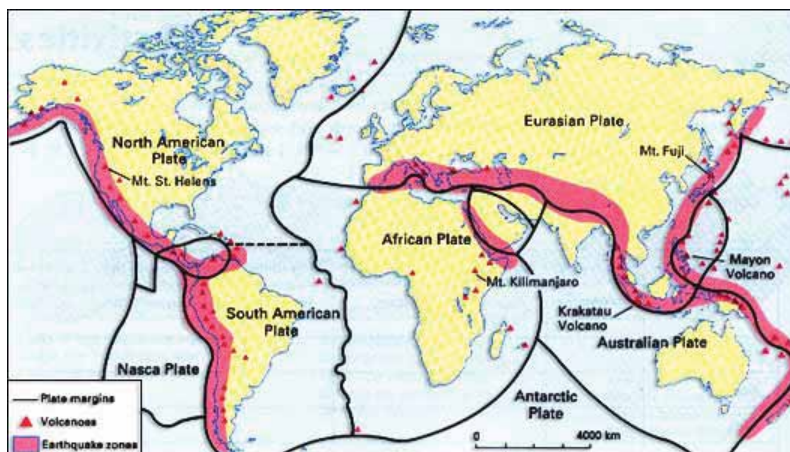


Fig 5: Distribution of earthquakes

Read through the case study that follows, it will give you an idea on the nature of earthquakes and their effects on people.



Case Study - Kobe Earthquake 1995

Kobe is a large city in central Japan. On Tuesday January 17 1995, at 5:46 local time, it fell victim to a devastating earthquake that measured 6.8 on the Richter scale. Japan lies on a fault 200km to the North of the trench where the Philippine and Pacific Plates subduct beneath the Eurasian Plate.

The epicentre of the earthquake lied beneath the island of Awajishima, 20km off the coast. The earthquake lasted for less than a minute, but the devastation covered an area of up to 100km around the city. Effects were also felt in Osaka and Kyoto. Buildings, roads and rail lines collapsed. Most of the destruction was caused by liquefaction of the ground. Over 5500 people were killed and many more suffered injuries. A quarter of a million lost their homes. Gas mains leaks caused fires across the city. After the initial quake came hundreds of smaller aftershocks, furthering the devastation and destruction. The damage was estimated to be in the region of \$96 billion.



Despite all the advanced technology and scientific research in Japan, the Kobe earthquake showed that structures such as motorways were not safe. Geophysicists did not know that an earthquake was imminent, despite the government spending over £600 million on earthquake research in the last thirty years.

Source:<http://www.mattmayer.com/essays/kobe95.htm><http://www.mattmayer.com/essays/kobe95.htm> - retrieved 12/05/10

From the case study you can realize that it is not surprising that Japan was hit by an earthquake as it is located near a destructive plate boundary. Refer to Topic 2 for more information on destructive plate boundaries. You may also realize that scientist were able to measure the exact location and time as well as the magnitude of this earthquake. Earlier on we talked about the aftershocks. Notice here how these aftershocks were at work in Kobe. The earthquake obviously caused a lot of destruction in terms of human life and property.

In the next section we will look closely at the effects of earthquakes.

5.0 Effects of earthquakes

The case study you just read about shows that earthquakes may be a serious threat to people. This section will focus on the effects of earthquakes on people's lives. It is important to note that the Richter Scale is not used to express damage. An earthquake in a densely populated area may cause many deaths and considerable damage but another earthquake of the same magnitude in a remote area or beneath the oceans may not even be felt by humans. Scientists use a different Mercalli Intensity Scale to measure the effects of an earthquake.

Primary effects of earthquakes are hazards that happen immediately as an earthquake strikes. Buildings that cannot withstand the earthquake collapse killing people. Falling objects like glass are also a hazard to people. Sometimes the land becomes liquefied and buildings sink. Earthquakes can cause landslides, open deep cracks on the surface, raise or lower the land. Figure 6 shows some of the earthquakes and their effects.

Year	Country	People killed
1993	Killari (India)	30 000
1999	Imit (Turkey)	15 000
2008	Sichuan (China)	12 000
2009	Italy	150
2010	Haiti	230 000

Fig 6: Some earthquakes and their effects

Secondary effects are hazards that happen hours or days after an earthquake. These include tsunamis or waves up to 30 meters high and travelling at speed of up to 500 km/h that occur at sea. Diseases like cholera may occur if water supply is cut off. Communication becomes a problem due to blocked roads and railways, fallen cables and communication lines. Fire outbreaks are some of the most devastating secondary effects.

Read through the caption that follows, it will give you more information on what a tsunami is. Remember that we said tsunamis are some of the effects of earthquakes.

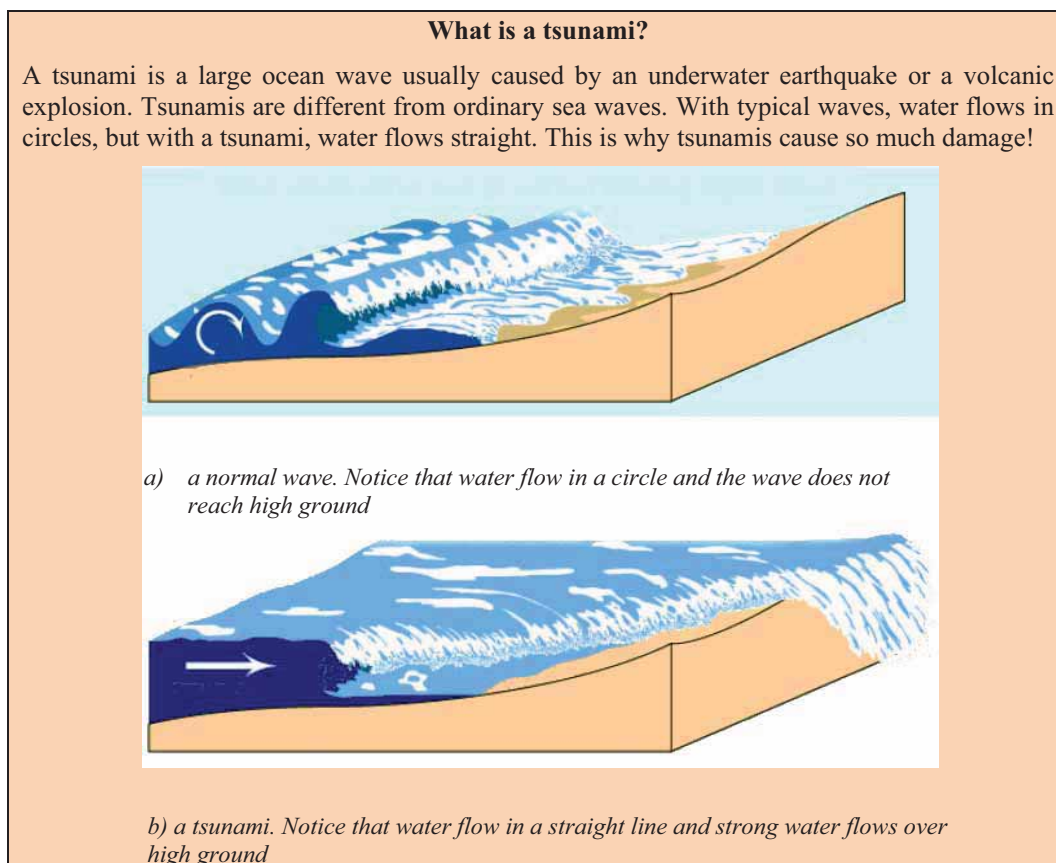


Fig 7 (a) A normal wind wave and (b) Tsunami

Source: <http://pdfresh.com/wp-content/uploads/2011/03/circle-and-straight-tsunami-flows-image.gif> - Retrieved:05/06/10

You know about the destructive effects of earthquakes, but how can we reduce some of the damage caused by earthquakes. This will be our focus in this last section of the topic.

5.1 Reducing Damage Caused by earthquakes

By now you have realised that earthquakes are a threat to people and have actually killed a lot of people in the past. What do you think could be done to stop this? If earthquakes could be predicted, a lot of lives could be saved. Scientist can tell that an earthquake in a particular area will happen in the future but they have no way of telling when it will happen. However, the following are some measures that can be taken to reduce damage caused by earthquakes

- Wooden houses are less likely to collapse because they are flexible. However, they can burn out in the event of a fire break out.
- Bricks are not good building materials in earthquake prone areas; concrete reinforced with steel bars should be used instead.
- Build houses on sites with hard rocks that can resist shock waves instead of building on soft rocks.
- Quick emergency rescue services help reduce further loss of life

Read through the textbox that follows, it will give you safety tips on what an individual can do during an earthquake.

Safety Tips

Before an earthquake choose a safe place in a room. During the earthquake drop under a strong piece of furniture like a table where nothing can fall on you and hold on. Protect your eyes by pressing your face against your arm. Stay indoors until the shaking stops. If you are outdoors, find a clear spot away from buildings, trees and power lines. Then, drop to the ground. If you're in a car, slow down and drive to a safe place. Stay in the car until the shaking stops. After the earthquake, check for injuries. Turn off leaking gases to avoid fire hazard.

We have come to the end of the topic. Read the summary below to remind you of what we discussed in the topic.



Summary

6.0 Summary

In this topic you learnt about earthquakes, which we said are the sudden vibrations of the earth crust. Earthquakes are common along active plate boundaries where pressure build by plate movements escapes as shock waves to the surface. There are two types of shock waves, body and surface waves. Body waves are divided into Primary and Secondary waves whilst surface waves are divided into Love and Rayleigh waves. A seismograph is used to record earthquakes but a Richter scale is used to measure their magnitudes. Earthquakes and their associated natural processes may cause loss of life and damage to property.

You will need to use the information you have learnt in this topic to do the assignment at the end of the topic below. Feedback is also provided to guide you.

The distribution of earthquakes is closely linked to the distribution of volcanic activity. In the next topic we are going to look closely at the topic volcanicity.

Topic 3: Earthquakes

1. Describe five major effects of earthquakes on humans. [5 marks]

Feedback

Your answers to the above assignment questions should be more or less similar to the following:

Topic 3

1. Effects of earthquakes
 - They kill people
 - Destroy property including communication infrastructure
 - Cause tsunamis which endanger shipping and coastal areas
 - Cause landslides which endanger lives and property
 - Cause fires
 - Cause diseases
 - Impoverish countries

I hope you have a good understanding of earthquakes now. Before we move into the next section, take a moment to think about the following questions:

1. Suggest long-term solutions to any two problems caused by earthquakes.
2. With the amount of technology today, do you think it is possible to predict a large earthquake? Think about what you have learned about earthquakes and explain with evidence and research if this is possible or not.

Once you have an answer, discuss this with peers and with your tutor or teacher.

Topic 4: Volcanicity

Introduction

This topic comes immediately after the topic on “Earthquakes” for good reasons. The main reason is that the two activities occur in the same regions and are both caused by the earth’s movements. Thus as you proceed with this topic you will need to study world maps which show major earthquake and volcanic belts and also refer to the plate boundary map in Topic 1. The maps will clearly show you that plate boundaries are the same regions of earthquakes and volcanic activity.

Topic Objectives

By the end of this lesson, you should be able to:

- Locate world volcanic belts on a world map
- Explain the causes of volcanicity
- Explain formation of intrusive and extrusive features and list the features which fall under each type
- Explain the difference between acid and basic lava and the volcanoes they form
- List and explain the different types of volcanoes/cones
- Explain and illustrate the three stages in the life cycle of a volcano
- List and explain the positive and negative effects of volcanicity on people and their environment.

Topic Contents List

- 1.0 What is volcanicity?
- 2.0 Distribution of volcanoes
- 3.0 Volcanic features
- 4.0 Types of volcanoes
- 5.0 Effects of volcanoes

1.0 What is Volcanicity?

You probably have heard or read about volcanoes in radios, television or newspapers. Volcanic eruptions are some of the most amazing occurrences on earth. They have also been responsible for the greatest disasters in the world destroying towns and killing millions of people. Fortunately, the Southern African region is just as safe from volcanoes as it is from earthquakes.

A volcano is a cone shaped mountain that is formed when molten rock called magma forces its way to the earth surface where it cools and solidifies. The term volcanicity refers to the various ways in which molten rocks and gases force their way to the earth crust.

Like earthquakes, volcanoes are caused by the movement of plates. They occur along destructive plate boundaries where two plates meet and one plate is forced below the other into the hot mantle where it melts into magma. As pressure builds up, this magma forces its way

through a line of weakness in the earth crust and rises to the surface to form volcanoes. Volcanoes also occur at constructive plate boundaries where two plates move apart and magma from the mantle come in to fill the gap. This process occurs in ocean floors and is responsible for the formation of mid oceanic ridges.

Read through the case study that follows, it will give you an idea of the nature and effects of volcanic eruptions.



Case study

Case Study: Krakatau 1883

Early in the morning of May 20, 1883, the captain of the German warship *Elizabeth* reported seeing about 11 km high cloud of ash and dust rising above the uninhabited island of Krakatau, thus documenting the first eruption from this Indonesian island in at least two centuries. Over the ensuing two months, crews on commercial vessels and sightseers on chartered ships would experience similar spectacles, all of which were associated with explosive noises and churning clouds of black to incandescent ash. From a distance, the largest of these natural fanfares impressed the local inhabitants on the coastal plains of Java and Sumatra, creating a near-festive environment. Little did they realize, however, that these awe-inspiring displays were only a prelude to one of the largest eruptions in historic times. A series of dreadful eruptions began at mid-day on August 26, and ended on August 27 with a huge deafening explosion. On this day, the northern two-thirds of the island collapsed beneath the sea, generating a series of devastating pyroclastic flows that rose to a height of 36km into the atmosphere. The explosion produced immense tsunamis up to 40 metres high that ravaged adjacent island and coastal areas of western Sumatra and Java killing over 36,000 people and destroying hundreds of coastal villages and towns.



Source: (story adapted from

http://www.geology.sdsu.edu/how_volcanoes_work/Krakatau.html) retrieved 15/06/10

From the case study of Krakatau, you can now appreciate the destructive power of volcanic eruptions and why they are said to be amazing occurrences. To locate the position of Krakatau study the map on figure 1(a) in the section below on the distribution of volcanoes. Note that this volcano is on a plate boundary.

2.0 Distribution of Volcanoes

As indicated earlier, volcanoes are caused by plate movements and therefore occur near plate boundaries. If you look carefully at the world map showing the distribution of earthquakes and another showing the distribution of volcanoes you will notice that the two tend to concentrate in plate boundaries. The area most prone to volcanic eruptions is the Pacific Ring of Fire, around the Pacific Ocean including countries such as Indonesia, Japan and New Zealand. Two-third of the world's active volcanoes are found in this region. Study the map in figure 1(a) showing the distribution of volcanoes. Notice that countries in southern Africa are relatively free from volcanic activity.

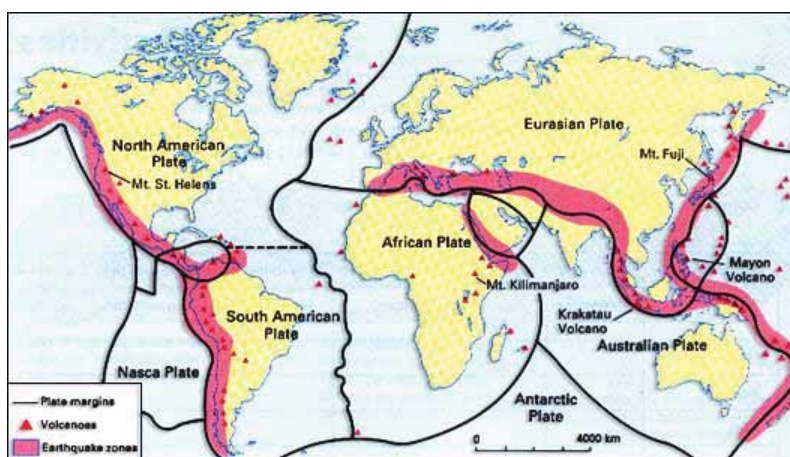


Fig 1(a): Distribution of volcanoes

Figure 1(b) shows the distribution of volcanoes in the Pacific Ocean forming an area commonly known as the Ring of Fire (see fig 1 (b)). This area is characterised by a large number volcanoes and many occurrences of earthquakes. There are about 452 volcanoes in the Ring of Fire and 75% of these are still active and the rest are dormant. If you look at the map again, you will note that the ring of fire occurs along plate boundaries characterised by trenches. This clearly shows that this belt is a result of plate movements. Can you identify plates involved in the formation of this belt? I hope you were able to identify the Nazca plate, Cocos plate, Caribbean plate, South American Plate and the Pacific plate. Trenches are formed where plates are subducted.

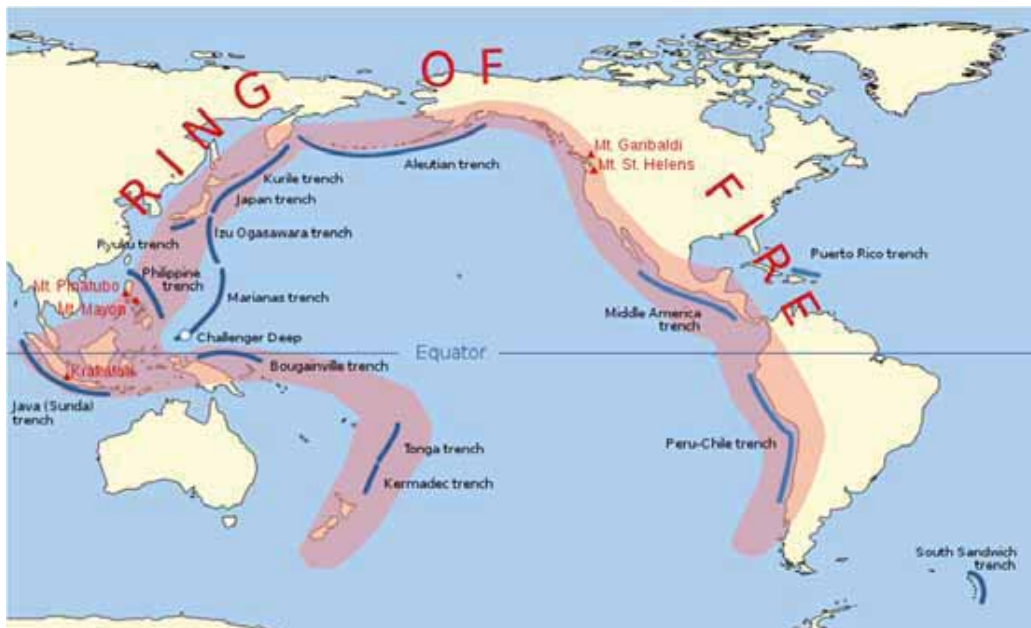


Fig 1(b): The ring of fire

http://upload.wikimedia.org/wikipedia/commons/5/52/Pacific_Ring_of_Fire.svg

Retrieved: 16/07/11

Now that you know what we mean by volcanicity and the distribution of volcanoes, we will in the section that follows discuss volcanic features. After this section, we will discuss types of volcanoes.

3.0 Volcanic Features

We have already said that volcanic activity may result in the formation of physical features. We are now going to look closely at the internal and external features formed from volcanic eruptions.

3.1 Internal Volcanic Features

Internal volcanic features are formed when magma from the mantle cools and solidifies within the earth crust. Examples of these features are batholiths, laccoliths, sills and dykes. A **batholith** is a large mass of solidified magma that is made of granite. A **laccolith** is a mushroom like feature formed from magma ejected into the crust by a pipe-like channel. A **sill** is formed from magma that is released along layers of rocks while a **dyke** is formed by magma cutting across layers of rocks creating a wall like feature.

All of these features may be exposed to the surface if the overlying rocks are removed by erosion. Now that you have learnt about internal features, let us now move on to external features.

3.2 External Volcanic Features

External volcanic features are formed when volcanic eruption causes magma to rise to the earth surface. Magma may reach the surface through a pipe like hole called a vent or through a small crack called a fissure. Vent eruption forms a volcano while fissure eruption builds a gentle sloping lava flow. When the magma reaches the surface it is called lava. There are two types of lava: fluid and viscous lava.

Fluid lava which is sometimes called basic lava is very hot, fluid and comes out quietly. The lava flows easily and can run for several kilometres before it cools. It results in the formation of gently sloping volcanic cones. Viscous lava which is sometimes called acid lava on the other hand is thick and sticky. It flows slowly and does not travel far before it solidifies. It forms steep sided cones and usually causes violent eruptions.

Now that you have learnt a bit about volcanicity, let us try the next activity and see how much you understood what you have covered so far.



Activity 1

1. Define the following terms: [3 marks]
 - (a) Volcanicity
 - (b) Extrusive features
 - (c) Intrusive features
2. Name two examples of each of the following; [4 marks]
 - (a) Extrusive features
 - (b) Intrusive features
3. Explain what is meant by: [3 marks]
 - (a) Vent eruption
 - (b) Fissure eruption
 - (c) Magma

Total [10 marks]

Feedback

Your responses to the above exercise should be something like the following:

1. (a) *Volcanicity is the movement of molten rocks and gases from the mantle into the crust and to the surface of the crust.*
(b) *Extrusive features are volcanic features that form on the surface of the crust*
(c) *Intrusive features are volcanic landforms that form inside the crust*

2. (a) *Extrusive - volcano, lava plateau, geyser, hot spring, caldera*
(b) *Intrusive - sill, dyke, batholiths, laccolith*

3. (a) *Vent eruption means that magma or molten rocks are ejected to the surface via a vent*
(b) *Fissure eruption means that magma or molten rocks reach the surface via small cracks in the crust*
(c) *Magma is a name given to molten rock when it is still inside the mantle*

4.0 Types of Volcanoes

We have already said that a volcano is an example of an external volcanic feature. However, there are several types of volcanoes. They are classified into different groups based on their shape, the material they are made of and the way they erupt. There are basically three types of volcanic cones: the cinder cones, the lava cones and composite cones.

4.1 Cinder Cones:

Cinder cones are the simplest and easily recognizable type of volcano. As their name suggest, these volcanoes consist almost entirely of loose, grainy cinders and almost no lava. They were formed by a violent eruption when a gas charged lava was ejected and blown into the air. The lava then breaks into small fragments that solidify and fall as cinders around a single vent to form a circular or oval cone as illustrated in figure 2. Most cinder cones have a bowl-shaped crater at the summit and rarely rise more than a thousand feet or so above their surroundings. Parícutin in Mexico is a good example of a cinder cone.



Fig 2: Cinder cone

Source: http://commons.wikimedia.org/wiki/File:Paricutin_30_612.jpg

Retrieved: 16/07/11

Lava Cones

The second types of volcanoes are those that consist entirely of solidified lava. Lava cones can be divided into three groups, namely shield volcanoes, lava plateaus and lava dome. Shield volcanoes as can be seen in figure 4 are formed from the quiet eruption of basic or fluid lava. The lava pours out in all direction from a central vent or a group of vents and flows a great distance before it cools and solidifies to build a broad, gently sloping cone that appear more like a warrior's shield. A good example of a shield volcano is Mauna Loa in Hawaii which spreads a distance of over 100 kilometres.



Fig 3: Lava cone or shield volcano

Source: http://en.wikipedia.org/wiki/File:Aa_channel_flow_from_Mauna_Loa.jpg

Retrieved: 16/07/11

Sometimes fluid lava erupts quietly through long fissures instead of central vents and floods the surrounding countryside with lava. Repeated fissure eruptions result in lava layers piling on top of each other leading to the formation of broad lava **plateaus**. Examples of lava plateaus are the Columbian Snake plateau in the USA and the Deccan plateau in India each covering an area of over 500 000 km².

Viscous lava gives rise to steep sloping volcanic cones. A **Lava Dome** is formed by relatively small masses of lava which is too viscous to flow any great distance. The lava then piles over and around its vent. A dome grows largely by expansion from within. As it grows its outer surface cools and hardens. Some domes form spines or plugs over the volcanic vent. Volcanic domes commonly occur within the craters or on the flanks of large composite volcanoes. A dome in Mount St Helena and Mont Pelée 1903, in Martinique are good examples of lava domes. Figure 4 below is another good example of a lava dome – see the roughly mound-shaped protrusion on top of the volcano.



Fig 4: A lava dome of Chaitén – Chile

Source: http://en.wikipedia.org/wiki/File:Volcán_Chaitén-Sam_Beebe-Ecotrust.jpg

Retrieved: 16/07/11

4.2 Composite Cones

Composite cones are some of the most impressive volcanic mountains. They are large steep-sided mountains built of alternating layers of lava flows and small rock fragments like ash, cinders and bombs. They occur at destructive plate boundaries where lava produced is thick and sticky. A violent eruption ejects ash into the atmosphere. When violence ceases and the ash settle near the vent, thick lava is released forming a layer on top of the ash. Repeated eruption

results in different layers of ash and lava. Most composite volcanoes have a crater at the summit which contains a central vent. Sometimes lava escapes from the sides of a cone to form a small conelet. Examples of composite volcanoes include Mount Fuji in Japan, Mount Kilimanjaro in Tanzania, Mount Mayon in the Philippines and Mount Vesuvius in Italy. Figure 5(a) shows clearly how a composite cone is formed. Figure 5(b) is a picture of a composite volcano.

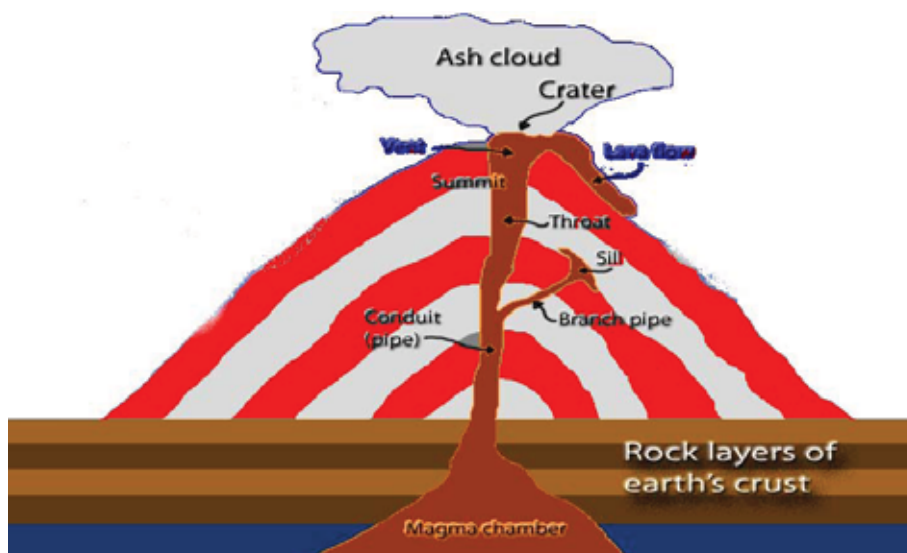


Fig 5(a): A composite cone formation



Fig 5(b): A composite cone – Mount Fuji in Japan

Source: <http://en.wikipedia.org/wiki/File:FujiSunriseKawaguchiko2025WP.jpg>

Retrieved: 16/07/11

Sometimes a caldera is formed on a composite cone. A caldera is an enlarged crater that is formed when a violent volcanic explosion blows away the upper part of a volcano resulting in the formation of a huge basin like depression on a mountain. It may also result from the sinking of the top part of the cone after a violent eruption. Rain water may collect inside the caldera thus forming a caldera lake. Examples of calderas and caldera lakes include Mount Meru and Ngorongoro Crater lake in Tanzania, Lake Toba in Indonesia and Crater Lake in USA.



Fig 6: A Crater lake

http://upload.wikimedia.org/wikipedia/commons/8/89/Nyos_Lake.jpg - Retrieved 11/06/11

Now that you have learnt about the various types of volcanic features, you need to pause a little and once again look at another case study of a volcanic eruption of Mount Pelee in 1903.



Case Study: Mount Pelee

At about 7:50 a.m. on May 8, 1902 the volcano erupted with a deafening roar. A large black cloud composed of superheated gas, ash and rock rolled headlong down the south flank of Mt. Pelée at more than 100 miles per hour, its path directed by the V-shaped notch at the summit. In less than one minute it struck St. Pierre with hurricane force. The blast was powerful enough to carry a three-ton statue sixteen meters from its mount. One-meter-thick masonry walls were blown into rubble and support girders were mangled into twisted strands of metal. The searing heat of the cloud ignited huge fires. Thousands of barrels of rum stored in the city's warehouses exploded, sending rivers of the flaming liquid through the streets and into the sea. The cloud continued to advance over the harbour where it destroyed at least twenty ships anchored offshore. The hurricane force of the blast capsized the steamship *Grappler*, and its scorching heat set ablaze the American sailing ship *Roraima*, killing most of her passengers and crew. The *Roraima* had the misfortune of arriving only a few hours before the eruption. Those on board could only watch in horror as the cloud descended on them after annihilating the city of St. Pierre. Of about 29,000 people in St. Pierre, there were only two known survivors.

Source: (adapted from : http://www.geology.sdsu.edu/how_volcanoes_work/Pelee.html)

Retrieved: 16/06/10

The case study you have just gone through serves as a good introduction to the next section on effects of volcanoes because it elaborates quite clearly what volcanoes can do to people.

5.0 Effects of Volcanoes

From what you have learned, you realise that volcanoes can have serious impacts not only on people but also on the environment. However, these effects can be both good and bad. A volcanic eruption may cause great damage to property and produce burning ash and gases that kill people. Do you know any example of a volcanic eruption that caused extensive damage? You may still remember the April 2010 eruptions of Eyjafjallajökull in Iceland. Figure 8 (a) below shows the first eruptions of the volcano as it released huge amounts of ash into the atmosphere. The eruptions continued for a period of six days emitting large tonnes of both carbon dioxide and ash.



Fig 8 (a): Eruptions of Eyjafjallajökull in Iceland

http://en.wikipedia.org/wiki/File:Eyjafjallajokull_volcano_plume_2010_04_18.JPG

Retrieved 20/07/11

These eruptions affected farming and about 500 farmers were evacuated. The April 2010 eruptions of Eyjafjallajökull in Iceland also caused huge disruptions to air travel across Europe (see fig 8 (b)). The red dot shows the position of the volcano and the black area is the actual area that was covered by both ash and carbon dioxide from the volcano. Ash clouds from the eruptions of Eyjafjallajökull in Iceland led to the closure of the European airspace for several weeks.

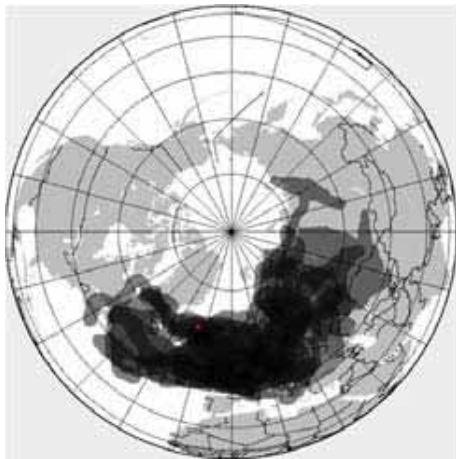


Fig 8 (b): Area covered by both ash and carbon dioxide from the volcano.

http://en.wikipedia.org/wiki/File:Eyjafjallajökull_volcanic_ash_composite.png

Retrieved 20/07/11

Volcanoes may trigger natural processes such as tsunamis, landslides, mudflows and avalanches which may cause further loss of lives and destruction to property. A landslide is when a mass of land or soil breaks loose and slides down the slope. A mudflow occurs when rainfall or melted ice mix with volcanic ash to form rivers of mud. An avalanche is when a mass of snow breaks loose and slide down the slope destroying everything in its path. The ancient city of Pompeii in Italy and St Pierre are examples of cities that together with their people were wiped out by volcanoes. If you look closely at figure 9, you will have a good idea of the destructive effects of volcanoes.

Year	Volcano	Deaths	Cause of death
1883	Krakatau	36 000	Tsunami
1902	Mt Pelee	29 000	Pyroclastic flow
1985	Ruiz	25 000	Mudflow
1991	Pinatubo	800	Collapse of houses & diseases

Fig 9: Effects of volcanoes

Destructive as they may be, volcanoes also have positive effects. For instance, in volcanic areas, underground water may come into contact with hot rocks. Water gets heated up and the pressure that builds up force it to the surface as gently flowing water called a hot spring or as a jet of steam and boiling water called a geyser. Hot water from geysers and hot springs can be supplied to people's homes. It can also be used to produce geothermal energy by using steam to power turbines and produce cheap electricity that does not pollute the environment.

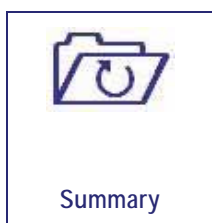
Volcanic features form spectacular landscapes such craters and geysers that are good tourist attractions. Volcanic lava often contains valuable minerals such as gold, diamonds, zinc, copper

and tin. One of the reasons people continue to live around dangerous volcanoes is that the ash and lava weather to produce fertile soils that are good for farming.

The question that may be uppermost in your mind after reading about the negative effects of volcanoes may be is it possible to predict volcanoes. This is the question we will address next in the last section of the topic.

5.1 Predicting Volcanoes

It is hard to predict volcanoes. However, unlike earthquakes, volcanoes usually give warning signs before they erupt such as release of poisonous gases like sulphur dioxide, a series of small earthquakes and swelling of sides of volcanoes. Lives will be saved if people heed the warning signs. Vibrant emergency services are needed in volcanic areas to evacuate people. People can also avoid hazardous areas of active volcanoes.



6.0 Summary

In this topic you learnt that volcanicity refers to the various ways in which molten rocks and gases from the mantle escape to the earth's surface. Molten magma results in the formation of intrusive volcanic landforms such as sills, dykes, batholiths and laccoliths. It also results in the formation of extrusive volcanic features such as ash and cinder cones, lava cones and composite cones. Other volcanic features include calderas, geysers and hot springs. Volcanic activity is common along active plate boundaries.

We have also realised that volcanoes can be both helpful and harmful to people. You will need to use the information you have learnt in this topic to do the assignment at the end of this topic below. Feedback is also provided to direct you.

Topic 4: Volcanicity

1. With the aid of diagram/diagrams, describe how a volcano may have been formed.
[6 marks]

Feedback

Your answers to the above assignment questions should be more or less similar to the following:

Topic 4

1. Formation of volcano
 - Plate movements cause collision of plates
 - Cracks/faults develop in the crust
 - Magma escapes through cracks or vent to the surface

Magma collects and solidifies to form a volcano

Just to recap what you have learned quickly try the following activity below:

1. The picture below shows 3 types of volcanic eruptions



Figure 2 – Volcanic eruptions Source: http://en.wikipedia.org/wiki/File:Lava_forms.jpg

Retrieved 27/01/12

- (i) Describe the types of volcanic eruptions as shown in figure 2
- (ii) Explain and illustrate the three stages in the life cycle of a volcano

Once you have your answer, discuss them with your peers and your instructor or tutor.

Unit summary



In this unit you were introduced you to the structure of the earth where you learned about the various layers that make the earth. These layers are the crust, the mantle and the core. We also discussed in detail plate movements and the various types of plate boundaries. Land forming processes of faulting, folding and volcanicity were discussed in detail highlighting the forces behind those processes, the resultant landforms, their distribution and effect on people. We also discussed earthquakes where we looked into their causes, distribution, effects on people and how they are measured.

The unit assessment is provided at the end of this unit. You are strongly encouraged to do this activity after completing the topic assignment as it will help you to better understand the unit. You are free to consult various books before compiling answers.

Assessment



Assessment

You need to make time and attempt all these questions. This will help you to understand the unit very well and will also help to prepare you for examinations.

1. Name the forces within the crust which cause plates to move? [2 marks]
2. Name **two** landforms caused by plate movements. [2 marks]
3. Name **three** types of plate boundaries. [3 marks]
4. Why are they given the names in question 3? [3 marks]
5. List the **four** major types of folds. [4 marks]
6. With the aid of a well labelled diagram describe how a fold mountain is formed. [5 marks]
7. Study the world map in Fig 9 and answer questions (a) and (b)

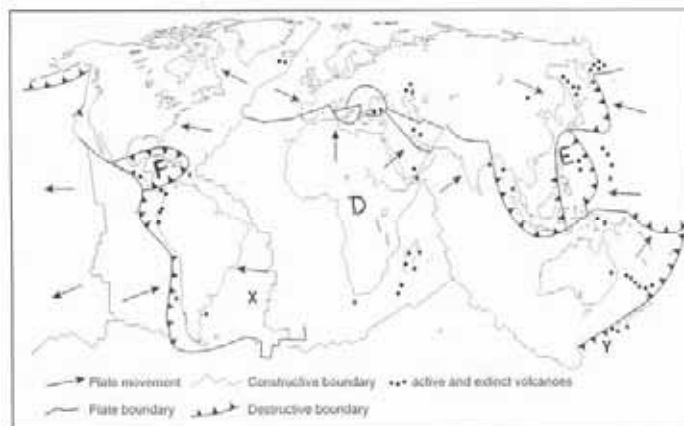


Fig 9: Physical map of the world

Source – BEC 2004

- (a) Name the plates D, E and F. [3 marks]
- (b) What type of boundaries occur at X and Y [2 marks]
8. What is the other name for Block Mountains? [1 mark]
9. Give **two** advantages and **two** disadvantages of mountains [4 marks]
10. Where do we find the most impressive rift valley system in the world? [1 mark]
11. What causes earthquakes? [2 Marks]

12. Describe the distribution of earthquakes around the world. [1 marks]
13. Define the following terms: Focus, Epicentre, Intensity and Magnitude [4 marks]
14. What are; a. Seismograph and b. Richter scale [2 marks]
15. What names are given to earthquake vibrations a. Inside the earth and b. On the surface of the earth? [2 marks]
16. Explain the meaning of the following: a. Active volcano, b. Dormant volcano and c. Extinct volcano [3 marks]
17. State the difference between acid and basic lava. [4 marks]
18. Why are volcanoes often present in the neighbourhood of rift valleys? [2 marks]
19. Describe **three** ways in which volcanoes may be useful to people. [3 marks]
20. State **two** ways in which volcanoes may be harmful to people [2 marks]
21. Describe how a caldera may form. [4 marks]

Total = [65 Marks]

Feedback

The following are answers to the assessment questions above. After you have answered the questions, you can go through this section to see whether you have answered the questions correctly.

1. Forces of Tension and Compression forces
2. Fold mountains, Block Mountains, volcanic mountains, rift valleys, trenches.
3. Convergent or destructive boundaries, divergent or constructive boundaries and transform or conservative boundaries.
4. **Convergent or destructive boundaries:** because it is where plate collide and are destroyed. **Divergent or Constructive Boundaries:** because plates move apaert and molten rock from the mantle swirls up to construct new features such as ridges and islands, **Transform or conservative boundaries:** where plate move alongside or past each other. No much change takes place other than the fault between the plates
5. a. simple fold
b asymmetrical fold
c. over fold
d. over thrust fold
6. Fold mountain

- plates colliding, two continental plates or continental and oceanic
- exert compression force on the crust
- block of land between two plates fold up

Diagram layers of rocks exposed to compression = Diagram layers fold up to form syncline, anticline and limbs

7. (a) D = African plate
E = Philippine plate
F = Caribbean
(b) X= Divergent or Constructive plate boundary
Y= convergent or Destructive plate boundary
8. Horst
9. Advantages of mountains
 - Mineral deposits
 - Source of important rivers
 - Tourist attractions
 - Used for recreation

Disadvantages of mountains

 - Act as climatic barriers
 - Barriers to communication
 - May be too rugged for human habitation
 - Some are prone to landslides and volcanicity
10. East Africa
11. Tectonic plates riding over one another along a fault line, movement of magma from the mantle into the crust (volcanicity)
12. Major earthquake belts are along the edges of tectonic plates
13. (a) Focus: the origin of the earthquake deep down the earth
(b) Epicentre: the area on the surface of the crust immediately above the focus
(c) Intensity: the effect produced by an earthquake
(d) Magnitude: the total amount of energy released which is normally measured by the Richter scale
14. (a) Seismograph: an instrument use to measure the intensity of an earthquake
(b) Richter scale: an instrument used to measure the magnitude of an earthquake
15. (a) Inside the earth – Body waves
(b) at the earth’s surface – Surface waves
16. (a) An active volcano is the one that erupts frequently
(b) A dormant volcano erupts infrequently. We say it is sleeping
(c) An extinct volcano is one that has not erupted in historic times. We say it is dead.
17. Acid and basic lava

- Acid lava is thick whereas basic lava is fluid
- Acid lava forms steep sided volcanoes whereas basic lava form gentle sided slopes
- Acid lava does not flow far from the vent whereas basic lava flows and spread far
- Acid lava solidifies quickly whereas basic lava will take more time to solidify.

18. Rift valleys are major cracks/faults in the crust, magma from the mantle may escape through these cracks to the surface forming volcanoes hence the presence of volcanoes around rift valleys

19. Useful

- Some precious minerals like diamonds are formed from volcanic activity
- Hot springs and geysers may supply people with hot water and are tourist attractions
- Volcanic ash weather to form fertile agricultural soil

20. Harmful

- People may die from a violent volcanic eruption and poisonous gases it releases
- Volcanic activity can trigger violent earthquakes which also kill people
- Volcanoes destroy cities, home and general damage to property

21. Formation of a Caldera

- A caldera is an enlarged crater
- Forms when violent eruption blow the top of a volcano
- Also forms when the volcano subsides into a magma below after a violent eruption
- The depression so created is called a caldera
- The depression may fill up with water to form a caldera lake



Reading

List of References

For further reading you should visit your study centres or your nearby library. These areas are well equipped with Geography books. Some of the books you may want to read include:

1. R.B Bunnett, *General Geography in Diagrams for Africa*,

2. Namcol, *Geography Unit 1 Grade 11-12*, Cambridge University Press
3. Pallister et al, *Longman Geography for GCSE*, Longman
4. Adam Arnell, *Geography Dictionary 11-14*, Letts Publishers
5. Collins, *Geography Basic Facts*, Harper Collins Publishers

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Unit 2

Map Reading Skills



Introduction

In the previous unit, you learnt about the structure of the earth which included plate movement and its associated landforms. Can you still recall some of the landforms formed? These include mountains, plains, valleys and lakes. Do you know that all these features can be shown on a map? You have probably done map reading in the Social Studies Junior Certificate Course or in the Junior Secondary School Geography Course. This unit will help you to consolidate your knowledge and skills in map reading and interpreting maps. Map Reading is a skill and you can only master it through constant practice. Map reading skills are very important for a Geography student and therefore, it is important that you master them. From your knowledge, can you explain why map reading is important? You probably mentioned that maps are important in that they show spatial relationships. Do you know what spatial relationship means? This means that maps show how for instance, buildings, roads and rivers are set out in relation to each other. As you proceed with your course, you will use your map reading skills in the units on farming, mining, tourism and settlements to mention only a few. You will be asked to locate areas, calculate distances, find bearing and even calculate time using your map reading and interpreting skills. Thus, maps are particularly useful to a geography student because they provide a basis for an orderly geographical description of a region, information on the nature and distribution of geographical phenomenon and insight into significant relations such as settlement and population and data for statistical analysis.

Upon completion of this unit you will be able to:



Outcomes

identify characteristics of a map such as the title, key, scale and direction.

- *demonstrate* the ability to use a scale in measuring distance, calculating area and gradient.
- *use* instruments to measure distance, find direction and calculate bearing.
- *use* maps to help in decision making, identify landforms on maps using contours and describe human activities in relation to the features on the map.
- *identify* and interpret ground, air photographs and satellite images.
- *locate* features on a map using 4 and 6 figure grid references.
- *locate* features on a map using longitudes and latitudes .
- *calculate* time with reference to the Greenwich meridian.

Time

You will need about two hours to study each topic. Note that this unit has 5 topics. It means you will need a total of 10 hours to study the whole unit. You might finish studying the topic in less than two hours or exceed your study time as this is determined by your reading pace and understanding of the lesson. On completion of each topic, you are required to do an assignment or self-assessment exercise. You need 1 hour 30 minutes to do this assignment. To further test your understanding of the unit, you must do a tutor marked assessment exercise. The assessment should take you about 1 hour to complete.

Learning Approaches

This is a skills acquisition unit. In order to promote map reading skills acquisition and application we engage you in several practical activities throughout the unit by asking you to practise the various skills. We also offer our experience or perspectives on raised questions based on possible responses.

Where possible, we also tried to guide you to some useful resources for learning. Most libraries and survey departments have maps that you can use for practice. Some of the recommended books on map reading can be found in the reference section found at the end of the unit. You may have access to additional resources, maps and relevant videos if there is a study centre in your area. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any challenges you may experience in this unit. Remember that the time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or at least before you attend tutorials. This will help you raise questions on difficult aspects of your study materials.

I would like to emphasise that map reading is a skill and you can only perfect it by continuous practice. Once you acquire the skill then you can use it virtually in any unit that requires you to show spatial relationships.

Assessment

Each topic has activities that are meant to enhance your learning and skills acquisition. These activities are meant to help you interact with your study material, reinforce what you have learnt through practice and also allow you to reflect and apply your experiences. It is therefore very

important for you to do all the activities. Do the activity before looking at the feedback given immediately after the activity. If you don't do well in an activity do not be discouraged. You may review the section related to the activity and later carry on with the topic with more concentration. Review the sections that you find difficult before continuing with the topic.

After completing the topic, you will find a self-assessment exercise for each topic in the assignment section of the unit. Do the exercise for the topic you have completed. This will help you to better understand the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low you must try again by going over the topic and the exercise.

The self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the self-assessment assignments. Submit your assessment for marking by your tutor. Your tutor's comments are very important and therefore you should act on them. You may ask your tutor for more information or look at other resources to correct your work. If you have finished acting on the comments raised by your tutor, you can then proceed to the next unit.



Terminology

Map:	A diagram that shows on a flat piece of paper, an area of the earth's surface
Physical maps:	Maps that show natural features such as rivers, lakes and mountains
Cartographers:	People who draw maps
Topographic maps:	Maps that show physical and human made features
Scale:	When a small distance is used on a map to represent a large distance
Gradient:	A measure of the slope between two points on a map
Bearing:	The angle of turn from one direction to another measured in degrees
Latitude:	Imaginary horizontal lines that increase northwards
Longitude:	Imaginary vertical lines increasing from the Greenwich meridian eastwards

Topic 1: Understanding Maps, Characteristics and Distance

Introduction

You probably learnt the main characteristics of a map in your Junior Certificate Geography or Social Studies programme. I have already mentioned the importance of map reading skills in the Unit introduction, so, even if you have learned about the characteristics of a map in the Junior Secondary programme, go through this topic carefully so as to perfect your map reading skills. You will use these skills throughout this course.

Topic Objectives

At the end of this topic you are expected to be able to:

- define a map
- identify different types of maps
- identify the characteristics of a map as the key, scale and direction
- demonstrate the ability to use a scale for measuring distance.

1.0 Maps

In this section we are going to learn one of the characteristics of Geography, maps. “Often you cannot talk of geographical issues without talking of maps.” In your opinion, how true is this statement? It is probably true to a large extent because, as you have already seen in unit one, you dealt with many different types of features: mountains, rivers, valleys and lakes and there is a need to locate them. Try and verbally describe the relationships between some of the features in your locality. You probably found it difficult and lengthy. If you were to show the same features in a map, it would be easier to observe the relationships between the various features. For instance, you may find that where there are salt pans, the land is flat and where there are fast flowing rivers there are steep slopes. Be on the lookout for these spatial relationships as you develop your map reading skills, as they will help you interpret the maps. Do you still remember what a map is? Write down your definition. You may use the internet to find out what a map is or you may just use any map reading textbook which should give you an answer. If you don’t have either, continue reading and the definition will be given below.

1.1 What is a Map?

In your definition, I hope you mentioned that a map is a diagram on a flat piece of paper that shows an area of the earth’s surface, which is normally drawn to a particular scale. A map shows you what the land looks like as seen from above. Some maps can give you information on physical features such as rivers, mountains, hills, valleys, pans and lakes. What else can a map show you? Of course some maps can show you settlements as shown in the map in Figure 1. Maps can give you information on farming, transportation and settlements among many others.



Fig1: A sample map of Botswana showing settlements and boundaries (Downloaded from <http://en.18dao.net/images/5/58/Map-Botswana.jpg> on 02/12/10

Let's see if you can interpret the map given in figure 1.



Activity 1

Look carefully at the settlements shown.

1. Briefly describe the location of the main settlements.

2. Explain why they are located where they are.

To get answers, you can use an atlas or your previous knowledge from the Junior Secondary Geography course or from the information gained from unit 1 on land forms.

Feedback

Well, the settlements are located along the eastern part of Botswana. One of the reasons for this settlement distribution is that the eastern part of Botswana has relatively high rainfall, fertile soils and a well developed communication network. I have not exhausted all the reasons. Think of some of them yourself. What you should notice is that a simple settlement map may get you thinking about a whole host of other related issues. Just by studying the map, we were able to show the interrelationship between settlements, communication and even rainfall.

Notice that whenever you study a map, try and understand the interrelationship of the features shown. Sometimes the features may not be shown on the map, but you may be asked to deduce or infer from the map. You were able to interpret most of the relationships from the above map through deduction or inference.

Of course there are many types of maps besides the maps showing settlements and boundaries as

discussed in the next section.

1.2 Types of Maps

To show different types of information clearly, people who make maps (cartographers) draw different types of maps. The various types of maps include physical, topographic, weather, climate and political. Each type of map has a specific purpose. Let us look at some of the types of maps.

(a) Physical maps

In Unit 1 you learnt how land forms or physical features such as rivers, lakes, mountains, pans, valleys and hills are formed. To locate these landforms we sometimes use maps known as relief or physical maps. Figure 2 shows a physical map of Botswana.

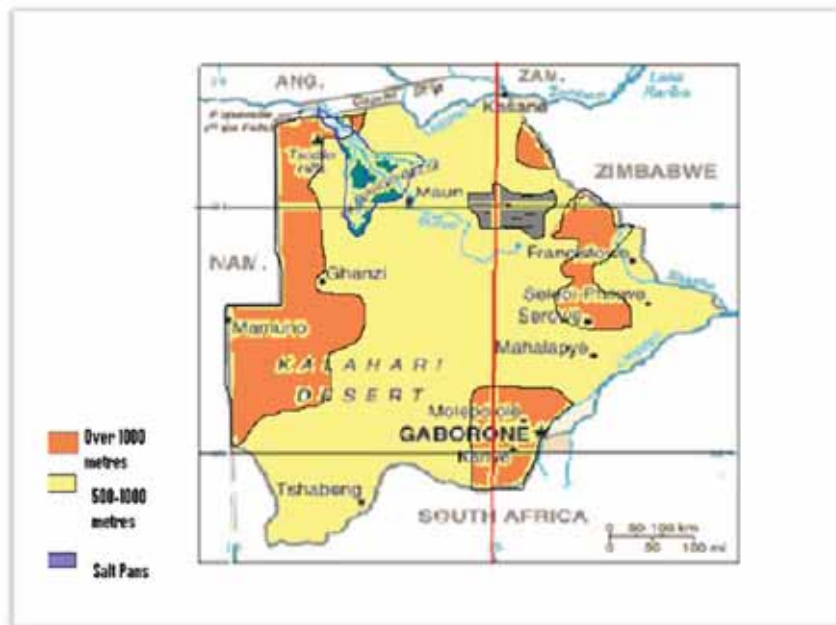


Fig 2: A physical map of Botswana (Drawn by the writer)

What features are shown on the map? Can you name some of the features shown on the map? Some of the features shown include rivers, hills and the desert.

Again carefully study the physical map (Figure 2). How has the cartographer shown areas of different height above sea level? In your opinion what is the disadvantage of using this method to show altitude? I hope you observed that the cartographer used colours to show differences in altitude. Most physical maps use colours to show altitude. Get an atlas and see what colours have been used to show different altitude. By convention, warmer colours such as red and brown are used to show areas of high altitude while cooler colours such as green and blue show low areas and water respectively. A key disadvantage of using colours is that other features may be obscured. The section that follows discusses maps that show both natural and human made features.

(b) Topographic maps

Use a dictionary to find the meaning of the word topography. Write down the meaning in your note book as shown in the dictionary. From the vocabulary section of this unit, write down what is meant by a topographic map. Are the two definitions the same? Most probably they are almost the same. In your dictionary, the word topography was probably explained as the description of a place, a detailed account of features of a place or a country, whereas in the vocabulary section of the unit topographic maps were explained as maps that show-detailed physical and human made features of an area including settlements. Can you see some of the features in the example of a topographic map shown in Figure 3 below?

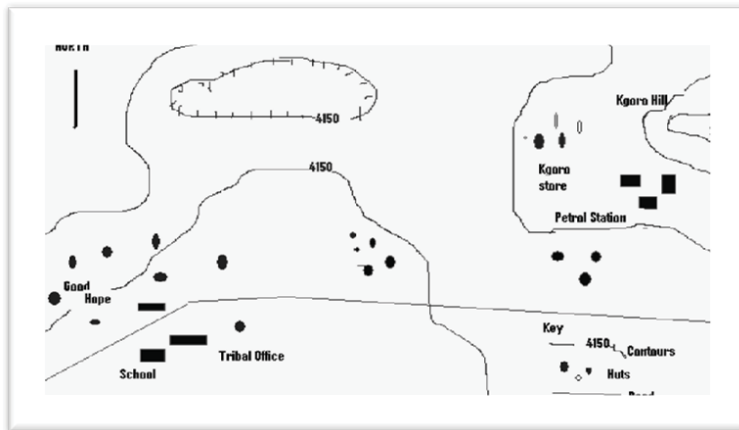


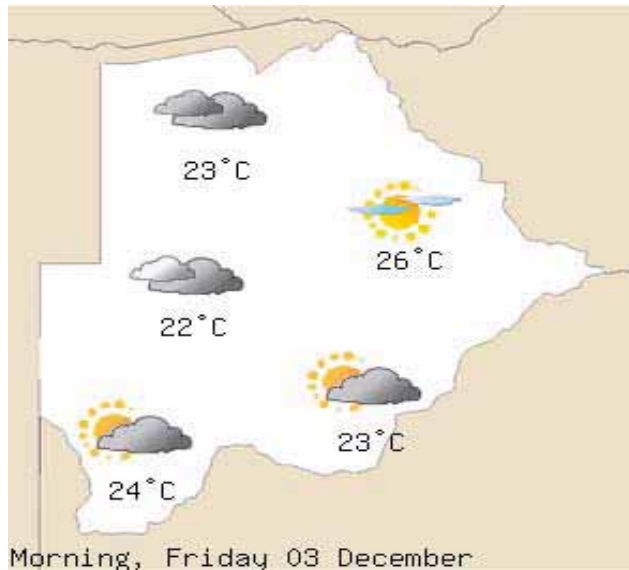
Fig 3: A sample of a topographic map (Drawn by the writer)

A topographic map will show you hills, rivers, lakes, roads, railway lines, farms and settlement areas. A topographic map shows only those features the mapmaker wants to show. We shall deal with topographic maps in more detail in the next lesson. Topographic maps also show land elevation through contour lines.

Remember maps do not show everything, they are selective with regard to the information they contain. So when you look at a map, it is very important to find out first, exactly what it is meant to show.

(c) Weather maps

Study the map given below:



Downloaded from http://www.afrik-news.com/imgmeteo/botswana_1_matin.png on 3/12/10

In your notebook, briefly describe the weather conditions in Botswana on the morning of December 3, 2010.

You probably described the weather on that day as partially cloudy in the south with average temperatures of 23°C . The north eastern part of Botswana was hot with high temperatures of about 26°C . The northern part was overcast with temperatures of about 23°C .

Weather maps are sometimes referred to as synoptic maps or charts. They give detailed weather conditions or a forecast over an area at a certain time. Farmers, travellers, aircraft pilots and many others may need weather information over a short space of time. You will learn more about synoptic charts later in your Geography Course.

(d) Climatic maps

A climatic map shows the average rainfall, temperature, winds, atmospheric pressure in a given area over a long period of time.

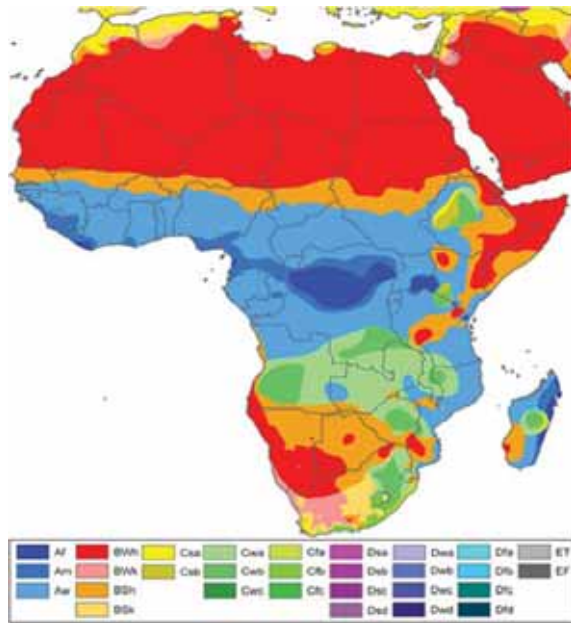


Fig 4: A climatic map of Africa downloaded from <http://upload.wikimedia.org/wikipedia/commons> on 3/12/10

The map in figure 4 shows the climatic regions of Africa. Some parts of Southern Africa are semi arid humid and subtropical and have dry summers. Can you give an example of a country which is semi arid and has dry summers? Of course it's part of Botswana and Namibia. Climatic maps are also used mainly for land use planning and management. For instance, decisions on farming in an area can be influenced by climatic conditions.

(e) Political maps

These show political divisions of land, such as countries, districts, and provinces. Political maps also often show towns, cities and villages.

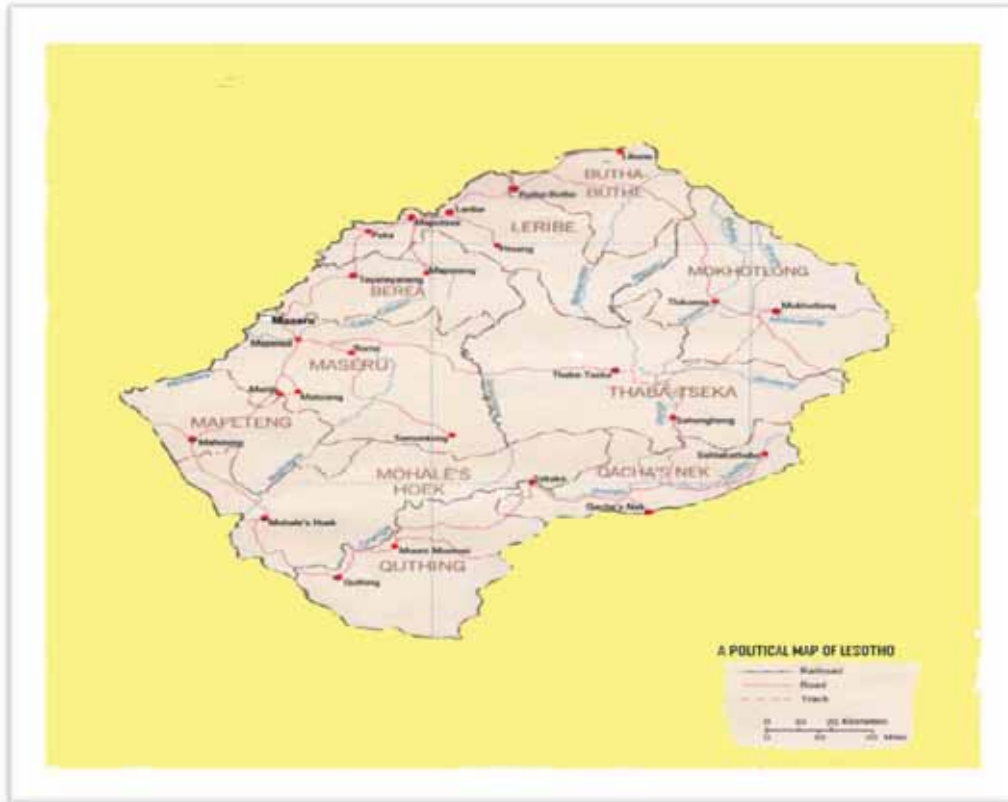


Figure 5: A political map of Lesotho

(Adapted from: <http://www.mapcruzim.com/free maps Lesotho on 3/12/10>) Note that on the bottom right corner, the words that are not clear are as follows: railroad, road, track.

Look at the political map of Lesotho in Figure 5. Can you identify any three provinces? What about towns?

Some of the districts shown are Mafeteng, Thaba Tseka, Quthing and Leribe. One of the cities shown is Maseru.

Now that you have gone through different types of maps, let's discuss the characteristics of a map.

1.3 Characteristics of a Map

From your Junior Certificate course, do you still remember the characteristics of a map? Do the activity given below.



Activity 2

Explain the following characteristics of a map:

1. A title

2. A key or legend

3. A direction north

4. A scale

Feedback

I hope you were able to describe the characteristics as given below:

(a) Title

The title tells you what the map is about. Look at figure 5 again. What does the title tell you about the map? The title tells you that the map provides information on the political boundaries of Lesotho.

(b) Scale

The ratio between the lengths of objects on the map to their actual length on the ground

(c) A key or legend

A key shows you all the symbols used on the map and their meanings. It is meant to help you to interpret the map.

(d) Direction North

On a map the direction in which the north lies is shown by an arrow printed in the margin on one side of the map. This direction helps find other directions.

We will deal with these map characteristics in more detail in the sections that follow. Let's start with symbols.

1.4 Symbols

Many features on the ground are too large to be shown as diagrams on maps. People who make maps

use a system of signs called symbols or conventional signs to represent different features. Map symbols are drawings on a map that represent something that exists on the ground. The symbols can be in form of signs, letter, points, numerals, shades and colours. These symbols are included in the key or legend, which normally appears at the bottom of the map. Sometimes symbols are drawn to look like the features they stand for; sometimes they may just be colours, lines and letters which do not look like the actual features. The types of symbols are described below and Figure 6 gives examples of symbols.

Types of symbols

Map symbols can be classified into five categories: colour symbols, line, point, area, pictorial symbols.

(a) Shade or Colour Symbols

Under types of maps in this topic, remember we said that shades or colours can be used to represent different land features. The colours that are usually used to show different features are:

Blue – is used for water features such as dams, rivers, lakes, canals, boreholes, wells, marshes, swamps and rainfall. You can see some of the symbols in figure 6 below.

Green – generally shows vegetation such as forests, trees, grasslands, bushes, cultivation, forests and farms.

Black- shows features that are made by people such as buildings, settlements, bridges, and railway lines. Rock-outcrops are also usually shown in black.

Brown – is used mainly to show contours and dry areas such as dry river beds, pans and sandy places.

Red- shows features such as national boundaries, main roads, airports and airstrips. It also shows political boundaries and areas with very high temperatures

Purple – shows very high altitudes.

(b) Line symbols

Line symbols represent features that are linear. I am sure you know some of the linear features. Can identify them in Figure 6?



Figure 6: Symbols used in most of maps of Southern Africa

(Adapted from: backwoodsok.org/control-descriptions-and-map) downloaded 3/12/10

An example of a linear symbol would be a road. You can think of many more yourself. They sometimes show direction of movement and boundaries.

(c) Point Symbols

These are found where the feature is found. For instance, a point symbol can be used to show a post office, a borehole and other features on a small map. When the scale is large the same features can be shown by different symbols.

(d) Area Symbols

These symbols show features that cover large areas such as areas with the same soil, vegetation regions or countries. The symbols would change according to the scale of the map.

(e) Pictorial symbols

These look similar to the objects they represent. They are sometimes used on plans and large scale

maps.

You don't need to memorise the symbols. They will be given in most of the maps. What you need to do is to just look at the map and check the meaning of the symbol in the legend or key.

Now try the activity given below.



Activity 3

1. Study the land use map in Figure 7. Look at the symbols used in the map carefully.

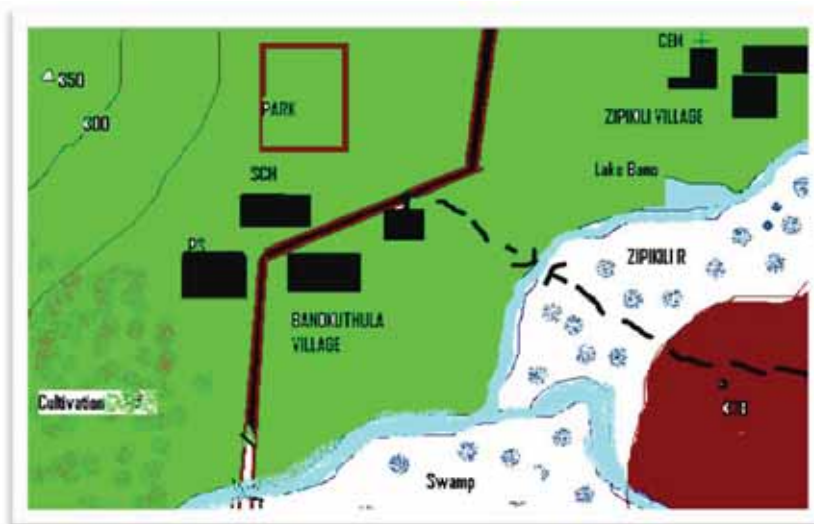


Figure 7: A land use map of Banokuthula

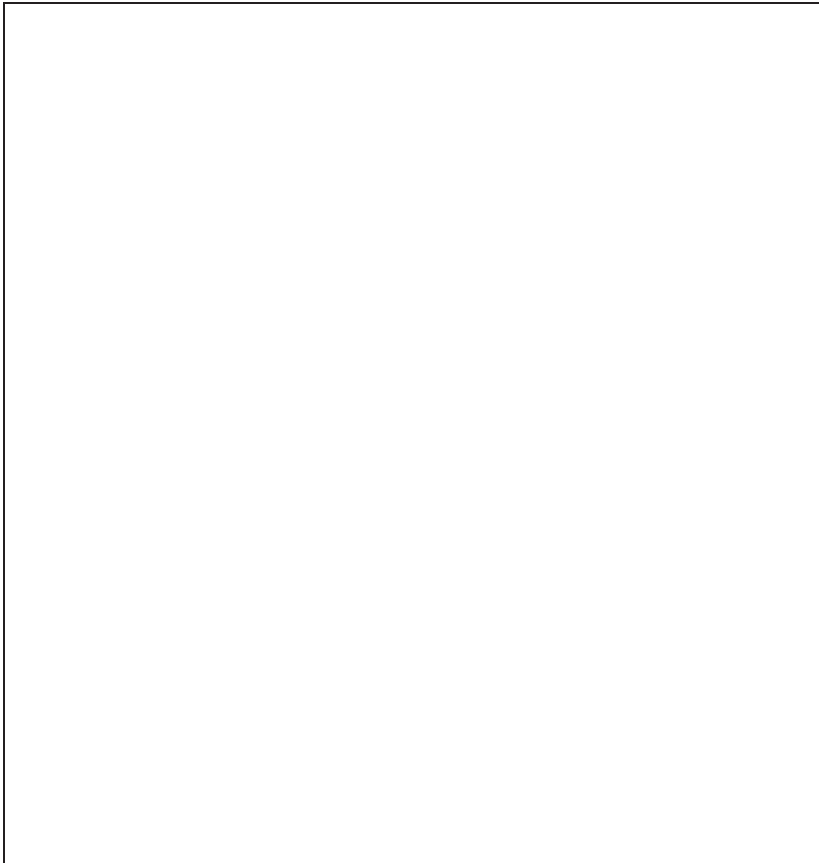
In the table below, insert the symbols that have been used to represent the features shown in column 1. Each correct symbol carries 2 marks.

Column 1: Features	Column 2: Symbols
Trigonometrical beacon	
Spot height	
Lake	
Settlement	
Park	

Cemetery	
River	
Swamp	
Land under cultivation	
School	

2. In one paragraph, state how you think the land in the map is used.

3. Draw a map of your village/settlement showing your home, a school, the post office and any other features of importance in your village.



4. Why do you think it is important to have a standard set of symbols?

Total: 20 Marks

Feedback

Probably you were able to identify the symbols.

1. Compare yours with mine given in Figure 8.











Column 1: Features	Column 2: Symbols
Trigonometrical beacon	
Spot height	
Lake	
Settlement	
Park	
Cemetery	
River	
Swamp	
Land under cultivation	
School	

Figure 8: A sample of symbols used in the land use map of Banokuthula

2. The land is used as a residential area probably because of the availability of water from the river. There is also crop cultivation and fishing. The park may also allow for tourism. (You probably thought of other correct reasons. This is not all. You probably thought of a lot more than what I have put here).

3. Your map probably shows both natural and human made features. The natural physical features can include mountains, hills, and rivers while the man-made features include your settlement, roads, railway line. You may have shown important buildings in your settlement such as the hospital, police station and schools. The location of these features will differ from one village/ settlement to the other. You may take your map and discuss it with members of your study group or your tutor.

4. It is important to have standard symbols for ease of recognition.

Now use an atlas to see the different symbols used to represent different features. Are they the same? Is there a scale? The scale has already been mentioned earlier on in this topic. Now let's discuss in more detail about a scale in the section that follows.

1.5 Scale

Since maps represent large areas, they cannot be drawn the same size as the real area on the ground.

Maps are drawn small in comparison but they still give us the actual area they cover on the ground and the same distance between places. In order to do this, a map uses a scale. Accurate maps are therefore, normally drawn to scale.

A scale is when a small distance is used on a map to represent a large distance.

Example 1

1 centimetre distance measured on the map represents 1 kilometre distance measured on the ground. So when you measure 1 centimetre on the map, the actual distance on the ground represented will be 1 kilometre.

(a) Types of scale

Probably you have encountered these in your Junior Secondary School Social Studies or Geography Course. Do you still remember them? Of course these are:

- Statement scale
- Representative Fraction Scale or R. F. Scale
- Linear or Line scale

(b) The statement scale

The statement scale is when you make a statement saying what the distance on the map represents on the ground. You may say 1 centimetre measured on the map represents 1 kilometre measured on the ground or 1 centimetre to 1 kilometre.

Notice that the statements mention two distances. The smaller distance refers to the map and the larger distance refers to the ground. For the statement scale, the distance on the ground is always given in kilometres or metres. Thus, in this case, the distance of 1 cm on the map represents a distance of 1 kilometre on the ground.

(c) The Representative Fraction (R. F.)

The scale is given as a fraction: $1/10$ or as a ratio: 1:10. What it means is that one unit measured on the map stands for ten of the same units on the ground. You can use any units that you are familiar with. So, you can say 1 centimetre represents 10 cm.

On most maps, the Representative Fraction is given as a ratio, which is usually 1:50,000 on topographic maps. Note that the larger the Representative Fraction denominator, the smaller the scale and the less detail that can be shown. A scale of 1:25 000 will show more detail than a scale of 1:100 000. The smaller the denominator of the Representative Fraction, the larger the scale and more detail can be shown for a given area.

(d) The linear scale or line scale

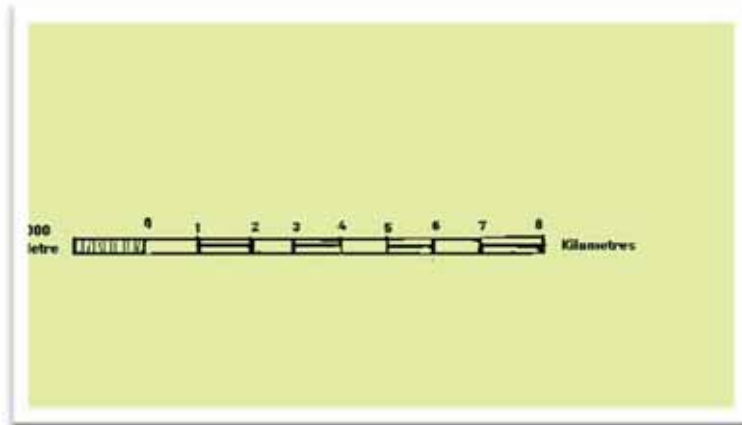


Fig 9:A linear scale

This is the most common scale used for maps and you need to really know how to use it. This is a special ruler that is drawn below a map that can be used to measure an area or distance. It is divided into a number of equal parts as shown in figure 9. The divisions on the line scale measures map distances and the labelling will give you the distance on the ground.

To the right of zero – each scale division represents a distance of 1 kilometre. To the left of zero – the distance representing 1 km is shown. This is subdivided into ten equal parts, each part representing a distance of 100m.

Distances can be measured and read off directly from the scale.

On many maps, two linear scales are drawn to show distance measured in the metric units, in kilometres and metres and in imperial units, in miles, yards and feet. If asked to measure a distance on a map, be sure to use the one that measures in metric units (kilometres and metres), because Commonwealth countries use the metric unit of measurement.

Now you can try the activity given below to see how much you have learnt.



Activity 4

1. Fill in the blank spaces [3 marks]
 - (a) A map uses _____ to help us to calculate distances between places.
 - (b) A scale is _____
 - (c) The types of scale are _____

2. Describe the three types of scale [3 marks]

(a) _____

(b) _____

(c) _____

3. Change the following statement scales to Representative Fraction scale: [3 marks]

(a) 1 centimetre to 2 kilometres

(b) 1/2 centimetre to 1 kilometre

(c) 1 centimetre to 1/2 kilometre

Total = [9 marks]

Feedback

1. (a) Scale
(b) A scale is a small distance representing a large distance on a map.
(c) Types of scale are linear, representative fraction and Statement Scale.
2. (a) Statement scale- a statement saying what distance on the map it represents on the ground.
(b) Representative fraction- Scale given as a fraction.
(c) Linear scale- ruler drawn below the map to measure distance.
- 3 (a) 1/200000
(b) 1/200000
(c) 1/50000

(Note that a and b above come out to the same answer)

You should always bear in mind that when making calculations or conversions of scale, that all your figures ought to have the same units of measurements.

Use any atlas to practice calculating distances using a scale. The more you practise, the better you will be in acquiring this skill. If you feel that you have acquired the skill of calculating the distance using the scale, it's time now for you to look at ways of measuring distances on maps.

1.6 Measuring Distance on Maps

In this section, I am going to lead you through some examples of measuring distance on maps and I expect you to practise doing this as well because I want you to learn this skill. When we talk about distance, we mean the measurement of how far we travel between two places. On a map, it is the

measurement between any two points. Do you still remember the three types of scale? Of course they are the Statement Scale, the Representative Fraction and the Linear Scale. They all give you the map distance and the actual distance represented on the ground by each unit. You can use a scale to measure any distance between two points on a map. The two points may be the distance along a route such as a road, railway line, a footpath or a river and distance between settlements.

Sometimes you may need to measure only straight distances but at times you may need to measure curved ones. The most convenient way of measuring distance is by using the linear scale. Do the activity given below. You will be given a step-by-step guidance using a straight edged-paper and using a pair of dividers.



Activity 5

Look at the map given below and then measure the distance between the police station (PS) and the post office (PO).

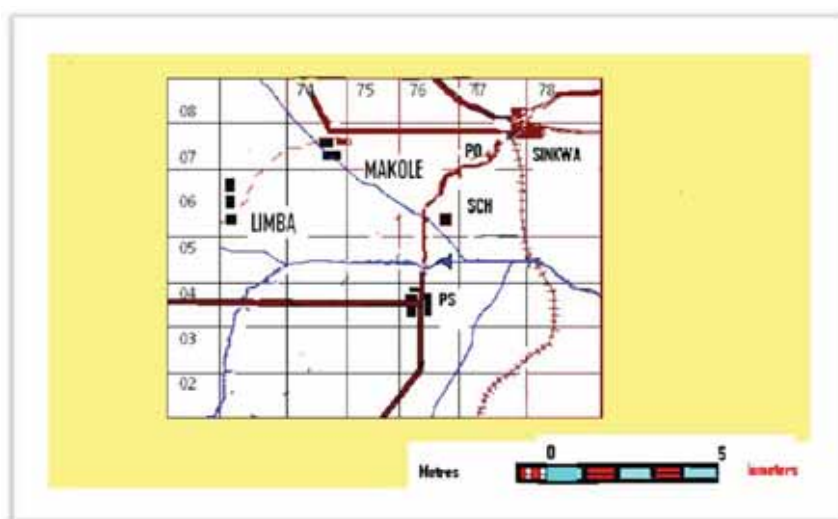


Figure 10 Map of Makole (Adapted from BOCODOL, Map Reading Unit 2, 2002)

(a) Straight edged paper method

Step 1 Draw a straight line joining the Police Station (PS) and the Post Office (PO).

Step 2 Get a piece of paper of a suitable length, which has a straight edge.

Step 3 Place the straight edge of paper on the map next to the line joining the Police Station and the Post Office. Mark off PS on the paper at the point where the Police Station is and PO where the Post Office is.

Step 4 Take the marked straight-edge of paper and put it against the linear scale given at the bottom of the map.

You can see that the distance between the Post Office and the Police Station is greater than 3 km but less than 4 km.

Step 5 Mark off a distance of 3 Km on the paper and label it A.

Step 6 The remaining distance B is measured using the part of the scale to the left of zero. Measure this distance in metres. You should get 80 metres.

Step 7 The total distance between the Police Station and the Post Office is:

$$\begin{aligned} & \text{Distance A} + \text{Distance B} \\ & = 3 \text{ km} + 80 \text{ metres} \\ & = 3 \text{ km } 80 \text{ m or } 3.08 \text{ km.} \end{aligned}$$

(b) The pair of dividers method

With this method you can follow the procedure given below:

Step 1 Draw a pencil line joining the places on a map; in this case the Police Station and the Post Office.

Step 2 Open the pair of dividers to obtain the distance between the two places.

Step 3 Use the dividers to read off the distance from the linear scale.

Distance A + Distance B = PS to PO

$$\begin{aligned} 3 \text{ km} + 80 \text{ m} & = 3 \text{ km } 80 \text{ m} \\ & = 3.08 \text{ km} \end{aligned}$$

Note that if you use a pair of dividers, do not change the span until you have read the distance in the linear scale.

(c) The string method

You can also use a string and follow the same steps as those you followed when using a piece of paper. Use a string that does not stretch.

I would like you to practise measuring distances using the straight edged paper method, the pair of dividers and the string method. You can use any atlas or map that has a scale. Do not just read and go to the next section without first practising and acquiring the skills. If you feel that you are now good at using these methods of measuring, then you can proceed to measuring distances which are not straight.

1.7 Measuring Distance along Routes which are Not Straight

You know that roads, railway lines, rivers and distances between settlements are not always straight. These may follow irregular patterns and you need to take great care when measuring them. There are many ways of measuring these irregular distances. You may use the following methods:

(a) Using a string

When measuring using a string, follow the given instructions:

Lay a piece of string, preferably white in colour, along the route to be measured following the curves carefully. Make a mark on the string with a pen or pencil where the line ends. Then lay the string against the linear scale and read off the distance.

Example 1

To find the length of the Mzila river shown on the map of Makole (fig. 7), first put your string along the river and follow its curves. Mark the beginning and the end of the string. Then remove the string and read it against the linear scale to get the distance.

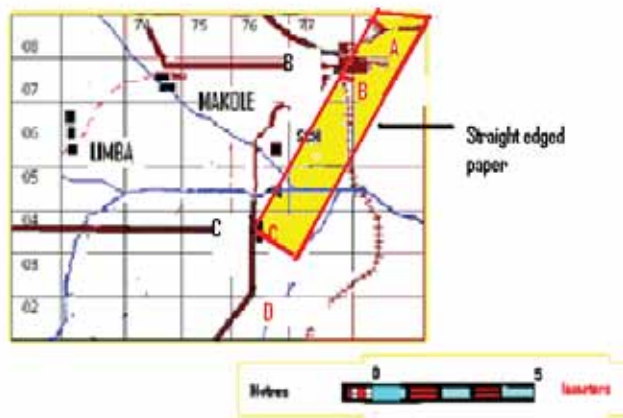
(b) Using the straight edge of a piece of paper.



Map of Makole (Adapted from BOCODOL, Map Reading Unit 2, 2002)

Put the edge of a piece of paper along the first straight section of the line ABCD to be measured.

Use your pencil to mark the edge of the paper from A to B. Move the paper so that it lies on B along BC. Mark out C on the edge of your paper.



Keep on moving the paper along the curves or bends, each time making a mark on the edge of your paper where a new curve starts and ends until you reach the end of the line, in this case F.

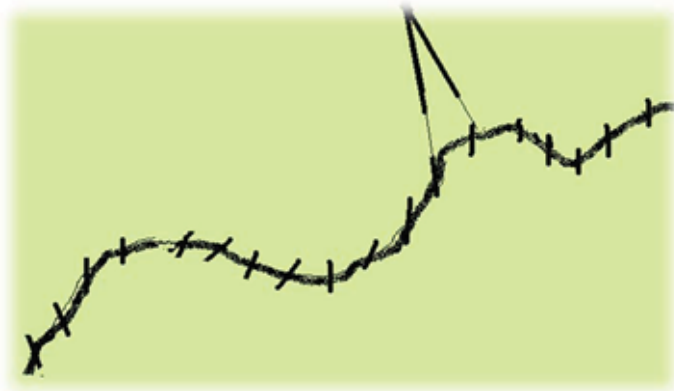
Measure the length of the marked paper against **the linear scale**. Read off the distance.

Use the same method to find distances between different settlements in any atlas that you have. You

need to practise this exercise so that you can measure distances in your course. In your final examinations you may be asked to measure curved distances. You can practise this either alone or with your colleagues at the study centre.

(c) Using a pair of dividers

Divide the line by pencil marks into sections that are almost straight as shown below.



Measure each of these sections with a pair of dividers and write down each measurement. Add the length of each of the straight sections. Then use the linear scale to find out the actual distance on the land.

Again, you can only excel in this skill through practice. Use this method for measuring the same distances which you measured using the string method. Find out which one is easier for you. Also, check if there are any differences in your answers. There ought to be none unless if you were not accurate!

2.0 Topic Summary

In this topic, you have learnt that a map is a diagram on a piece of paper that represents an area of land on the ground. There are many types of maps including physical, topographic, climatic and political maps. The main characteristics of maps are the title, scale, key and direction north. There are three types of scale, the statement scale, Representative Fraction and the linear scale. It is important that you learnt how to measure distances using different methods such as the use of a string and a pair of dividers.

Now try the self-assessment exercise that is given at the end of the unit. The exercise is meant to increase your competency in using map symbols and the scale. If you find the exercise difficult, revisit the aspects that you find difficult. If you have mastered the exercise, proceed to the next topic which is on finding direction and calculating the area.

Topic 2: Finding Direction and Area

Introduction

I believe you are familiar with directions. Remember what you did at Junior Certificate level? You may even have known the directions long before doing your Junior Certificate course. In this topic we will discuss ways of finding directions using a compass. Again in Topic 1 we touched very briefly on the direction north and how it can be used to find other directions. Maps can give you the direction from one place to another. They can also be used to find the distance and the slope (gradient) of the land. In this topic, you will learn how to find direction, how to calculate the slope of the land and the area represented in a map. As in the previous topic, I would like you to apply the skills that you acquire.

Topic Objectives

At the end of this topic, you should be able to:

- identify the cardinal points
- find direction using compass points
- find bearing on a map
- calculate the area of regular and irregular features
- calculate the gradient.

1.0 The Compass

Have you ever been lost in a place like a desert, a forest or a very big town? In such a situation, you may find it difficult to determine the direction from your hotel, home or even where you can get help from like a police camp or rescue organisation. An instrument like a compass can help you to locate the direction. That is why you find people like scouts, soldiers and pilots carrying compasses when they are going to places like deserts or thick forests. What then is a compass? A compass is an instrument that is used for finding direction. Figure 12 shows a typical magnetic compass.



Fig 12: A compass adapted from <http://www.brasscompass.com/compass.jpg> downloaded on 3/12/10

In your notebook, describe a compass. Use the diagram above to help you. What you can see are the cardinal points and the compass needle (a pointer). We shall discuss more about these in the section that follows.

1.1 Using a Compass

As mentioned above, a prismatic compass is an instrument used to find direction. It has a pointer, which always shows the direction north. There are four main direction points in a compass known as **cardinal points**. These are north, south, east and west. You can clearly see the four directions in the prismatic compass shown in Figure 12 above.

On a map, the key always shows the north direction with an arrow pointing to the top of the map. So, the south will be at the bottom of the map, west to the left and east to the right. If a map does not have the north direction, you should take the top of the map as north and the bottom part as the south.

Besides what other points does a compass have? These are the inter-cardinal or intermediate compass points or directions north, north east (NE), north west (NW), south, south east (SE), south west (SW), east and west as shown in Figure 13 below.

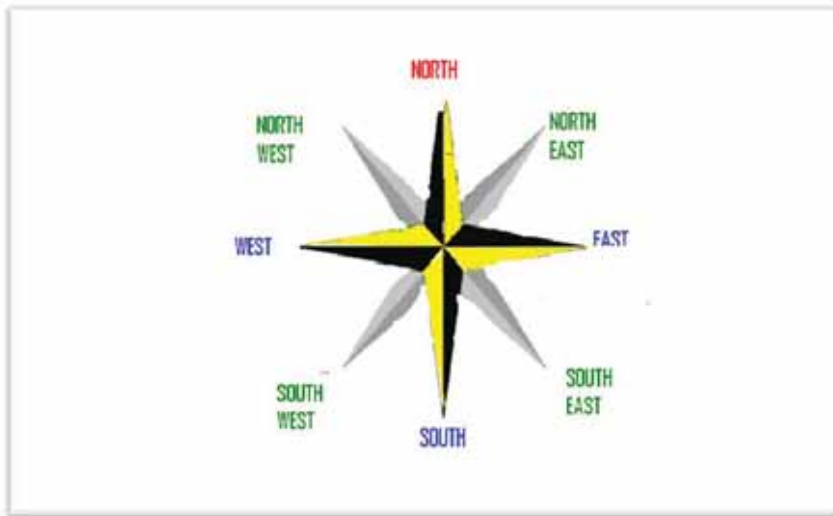


Fig13: Intermediate cardinal points adapted from <http://images-mediawiki-sites.thefullwiki.org/03/3/3/4/37205632152079435.png> down loaded 3/12/10

The eight point compass may have further subdivisions into 16 points as shown below.

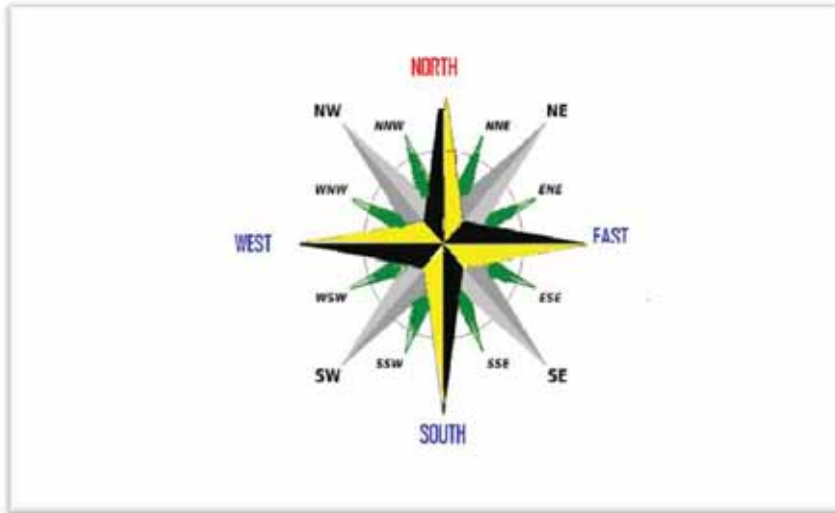


Fig 14: 16 Compass Points adapted from <http://images-mediawikisites.thefullwiki.org/03/3/3/4/37205632152079435.png> downloaded on 3/12/10

On maps, direction helps us to determine the location of one place in relation to another. The location of a map can be given as a compass direction.

Example 1

Points A and B represent two places A and B.

A. . B

What do you think is the direction of B from A?

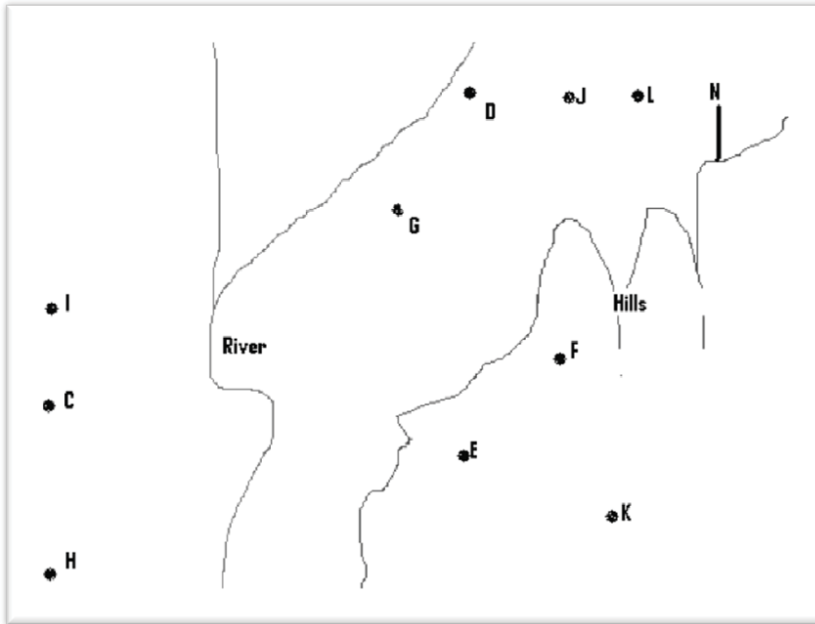
Imagine you are standing at A and looking towards place B. Which direction are you facing? You are looking towards the east. Therefore we can say that B is east of A, or A is west of B. In case you have any doubt, you should refer to figure13.

Now do the following activity.



Activity 1

Study the sketch diagram given below.



1. What is the direction of C to D? [2 marks]
The direction of C from D is -----
2. What is the direction of D from C? [2 marks]
The direction of D from C is -----
3. What is direction of: [4 marks]
 - (a) D from E?
The direction of D from E is -----
 - (b) E from D?
The direction of E from D is -----
4. In which direction do you think the river is flowing? [2 marks]
The river is flowing from -----

Total = [10 marks]

Feedback

1. *The direction of C from D is south west*
2. *The direction of D from C is north east*
3. *What is direction of:[4 marks]*

- (a) The direction of D from E is north
- (b) The direction of E from D is south

4. The river is flowing from north to south

Total = [10 Marks)

How well did you do? If you have mastered the skill then move on to the section on bearings.

1.2 Bearings

Using compass directions for obtaining map direction is not very accurate. To get a more accurate reading you use compass or grid bearings. A compass or grid bearing is a direction that is given in degrees. The compass directions may be shown as grid bearings as given in the diagram below (Figure 15).

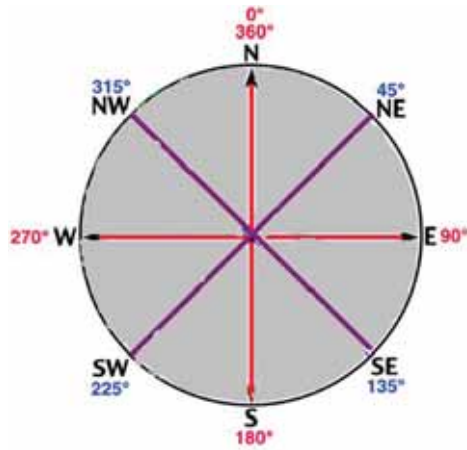


Fig 15: Compass Bearings

Bearings start with 0° as the North or 360° as the North (Figure 15). Notice that bearings start from the North and go in a clockwise direction (figure 15).

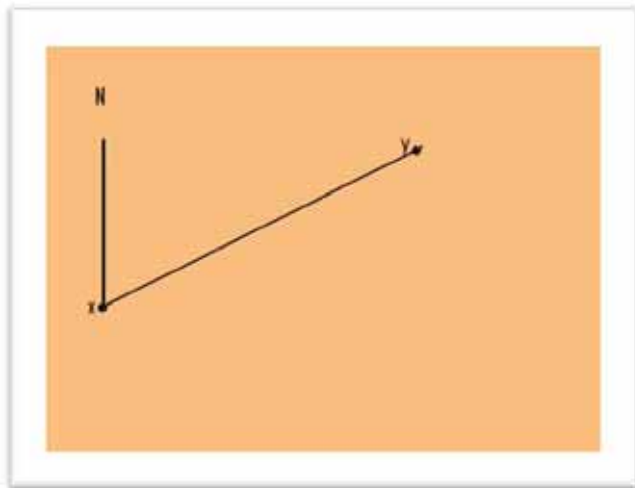
A clockwise direction means the direction in which the hands of a clock or watch move as shown above (fig.15). If you stand facing north and turn and face east, you would have turned 90° . If you are facing east then you turn and face south you would have turned again another 90° . If you face west it is another 90° and if you turn from the west to the north by now you would have turned a complete circle of 360° .

1.3 How to Find the Bearing on a Map

Example 2

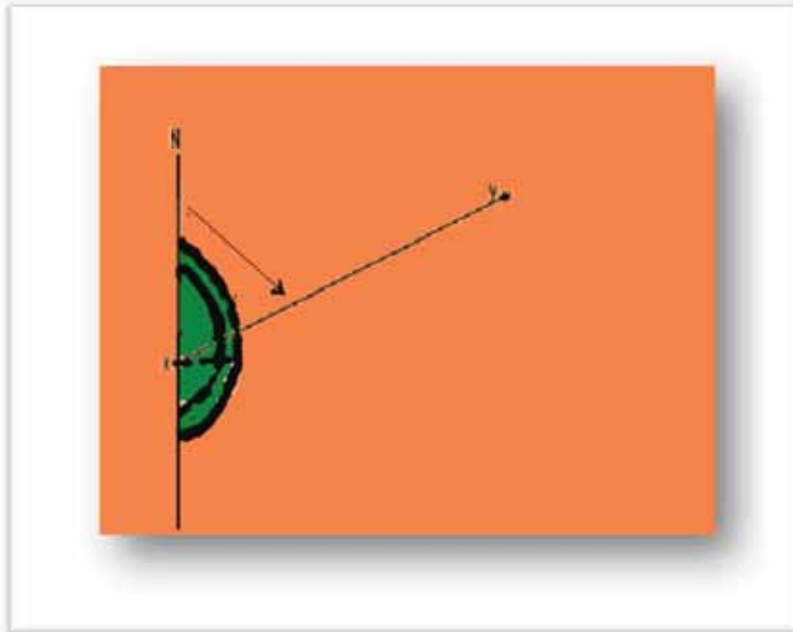
Find the bearing of Y from X. You should follow carefully the step by step approach to working out the bearing.

Step 1 Find the points X and Y on your Map.



Step 2 Join points X and Y using a straight line.

Step 3 Make sure that you know which point you are supposed to get. In this case you are at X and you want the direction of Y. Because you are at X draw in the North line from X as shown above.



Step 4 Now, take your protractor and lie it along line XN with 0 at point X as shown in the diagram below.

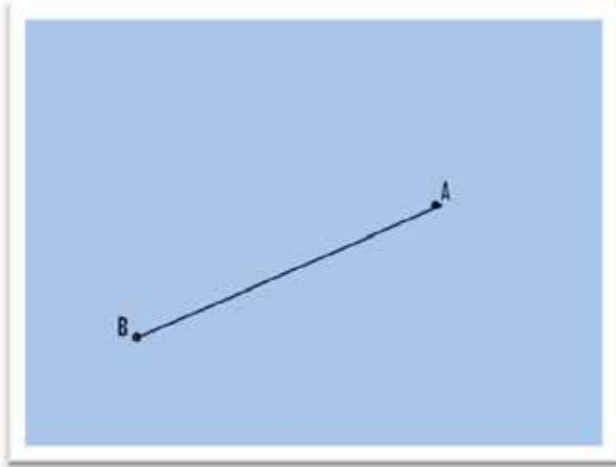
Step 5 From the North line, read off angle NXY.

In this case Y is 45 degrees from X.

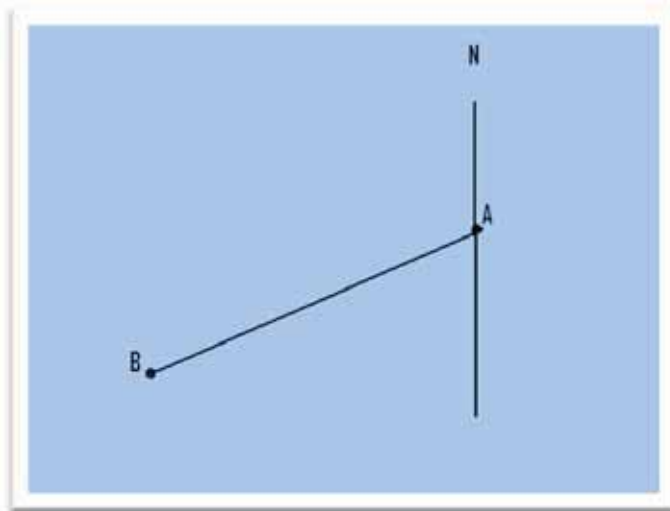
You may not always be asked to find the bearing of an acute angle as was given above. (An acute angle is an angle, which is smaller than 90 degrees). You may be asked to find the bearing of a reflex angle (larger than 180 degrees).

Example 3

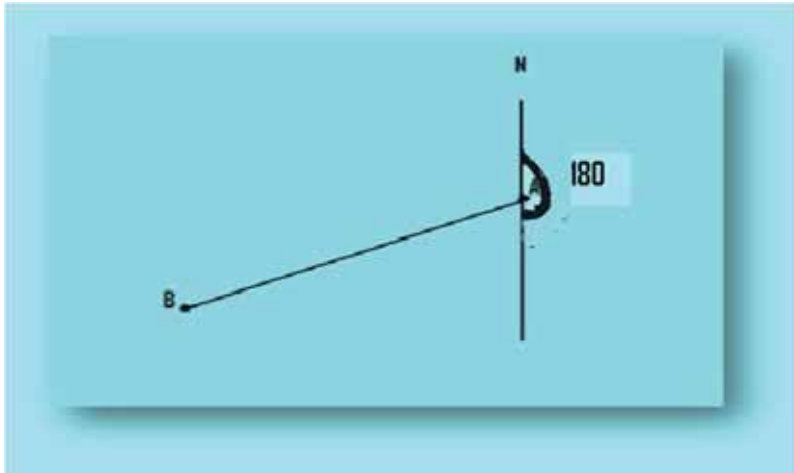
Find the bearing of B from A.



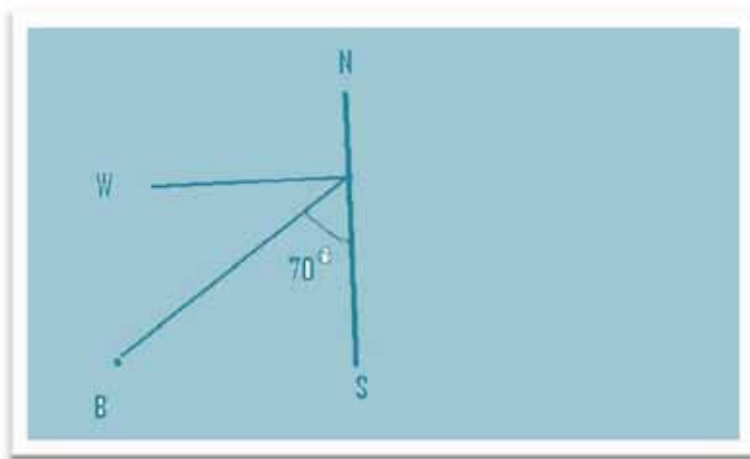
Follow the steps as given above. Do you still remember them? Join points AB with a straight line. At A draw the line north.



From north to south in a clockwise direction it is 180° (a straight line).



This means you still need to measure the remaining angle SAB. Place your protractor along the NS line and read angle SAB from your protractor as shown. It is 70° .



To get the total bearing from A to B you add 180° (from north to south) and 70° (from south to B). Thus, the bearing of A to B is 250° , pointing south west.

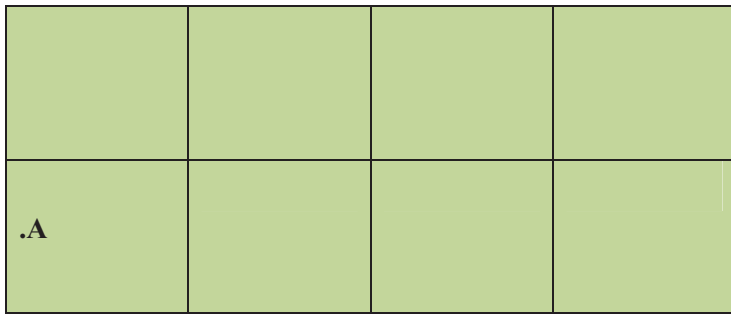
Now try the activity given below to master the skill of measuring the bearing.



Activity 2

Study the diagram given below

.T			z.
		B.	Q.



1. What is the bearing of:

(a) Z from A? _____

(b) Q from B _____

(c) T from B? _____

(d) B from Z? _____

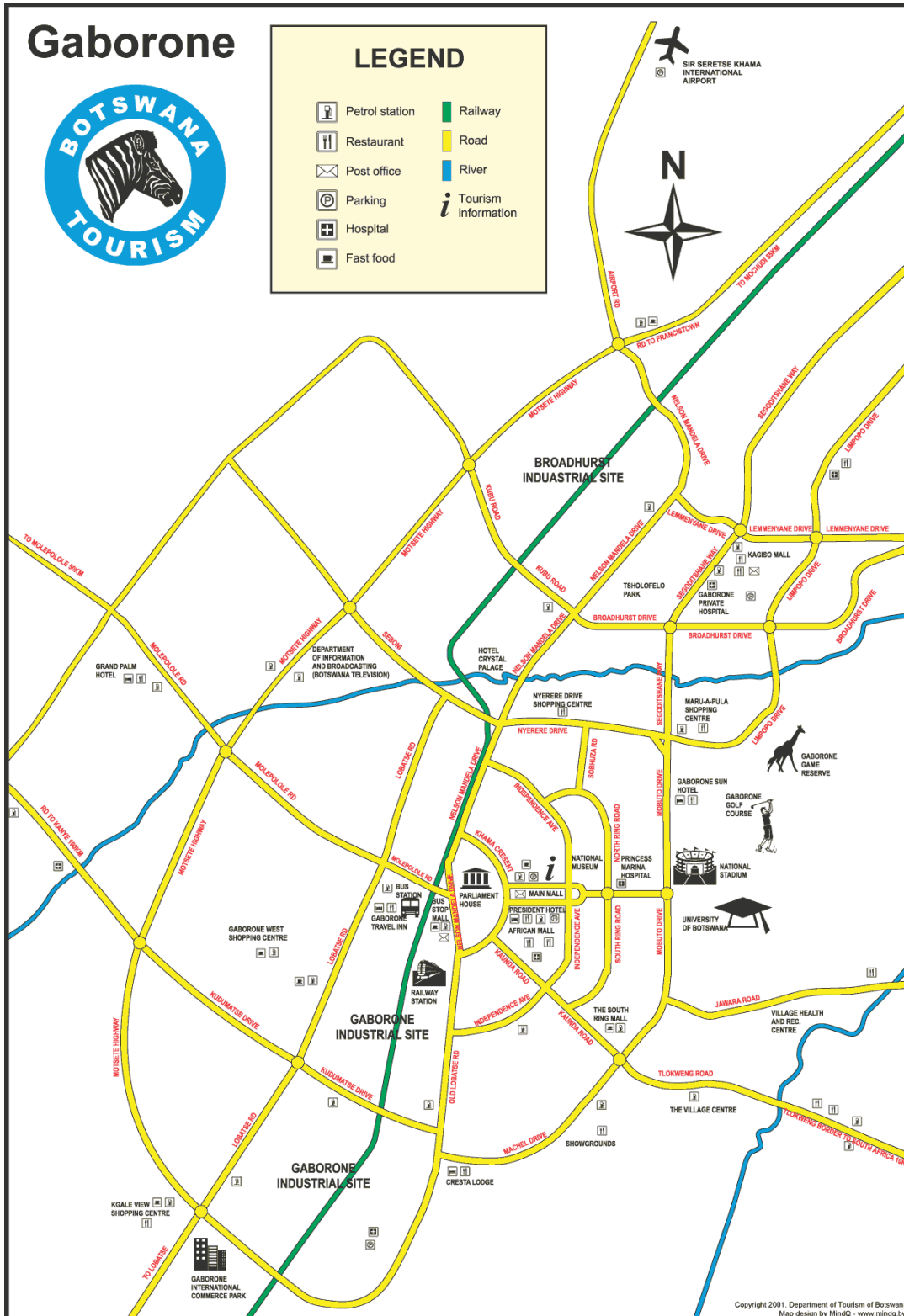
2. Study the map given below.

Gaborone



LEGEND

- | | | | |
|--|----------------|--|---------------------|
| | Petrol station | | Railway |
| | Restaurant | | Road |
| | Post office | | River |
| | Parking | | Tourism information |
| | Hospital | | |
| | Fast food | | |



Copyright 2001. Department of Tourism of Botswana
Map design by MindQ - www.mindq.bw

A tourist map of Gaborone downloaded from mappery.com/Gaborone-Tourist-Map on 4/12/10

Use the map above to calculate the bearing from

- (a) The University to Cresta Lodge
- (b) The aerodrome to the university
- (c) Gaborone Game reserve to the Cresta Lodge
- (d) Cresta Lodge to the National Stadium
- (e) The railway station to Grand Palm H

Each correct answer carries 2 Mark

Total 8 Marks

Feedback

1. What is the bearing of:
 - (a) Z from A is 45°
 - (b) Q from B is 91°
 - (c) T from B is 310°
 - (d) B from Z is 200°

You need to discuss the difficulties of calculating the bearing using the tourist map above with members of your study group. What challenges did you face? How did you try to address the challenges? You probably noticed that the map above has no clearly demarcated points. You still need to practice on your own so that you can perfect your skill in calculating the bearing.

Sometimes you may not only be required to measure the distance and calculate the bearing only, you may be required to calculate the area of both regular and irregular shapes. The sections that follows will give you practice in calculating the area of a map.

2.0 Calculating the Area on a Map

Now that you know how to find the bearing, let's see if you can master another skill: the skill of calculating the area on a map. What is the shape of a football field? What about the map of Botswana and the map of Lesotho (You may want to take a look at an atlas)? I am sure you observed that the football ground is rectangular. It therefore, has a regular shape. The maps of both Botswana and Lesotho have irregular shapes. You need to be able to calculate the area of both regular and irregular shaped maps. As with the previous skills, I request that you practise along with me.

2.1 Measuring Regular Shapes

To find the area of a regular shape such as a rectangle on a map, measure the length and breadth. Use

your previous knowledge to calculate the area of a rectangle.



Fig 17: Calculating the area of a rectangular shaped map

(Diagram created by author)

In a rectangular map, the opposite sides are equal. In the above diagram, the length would be X centimetres for AB and CD. The width AC and BD would be Y cm.

Use the scale of the map to calculate the actual ground distances of the measured sides. Then multiply the actual ground length by the actual ground width of the map.

Example 4



To calculate the area of JKLM, calculate the actual ground distance for JM and JL. If we use a scale of 1cm representing 1 km we get the following:

Length	9 km
Width	3 km
Area	= length x width
	= (3 x 9) km
	= 27 square kilometres

2.2 Calculating the Area of a Square on a Map

To calculate the area of a square on a map, first measure the length of one side of the map. Use the scale of the map to calculate the actual distance on the ground. Then multiply the length of the side by itself.

Example 5

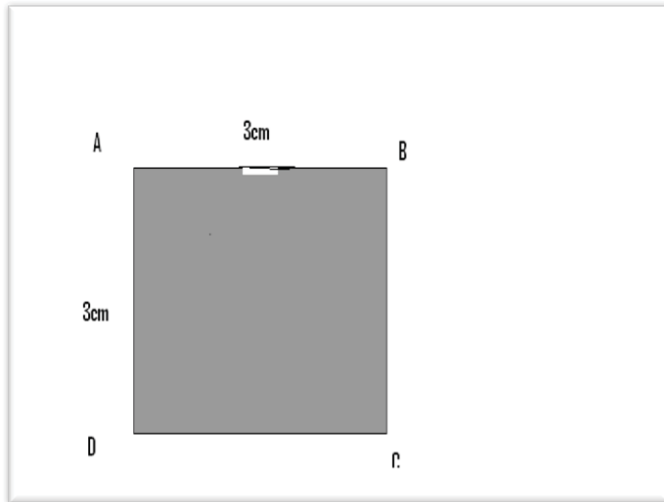


Figure 18 Calculating Area of a square map

Using the scale 1cm represents 1 km.

One side is 3 km

$$\begin{aligned} \text{Area of the square map ABCD} &= (3 \times 3) \text{ km} \\ &= 9 \text{ square kilometres} \end{aligned}$$

2.3 Measuring the area of a triangular area on maps

- (a) Measure the length of the base of the triangle.
- (b) Measure the length of the perpendicular from the apex to the base. (Use the scale to change the measurements to the actual ground distances).
- (c) Multiply the length of the base of the triangle by the perpendicular height and divide your answer by 2. (The formula to calculate the area of a triangle is half base multiplied by height).

Example 6

In the figure given below the length of the base BC of the triangle ABC is 6cm. The perpendicular height AQ is 4cm. Using a scale of 1 cm represents 1km. The length of the base is 6 km and the height is 4km.

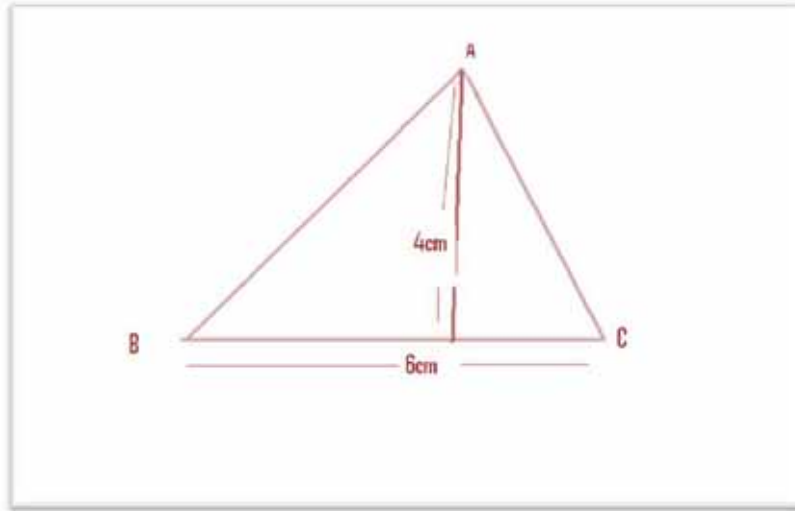


Fig. 19 Calculating Area of a triangular area on a map

The area of the triangular map ABC is $\frac{BC \times AP}{2} = \frac{(6 \times 4)}{2}$ Square km

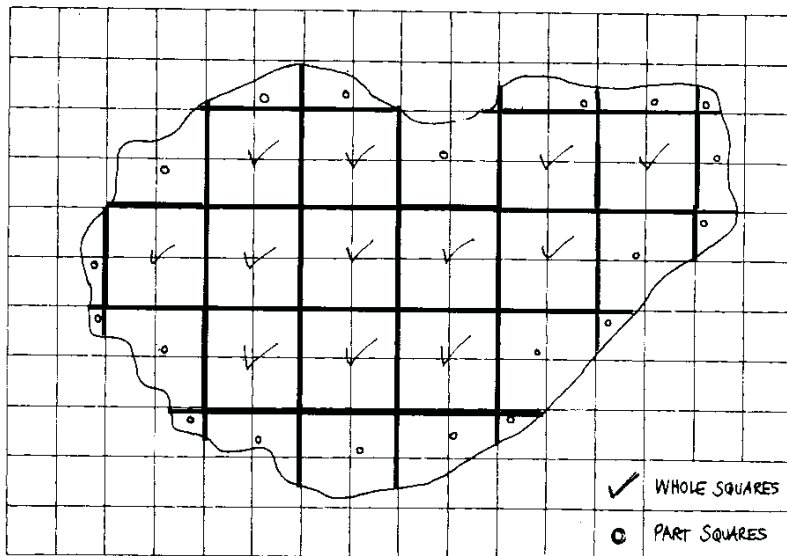
= 12 square kilometres

2.4 Measuring irregularly shaped areas on a map

1. Trace the outline of the section of the map whose area you want to calculate
2. Transfer the outline of the section you have traced to a piece of graph paper
3. Count the number of whole squares and part squares on the graph paper within the outline.

In the figure below there are 12 whole squares and 20 part squares. Part squares are counted as half squares. To change 20 part squares into complete squares you calculate $20/2 = 10$

The total area is therefore $12 + 10 = 22$ Square km



If you use a metric graph paper, one large square measures 2 x 2 cm. If the scale of a map is 1 centimetre to 1/2 kilometre or 500 metres, each large square is equivalent to 1 square kilometre of land. If a scale of 1 centimetre to 1 kilometre is used, then each large square represents 4 square kilometres of land.

Now try the activity given below.



Activity 3

1. A map measures 60 x 40 centimetres. Its scale is 1 centimetre to 1/2 kilometre. Calculate the area of the map in square kilometres.

The area of the map is _____

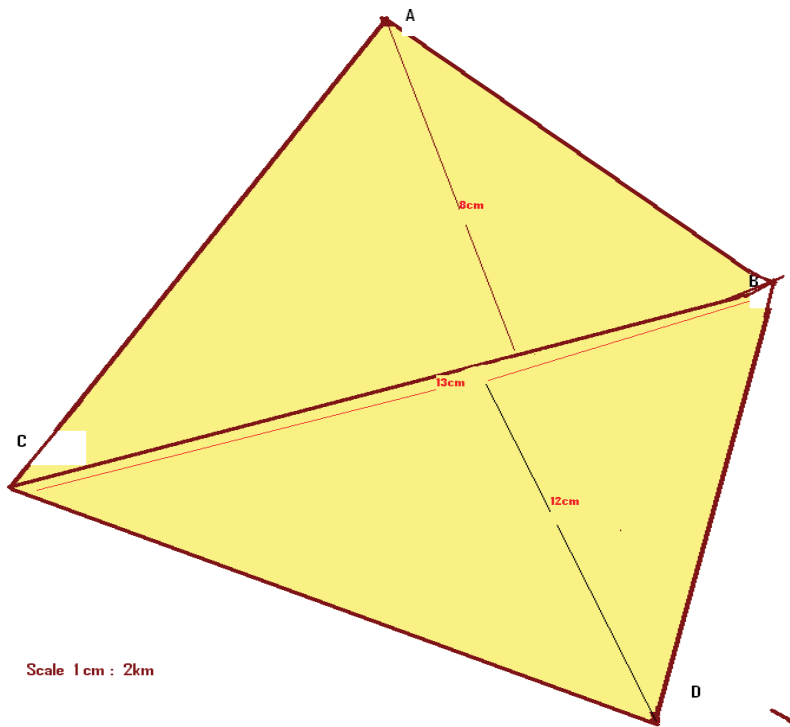
(2 marks)

2. A map measures 100 x 80 centimetres. Its scale is 1 centimetre to 10 kilometres. Calculate the area of the map in square kilometres.

The area of the map is _____

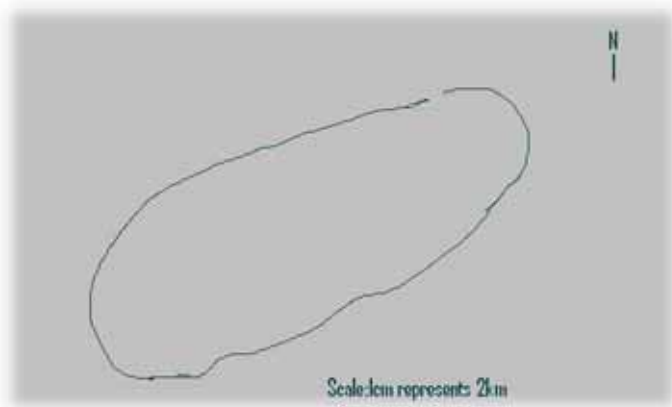
(2 marks)

3. Calculate the area of the field ABDC.



The area of the AABDC is-----

4. Calculate the area of Kasane forest



The area of the Kasane forest is _____

(4 Marks)

Total 8 Marks

Feedback

1. The area of the map is 600 square kilometres
2. The area of the map is 800000 square kilometres
3. 130km²
4. The area of the Kasane forest is 88 square kilometres

By now you should be able to use a scale, find directions and calculate bearing and calculate the area of regular and irregular shapes in maps. What you need to know now is how to calculate gradients. You may be wondering what a gradient is. To find out, read the section that follows.

2.5 Calculating the Gradient

Why do you think foot paths, roads and railway lines usually run on flatland? Why is it that they don't go straight up the steep slopes? Have you ever tried to run up a steep slope? You have probably found it difficult and tiring. If the slope is very steep and you are riding a bicycle, you may even get off the bicycle and push it instead!

A gradient is a measure of the slope between two points on a map. It is the change in height per unit of the distance you cover on the ground. For every unit, you go a certain distance across, for instance for every metre you go up, you may go 2 metres across (horizontal distance). A gradient is important in that it can show you how steep a slope is. It is given as a fraction, e.g. 1/3000 or more commonly, as a ratio e.g. 1:5000

To find this steepness or gradient of a slope work out:

- (a) the difference in height in metres between the lowest and the highest points along the slope- this is the vertical distance between the points
- (b) the length of the horizontal distance between the two points

The gradient is therefore: Difference in height (Vertical Interval) /Horizontal distance (Horizontal Equivalence)

Figure 20 shows a gradient triangle.

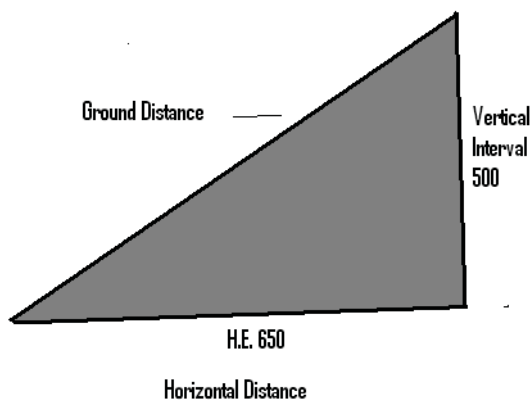
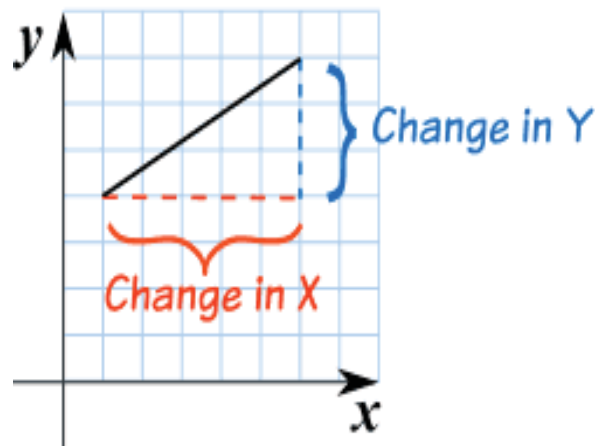


Figure 20: Gradient of a slope

In Figure 20, gradient equals the ratio of the vertical interval (V.I.) to the horizontal equivalent (H.E.):
 $500/650 = 1/1.3$ or $1:1.3$

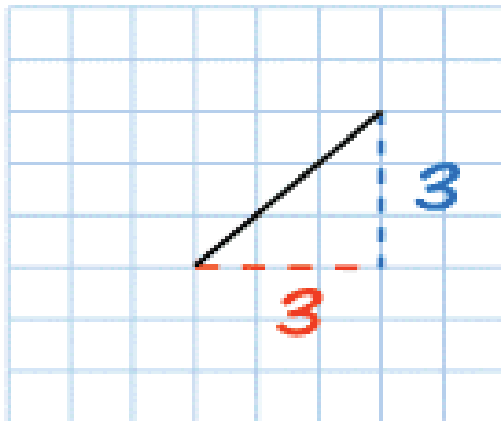
To calculate the Gradient:

Divide the **change in height** by the **change in horizontal distance**



Gradient = change in Y/Change in X

I have given you one more example for you to better understand gradient.



The gradient is $3/3=1:1$

The gradient is 1:1

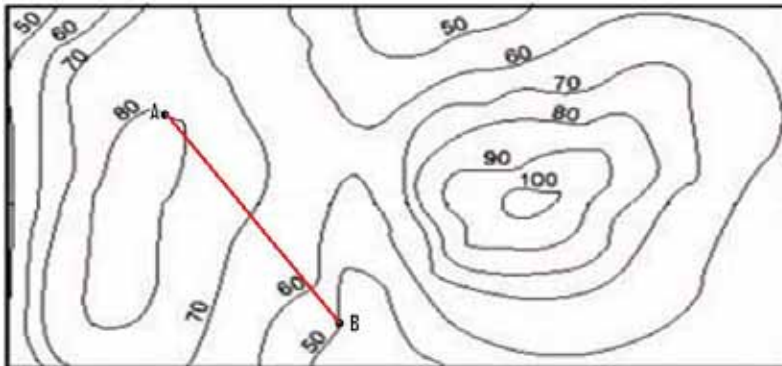
This means that the slope is very steep. Only mountain climbers can go up this slope! If the gradient is 1:10 for example, you may have to push your bicycle to go up the slope. If the gradient is 1:3 cars cannot proceed! Can you think of a reason why railway lines are constructed on fairly flat low land? It's because of their heavy engines and the large coaches and goods they carry. They cannot go up very steep slopes.

Now try the activity given below.



Activity 4

1. A gradient means: _____ [2 marks]
2. Find the gradient of the following:
 - (a) A to B where the difference in height is 100 metres and the horizontal distance is 4km. [2 marks]
The gradient is _____
 - (b) X to Y where the difference in height is 50 metres and the distance on the ground is 1.5 kilometres. [2 marks]
The gradient is _____
3. Given that the horizontal distance between A and B in the map given below is 5 km, work out the gradient from A to B.



The gradient is _____

Feedback

1. A gradient means a measure of a slope between two points on a map.
2. Find the gradient of the following:
 - (a) The gradient is 1:40
 - (b) The gradient is 1:30

3. The gradient is 1: 166.6

You may use any topographic map to practise calculating the gradient. If you feel that you have mastered the skill, then you can read the summary given below and then do the self-assessment exercise 2 given at the end of the unit.

3.0 Topic Summary

In this lesson you learnt that a compass is used for finding direction using the cardinal points. Direction can also be indicated through the bearing. Sometimes you may be required to calculate the area of a map. You first change the map measurements into ground measurements then do the calculations. You also learnt how to calculate the gradient, which is the rise in the slope of land.

Now try the self-assessment exercise 2 at the end of the unit. If you do well, then proceed to the next topic. However, if you find that there are skills that you still can't perform, then practise those skills till you master them before proceeding to topic 3 which is on other methods of locating features on a map.

Topic 3: Locating Features

Introduction

By now you know how to read symbols, scale and key on a map. However, you may still find it difficult to find particular places on a map. In topic 2 you learnt how to find direction using the compass cardinal points and by using the bearing. These methods of locating places are not always very accurate. They will only give you the direction from a given point. In this lesson, you will learn how to locate places using the lines of longitude and latitude. You will also learn how to locate places using the four and six figure grid references. You will also learn how to calculate time using longitude.

Topic Objectives

At the end of this topic, you should be able to:

- identify lines of longitude and latitude
- locate places using longitude and latitude
- locate places using the four- figure grid reference
- locate a place using the six-figure grid reference
- calculate time using longitude.

1.0 Locating Features on Maps

All along you have been practising such skills as interpreting symbols, using a scale, calculating distances on a map, calculating area, finding direction and calculating the bearing of one place to another. You probably noticed lines running either from the south to the north or from west to the east. What are these lines? Why do you think is the purpose of these lines on maps? In order to measure accurately the position of any place on the surface of the earth, a grid system has been set up. It pinpoints location by using two coordinates: latitude and longitude. These are purely imaginary lines tied to two fixed points established by the earth's motion. The two fixed point include the poles, or ends of the earth's rotational axis.

1.1 Lines of Latitude

Let us start with the lines of latitude. Lines of latitude are imaginary lines that cut horizontally across the map in an east-west direction. Figure 22 shows some of the lines of latitude as they appear on the globe.

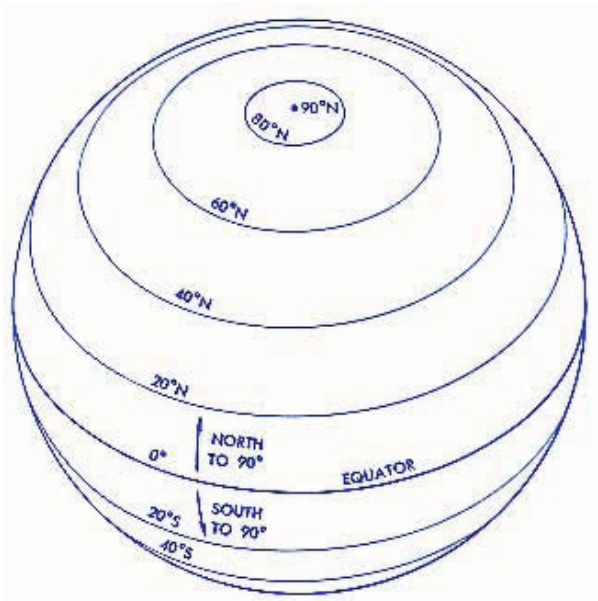


Figure: 22 Lines of latitude downloaded from [http://homepages.ius.edu/PGALVIN/lat long/Geographic%20Grid files](http://homepages.ius.edu/PGALVIN/lat_long/Geographic%20Grid_files) on 7/12/10

If you look at the above diagram, you will note that there is a horizontal line that divides the earth into two halves. This is the **Equator** and it is the longest latitude line (40075 Km around the middle of the earth). It divides the earth into two hemispheres. In the northern hemisphere (places north of the Equator), the latitudes increase as you go north and in the Southern hemisphere (places south of the Equator), they increase as you go south from 0° at the Equator to 90° at the poles. Note that the number showing latitude is always followed by the letter N if the place located is in the Northern hemisphere and S if the place is located in the Southern hemisphere.

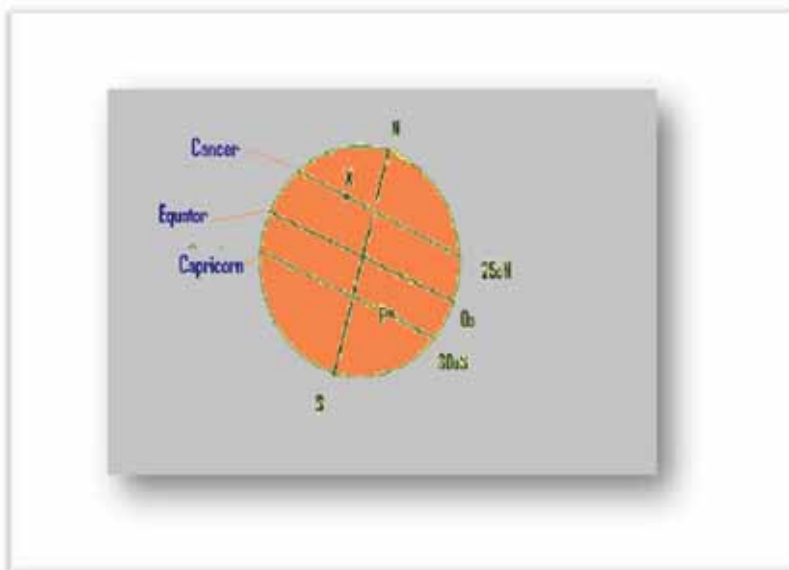


Figure 23 Sample lines of latitude

Important lines of latitude are the Equator (0 degrees), the Tropic of Cancer (23½ degrees N) the Tropic of Capricorn (23½ degrees south). The Tropic of Capricorn passes just 40 Km south of Mahalapye.

Besides understanding that latitude is important for locating various part of the globe, you also need to understand that different latitudes are also related to seasons. Seasons are caused by the tilt of the earth's axis. As the areas closer to the Tropic of Capricorn come closer to the sun, they become warmer , which causes summer in the southern hemisphere. Now what do you think causes winter? Obviously the areas farthest away from the sun experience cold temperatures and hence becomes winter for them! Note that areas that are close to the equator have high temperatures throughout the year.

In your study group discuss with others the importance of seasons on human activities. You may want to discuss what you do in winter, summer and in spring! Now let's discuss lines of longitude.

1.2 Lines of Longitude

Lines of longitude are imaginary vertical lines that connect the North Pole to the South Pole. These lines are called meridians. They show the angular distance to places east or west of the Greenwich Meridian. Figure 24 shows you the lines of longitude. Longitude 0 (zero) degrees runs through a place in London known as Greenwich and this zero line is referred to as the Greenwich Meridian.

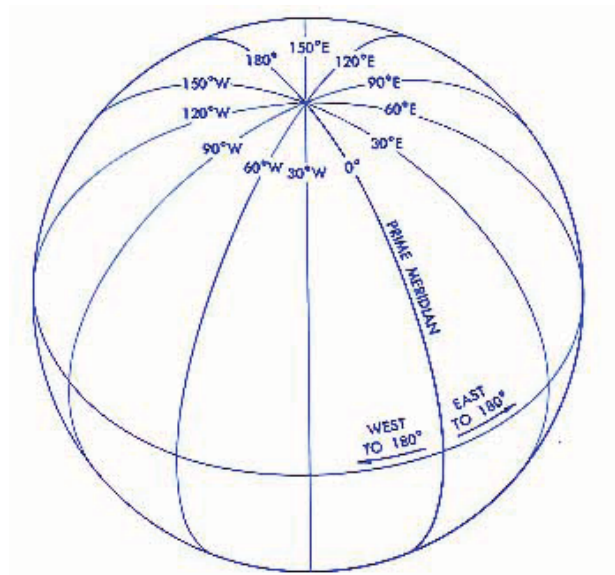


Figure 24: Lines of longitude (Adapted from [http://homepages.ius.edu/PGALVIN/lat long/Geographic%20Grid files](http://homepages.ius.edu/PGALVIN/lat_long/Geographic%20Grid_files) on 7/12/10

The Greenwich Meridian divides the earth into two hemispheres: the eastern and western

hemispheres. The lines of longitude on the eastern hemisphere increase in degrees eastwards while those in the western hemisphere increase in degrees westwards. The lines of longitude start from 0° to 180° either east or west. Each degree of meridian consists of 60 minutes (') of arc and 1 minute consists of 60 seconds (") of arc. On the earth's surface 1 degree of longitude is equivalent to approximately 111km at the equator. You can use your atlas to note all the important latitudes or longitudes.

Example 1

R lies along 120°W , S lies along longitude 60° . Q lies along longitude 120°E while P lies along longitude 60°E .

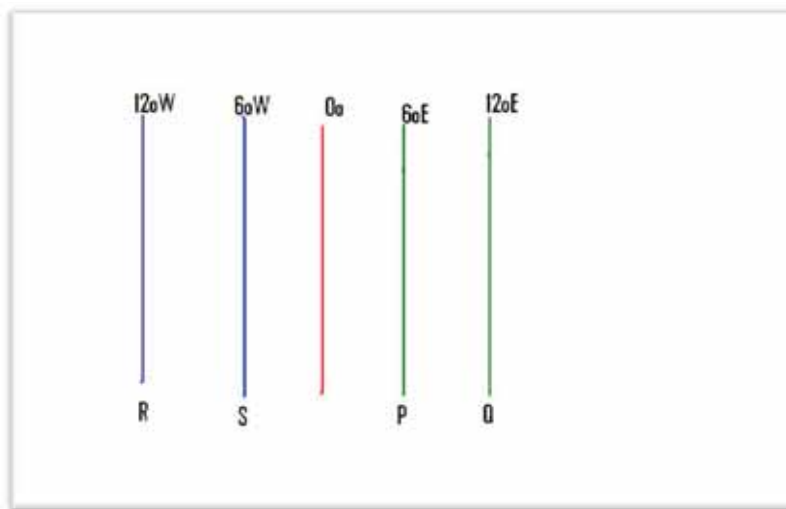
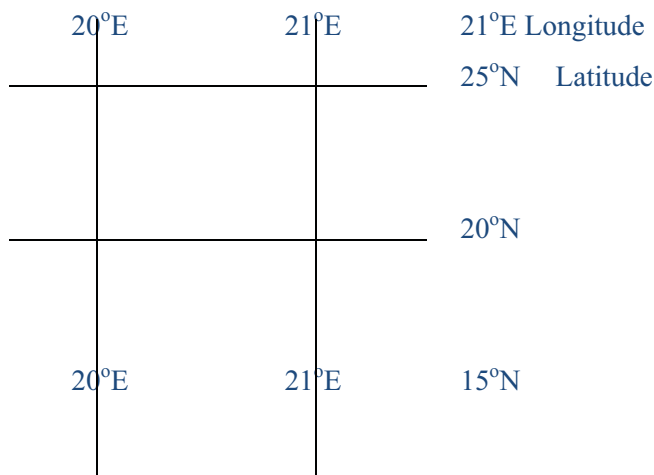


Fig 25: Sample location

A network of lines of latitude and longitude is referred to as **graticule**. In most topographic maps, the lines of latitude and longitude are marked at intervals of 1 degree. You will note that these lines are sometimes coloured differently from other lines on maps. You will be able to notice them by their labelling which is either the number of degrees east or west if they are longitudes and the number of degrees north or south if they are latitudes.



20°E

20°E

Fig 26: Lines of longitude and Latitude

The value of these lines of longitude and latitude are often marked on the edge of a map as shown above. Botswana is in the Southern Hemisphere and therefore, lies south of the Equator. The lines of latitude increase southwards as shown in figure 27 below.

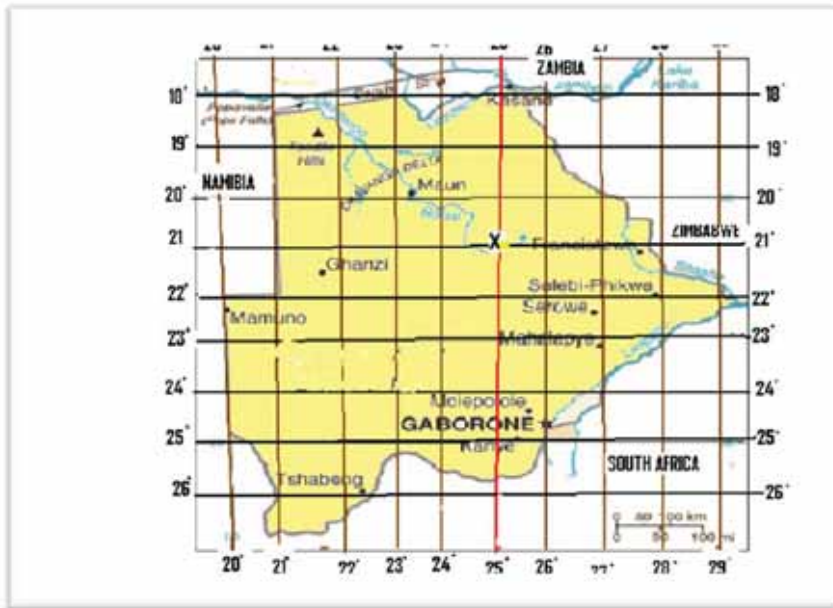


Fig27: Map of Botswana showing lines of latitude and longitude adapted from www.geographicguide.net/africa/botswana.htm on 7/12/10

Botswana also lies east of the Greenwich. Can you identify Ghanzi? It is near latitude 21° 46'S and longitude 21°45'E.

The examples given were easy because they lie almost along the lines of latitude and longitude. Sometimes places that you may want to locate may not be found lying along the lines of latitude and longitude.



Activity 1

Using the map of Botswana (figure.27) locate position X using lines of latitude and longitude.

Total 2 Marks

Feedback

You can see that X lies along 21°S . It also lies on longitude 25°E . Therefore, the position of X is latitude 21°S and longitude 25°E .

On maps that show small areas in more detail, both latitude and longitude may be expressed in degrees and minutes. For instance, you may say $25^{\circ} 30' \text{S}$ (25 degrees 30 minutes south). There are 60 minutes in 1 degree. Look at figure 27 again. You notice that the lines of longitude increase eastwards.

By now you obviously are aware that for you to perfect your map reading skills, you need to practise using maps. Look for a large scale map and practise locating places with your group mates in your study group.

Now we need to use both the longitude and latitude

1.3 Locating Positions Using Latitudes and Longitudes

The procedure when reporting longitudes and latitudes to give the position of a place is to mention the latitude **first** before the longitude. The identified latitudes and longitudes should be quoted in degrees and minutes.

Example 2

Use the map of Botswana (Fig.27) on which lines of latitude and longitude is shown in whole degrees. To locate the position of Molepolole follow the steps below:

Step 1: Locate Molepolole on the map (South Eastern Botswana).

Step 2: Identify the latitude that passes near Molepolole. It is 24°S .

Step 3: Then identify the longitude that passes near Molepolole. It is 25°E

Therefore, the position of Molopolole is latitude 24°S and longitude 25°E .

Now, calculate the latitude and longitude of Gantsi using the same map (Figure. 27).

First, you must decide whether Gantsi is in the Northern or Southern Hemisphere. Are the latitudes increasing southwards or northwards? They are increasing southwards which means Gantsi is in the Southern Hemisphere. It means those latitudes should be labelled $^{\circ}\text{South}$ ($^{\circ}\text{S}$).

Look carefully at the longitude lines. Are they increasing in an easterly or westerly direction? They are increasing in easterly direction. This means that Gantsi is in the eastern hemisphere. It means all the longitude lines should be labelled $^{\circ}\text{East}$ ($^{\circ}\text{E}$).

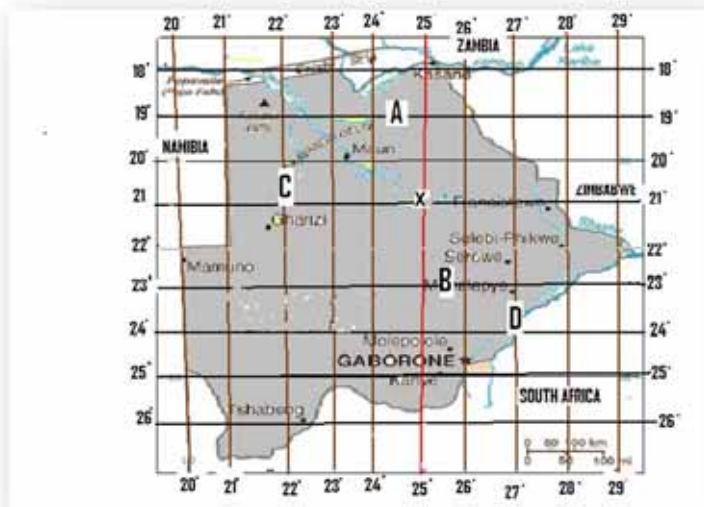
Read off the latitude Gantsi, which is $23^{\circ} 45' \text{S}$ and the longitude of Gantsi which is $22^{\circ} 45' \text{S}$.

Now try the activity given below.



Activity 2

Study the map given below and answer the following questions.



Map of Botswana adapted from www.geographicguide.net/africa/botswana.htm on 7/12/10

1. Give the numbers for the:
 - (a) Lines of latitudes A and B

A is _____ [1 mark]

B is _____ [1 mark]
 - (b) The lines of longitude C and D

C is _____ [1 mark]

D is _____ [1 mark]
2. Calculate the latitude and longitude of Francistown

It is _____ [1 mark]
3. Calculate the latitude and longitude of the following countries:



A Political Map of Africa adapted from gifmapmaker.rutgers.edu on 7/12/10

- (a) Angola
- (b) Lesotho
- (c) Botswana
- (d) Namibia

(e) South Africa

(f) Madagascar

Marks

Total 6

Feedback

1. A is 19°S

B is 23°S

C is 23°E]

D is 23°E

2. It is latitude 21°S and longitude 27°E.

How did you locate countries that cut across the latitudes and longitudes? Discuss this with your study group. You may even pass it on to your tutor if you are not certain.

This is what you have learnt so far. You have learnt how to identify lines of latitude and lines of longitude. Lines of latitude are horizontal lines whose values increase as you move away from the equator. The values increase northwards in the Northern Hemisphere and southwards in the Southern Hemisphere. The lines of longitude are vertical lines that join the North and South poles. The Greenwich meridian divides the earth into the Western and Eastern Hemisphere and it is 0° longitude. Lines of longitude increase in value from the Greenwich meridian. A network of lines of latitude and longitude is referred to as **graticule**. You have also learnt how to locate places using latitude and longitude. Now let's discuss another way of locating places using the grid reference.

1.4 Locating Places Using the Grid Reference

You have seen that we can locate a place on a map using lines of latitude and longitude. Sometimes we use grid lines to locate places on a map. These are horizontal and vertical lines drawn on the face of a map, which divide the map into squares. These squares can be divided into smaller squares. In fact, a grid is the same as a graticule. The only difference is that it is not based on latitude and longitude.

Study the map of Gaborone below.

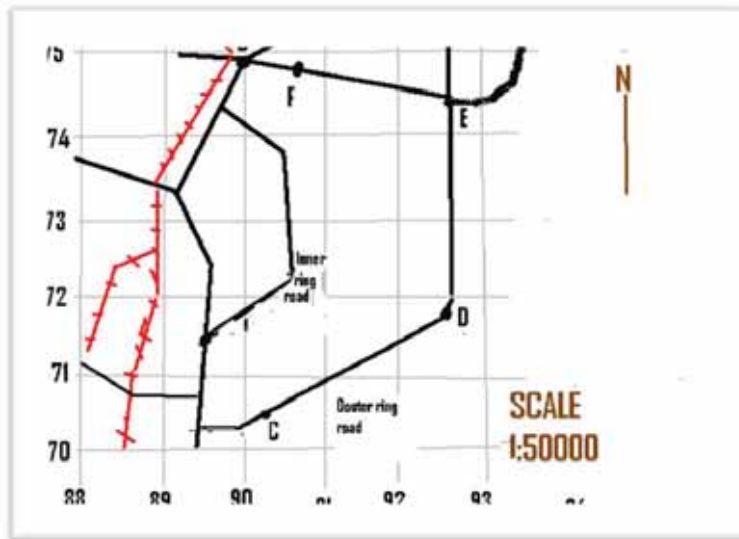


Fig 28: Map of Gaborone (Adapted from maps.nationmaster.com/country/bc/1 on 7/12/10)

You will observe that it is divided by grid lines. On this map, 2 centimetres represent 1 kilometre, so each grid square covers 1 square kilometre. Some of the most common grids are based on squares with sides that represent 1 km, 10 km and 100 km.

The numbering starts from a single point, which is usually the south-western corner of the entire grid for the country or area of the continent. This is known as the grid origin.

On the map of Gaborone you can see the vertical lines running from the north to the south. These vertical lines are known as Eastings. Diagram below shows you the Eastings 88,89,90 and 91.

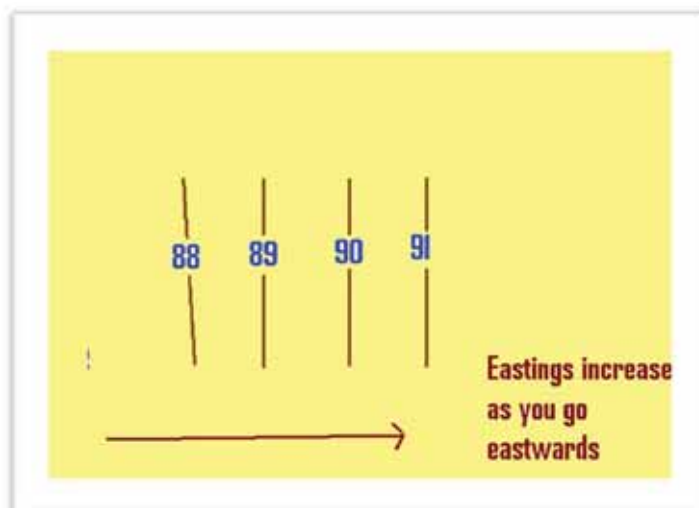


Fig 29: Eastings

Note that eastings figures increase as you go eastwards from the grid origin. For example, in the above diagram, easting 90^0 lies east of easting 89^0 .

(a) Northings

These are horizontal lines which run from the south to the north.

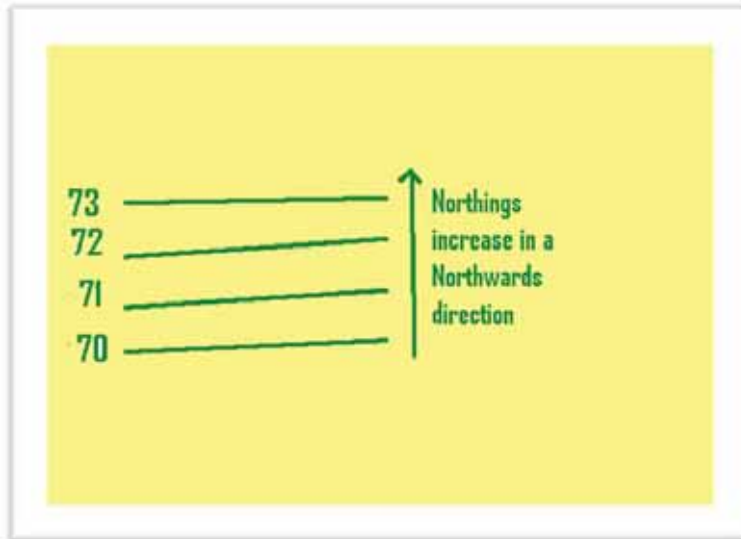


Fig 30: A sample of northings

The northings increase in a northwards direction. In the above diagram, for example, northing 73 is north of northing 72.

If we combine the eastings and the northings we get a grid with equal squares as shown in Fig. 31

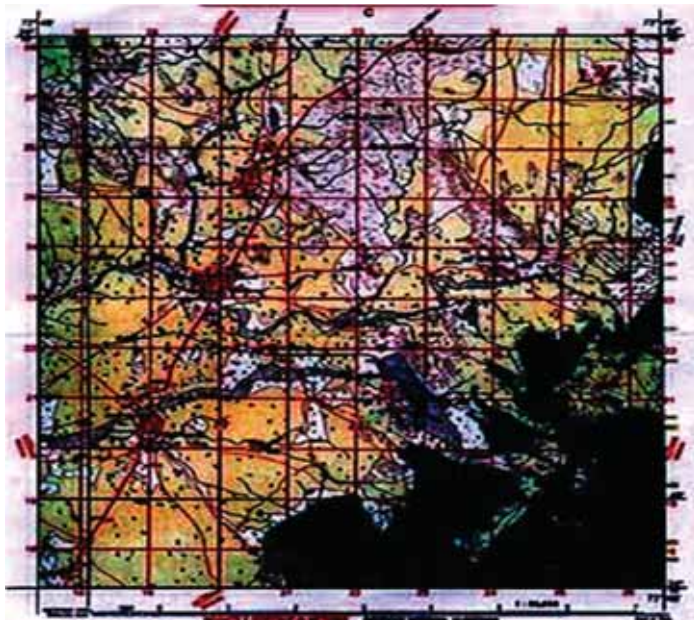


Fig 31; A Map showing a graticule downloaded and modified from <http://brhectorsgeoworld.blogspot.com> on 7/12/10

The vertical lines are the eastings increasing eastwards and the horizontal ones are the northings increasing northwards. Smaller figures that appear on the bigger figures should be disregarded when giving grid references. You now need to actually practise how to locate a place using the grid reference.

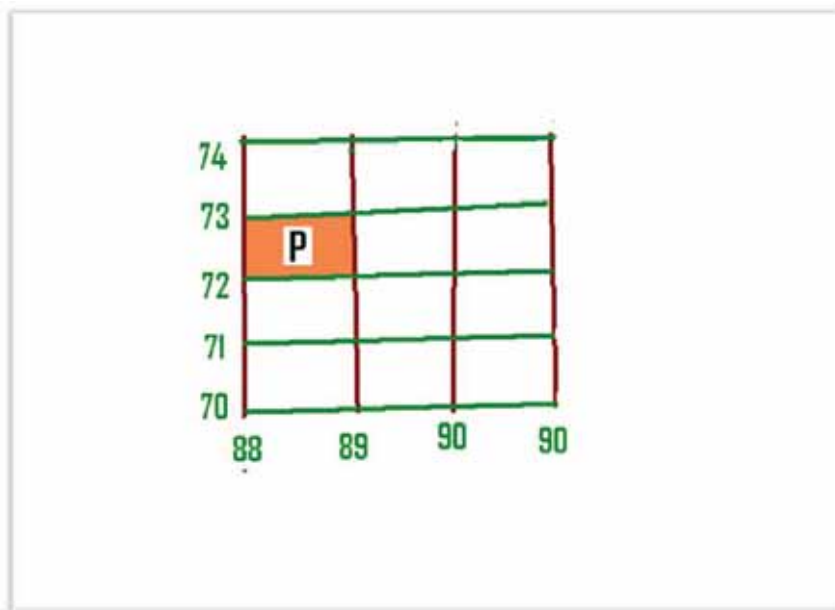
1.5 Locating Places Using the Four Figure Grid Reference

The grid lines are used for the accurate location of places on topographical maps. Each grid square may be given a four-figure reference.

Example 3

What is the grid reference of the shaded square P?

Remember, that the vertical lines are the eastings, increasing eastwards and horizontal ones are the northings, increasing northwards.



Step 1 Locate the bottom left corner of the shaded square P. At this point, two grid lines, an easting and a northing intersect. The easting forms the western edge of the square and the northing forms the southern edge.

Step 2 State the number of the easting that forms the western edge of the square. The number is 88.

Step 3 State the number of the northing that forms the southern edge of the square. The number is 72.

Step 4 The four-figure grid reference for square P is 8872.

Now try the activity below on your own and see if you can locate the given squares using

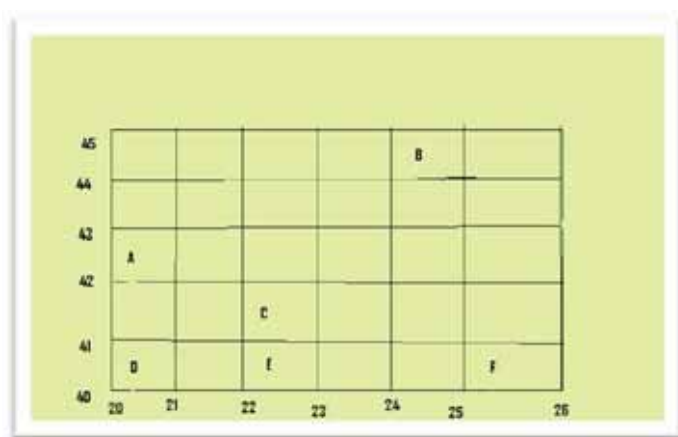
the four-figure grid reference.



Activity 3

Study the grid given below.

Locate the squares A, B, C, D, E and F using the four-figure grid reference.



- A. _____ [2 Marks]
B. _____ [2 Marks]
C. _____ [2 Marks]
D. _____ [2 Marks]
E. _____ [2 Marks]
F. _____ [2 Marks]

Total = [12 Marks]

Feedback

Did you get them right? I hope you remembered to start with the eastings first and northings second.

- A is 2042
B. is 2444
C. is 2241
D. is 2040
E. is 2240
F. is 2540

To get a more accurate location we use a six figure grid reference. Have you used it before? Explain how the six figure grid reference is used to get a more accurate location. Check the discussion and practice that follows.

1.6 Locating Places Using the Six Grid Reference

The four-figure grid reference can only locate the position of the whole square. A more accurate method of locating places is the six-figure grid reference. Carefully study the example given below.

Example 4

The diagram below (figure 32) shows a grid for 1:50,000 scale map. There is a Church (B) in one of the grid squares. The 4-figure grid reference to this square is 6613. You should fix the position of the church more accurately using a 6-figure grid reference.

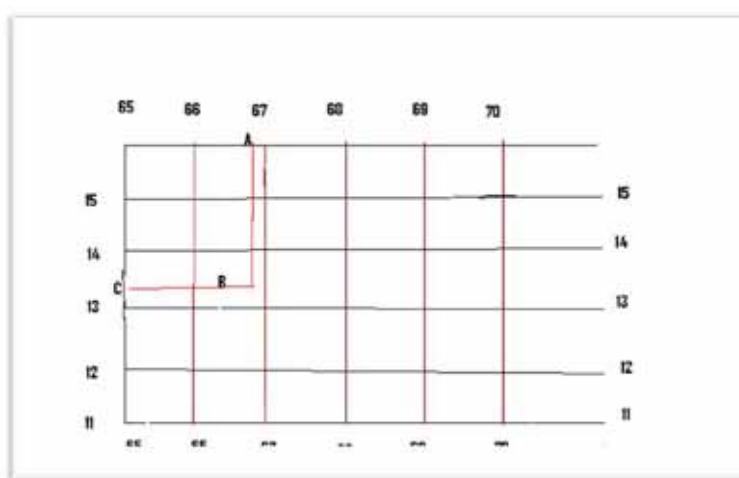


Fig 31: A grid for 1:50,000 scale map

To fix the position of the church you should follow the steps given below:

Step 1 Draw lines AB, BC as in the diagram.

Step 2 Estimate the position of A in relation to 66 and 67 by imagining the line between 66 and 67 is divided into ten equal parts. A is 8/10 of the distance between 66 and 67. The easting is written as 668.

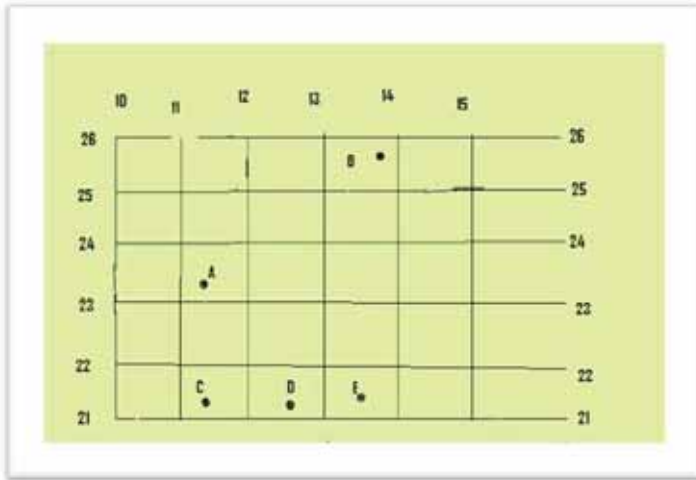
Step 3 Estimate the position of C in relation to 13 and 14 as you did in Step 2. B is 3/10 of the distance between 13 and 14. The northing is written as 133.

Step 4 The 6-figure reference of the church (B) is therefore 668133.

Now try the activity given below on your own.

Activity 4

Find the six-figure grid reference for A, B, C, D and E given in the grid below.



A is _____ [2 Marks]

B is _____ [2 Marks]

C is _____ [2 Marks]

D is _____ [2 Marks]

E is _____ [2 Marks]

Total = [10 Marks]

Feedback

A is 114232

B is 138258

C is 114212

D is 126212

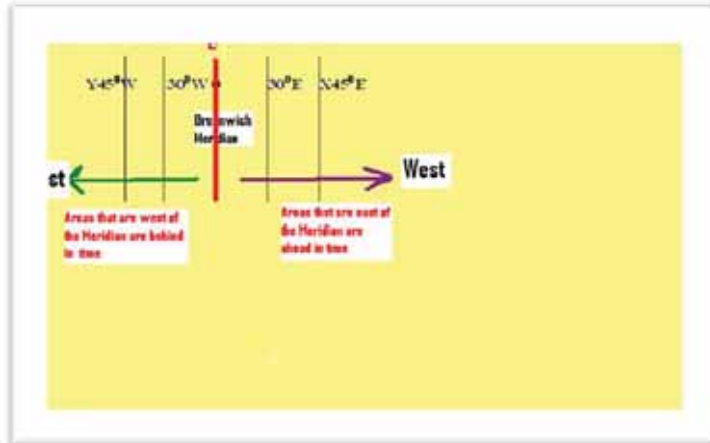
E is 135214

Like any other skill, you need to practise this as much as possible. If you have mastered this skill, proceed to the next section where we learn how to use lines of longitude to calculate time.

1.7 Using Lines of Longitude to Calculate Time

Lines of longitude are sometimes used for calculating time. Time is an important concept in everyday life. We shall only look at the simple aspects of time.

The earth takes 24 hours to complete a rotation. In other words, it takes 1440 minutes for it to turn 360 degrees. From these figures it is clear that the earth takes 1 hour to turn around 15 degrees. It takes 4 minutes to turn around 1 degree. Using these basic facts, **we can calculate time for any given area.**



However, you need to first understand the role of the Greenwich Meridian in the calculation of time. The Greenwich Meridian is the 0 degrees longitude. Time is calculated from the Greenwich Meridian. The areas which are to the east (right) of the Greenwich meridian are always ahead in time. All the areas to the west of the Greenwich Meridian are behind in time.

Example 5

It is 2.00 p.m. at the Greenwich Meridian. What time would it be at a place X, 45 degrees east?

Time at Greenwich is 2.00 p.m.

Longitude at Greenwich is 0 degrees.

Longitude at the place X is 45 degrees east

Difference in degrees is 45 degrees.

Difference in time is $(45/15)$ that is 3 hours.

Since X is east of the Greenwich Meridian then it means that it is ahead in time.

3 hours ahead of 2 pm is (2hours +3 hours) 5 p.m.

Therefore the time at X is 5 p.m. the same day.

What is the time at Y which is to the west of Greenwich meridian?

To answer this question, you will follow the same steps as above but instead of saying 3 hours ahead of Greenwich Time, because it is west of the Greenwich, you will say it is 3 hours behind 2:00 pm.

The time at Y is therefore 11:00 am the same day.

Imagine what would happen if Mahalapye and Francistown had different times! What problems would be caused by differences in time within the same country? Discuss this with members of your study groups then read on to the next section which will provide you with some of the problems that are likely to arise.

(a) Standard time (local time)

Different areas within the same country or region often use the same time. They use the same line of longitude to calculate their time. This helps to avoid confusion between areas in the same region. Countries in the Southern African region use the 30 degrees line of longitude for calculating their local time. This is the reason why Botswana, South Africa, Lesotho and Zimbabwe have similar

times. When calculating standard time you will need to find the differences in the longitude lines used, determine whether it lies to the east or west and then calculate the time difference.

Example 6

The time in Gaborone is 6 p.m. on Monday. Gaborone lies along 30 degrees longitude. Calculate the time at Singy, which lies along 45 degrees East longitude.

Differences in degrees between Gaborone and Singy is $(45-30) = 15$ degrees.

Difference in time is 1 hour.

Is Singy to the West or East of Gaborone? It is to the East.

Then it must be ahead of Gaborone's time.

Therefore, it is 1 hour ahead of 6 p.m. The time at Singy is 7:00 p.m.

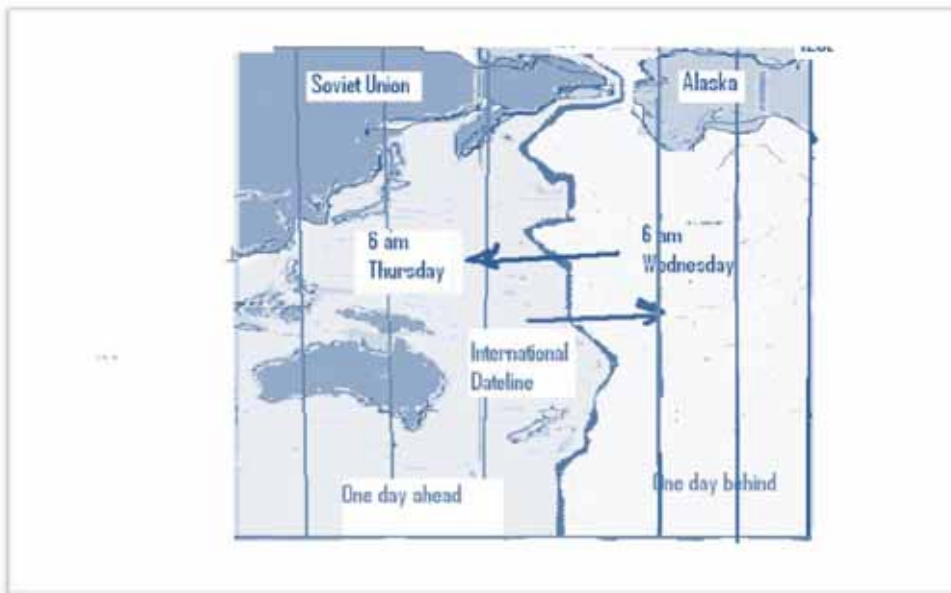


Figure 32: International dateline adapted from astro.sunysb.edu on 7/12/10

(b) The international dateline

The international dateline is an imaginary line that runs roughly along 180 degrees. Its purpose is to adjust for the difference in time of one day if eastwards or westwards. If you were to travel right round the earth you would either lose or gain one day depending on the direction in which you would be travelling. The International dateline lies in the middle of the Pacific Ocean and avoids areas with settlements, as this would cause confusion in time. So each time you cross the international dateline you either lose or gain a day.

2.0 Topic Summary

In this topic you have learnt that lines of latitude are imaginary lines that run from the Equator to the

poles. The Equator is the line of latitude that divides the earth into two hemispheres. The imaginary vertical lines running from the east to the west are called lines of longitude. A network of these lines is known as a graticule. In this topic you have learnt how to locate positions using latitude and longitude. A more accurate method of locating places is by using the 4-figure and the 6-figure grid reference. Using these you were able to locate the exact positions of places in maps. Furthermore, you have learnt that longitudes can be used for calculating time.

Congratulations! You have completed this topic. Now attempt the self-assessment assignment 3 at the end of this unit. Check your answers from the feedback for the assignment. If you have mastered all the skills in this topic then you can proceed. However, if you still have difficulties with some of the questions, you need to further discuss the topic section with your study mates. You may even ask for help from your tutor. If you are finished doing so, then go on to topic 4 on land forms.

Topic 4: Identifying Landforms on Maps

Introduction

You have studied many types of landforms in your Junior Certificate Social Studies course or in your Geography course. In your own locality, I am sure there are many different types of landforms. Can you name some of the landforms?

You probably mentioned such landforms as hills, mountains, seas, rivers and valleys among many others. In topic 1 you were asked to draw a map of your village showing the major features. You probably had problems in showing the relief of the land (the variations in height). Your map probably did not indicate to the reader how the land rose or fell. Map-makers often have problems showing these landforms because they involve different heights. On a map of a large area, it is important to show changes in the height of the land or difference in elevation. We shall discuss how to represent height in the course of this topic.

Topic Objectives

At the end of this topic, you should be able to:

- read, interpret and describe various relief features by using contours
- describe ways of representing relief
- describe a landscape in relation to a contour and drainage pattern
- identify the relationship between landforms and land use.

1.0 Ways of Showing Relief

The earth's surface is made of many types of land forms like mountains, hills, valleys, lakes, rivers among many others.

These features or landforms have to be represented on a map so that the map can serve the purpose of guiding people who use the earth's surface. In the following sections we will learn the various types of landforms and how these can be identified on maps.

1.1 Profiles

The earliest method of showing landforms on maps was by using profiles or outlines. These showed the physical features as they appear when viewed from the ground.

Write down in your field note book what you think is the greatest weakness of this method of representation? I hope you mentioned that a major weakness of this type of representation is that it does not indicate distances and heights and it does not show all the details.

1.2 Hill Shading

Another method of showing landforms is by hill shading. In such instances the light area usually represents the higher areas. The shadows are drawn as if the light rays are vertical. This gives the wrong impression that lighter coloured slopes are less steep. Hill shading is sometimes accompanied by spot heights.

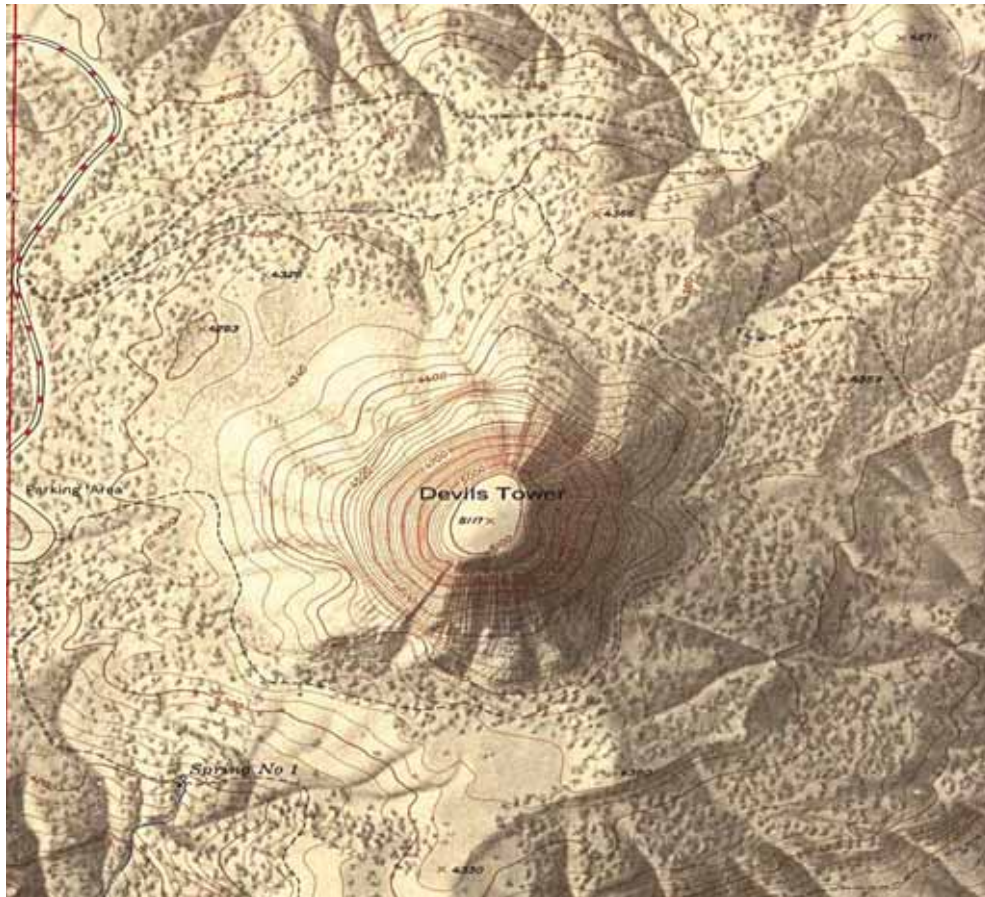


Fig 34: An example of hill shading downloaded from http://www.lib.utexas.edu/maps/national_parks/devils_tower.jpg on 7/12/10

Note that in hill shading as shown in figure 34, the steeper the slope, the darker the shadow will be. Flat land will appear well lit. This method is hardly ever used in Southern Africa.

1.3 Hachuring

This method uses short lines known as hachures to show the direction water would flow. If the slope is very steep, the hachures are close together, on a gentle slope, the lines are widely spaced. On flat land there is no shading. In steep areas **hachures** can be so close that you cannot see other features. Again, hachuring is not used as much in the maps of Southern Africa.

1.4 Layer Shading

This method is sometimes referred to as layer colouring and is used to show height on physical maps in atlases. For example, in most atlases, green is used to show low lands while the brown colour shows high areas. In this case, hills and mountains will be shown by a brown colour.

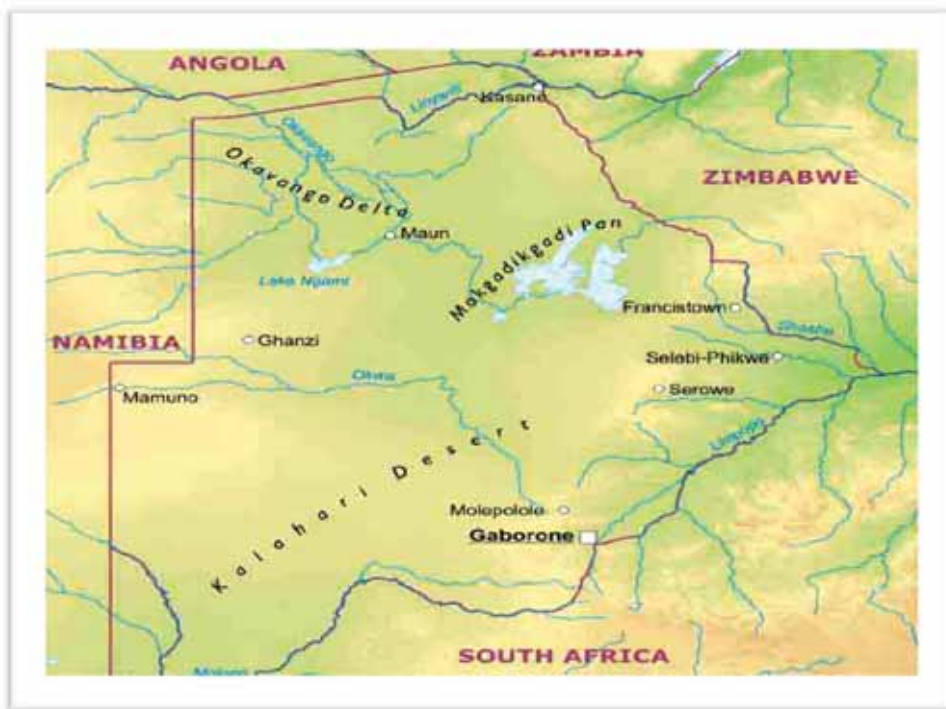


Fig 36:
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na downloaded from [Maps.com](https://www.maps.com) on 7/12/10



Activity 1

Study the map of Botswana in figure 36. Then answer the following questions.

1. In which part of the country is the highest land found? [1 mark]
2. Which colour is used to show the lowest part of the land? [1 mark]
3. In which part of the country is the lowest land found? [1 mark]
4. What colour is used for showing rivers? [1 mark]
5. What is the disadvantage of using the colouring method?

Total = [4 marks]

Feedback

1. The highest part is around Mamuno (1 Mark)
2. The lowest part of the land is shown by the green colour [1 mark]
3. The lowest part is found around the Okavango delta. [1 mark]

4. Rivers are blue[1 mark]

5. It does not give the actual altitude and does not show the height of particular relief features such as hills.

You may recall that earlier on when learning about map symbols we said some colours are used to represent certain features. Now that you have looked at different maps, what conclusion can you draw? Do maps use the same symbols and the same colours to represent certain features? Discuss this with your study group and if necessary check with your tutor.

1.5 Point Elevations

When map- makers are carrying out a mapping survey of an area, heights of certain points such as summits of hills are accurately measured to a fraction of a metre. These are referred to as point elevations. Point elevations include trigonometrical stations or, beacons and spot heights.

(a) Trigonometrical stations

These are sometimes known as triangulation stations. These are concrete pillars or beacons erected by surveyors on hill summits from which there are good views of the surrounding country.

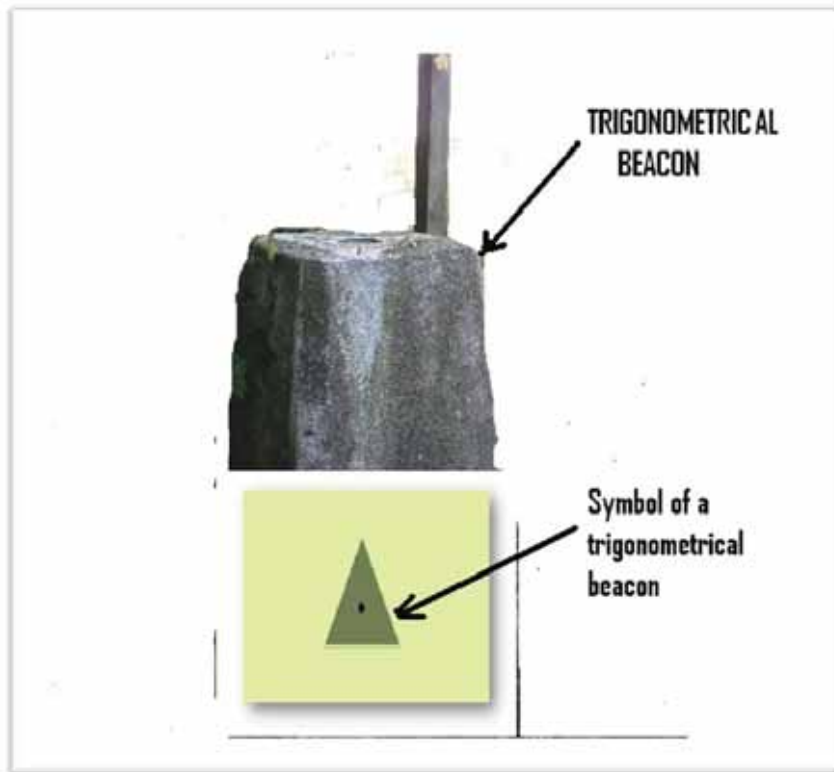


Figure 37: A trigonometrical beacon adapted from [flickr.com/photos/kinetawherlock/3759010364/](https://www.flickr.com/photos/kinetawherlock/3759010364/) on 7/12/10

The surveyors use the pillars for mapping the area. The method used for mapping from a **trigonometrical beacon** is called triangulation ground survey (figure 37). In this method, the land being surveyed or mapped is divided into a series of triangles with individual trigonometrical beacons forming their summit. Figure 36 shows a sample of a trigonometrical beacon. These accurately measured points are mostly on higher ground, on hill tops and mountain tops. You can practise reading altitude from these symbols using the map given below.

Example 1

Study the map of Palapye area given below:

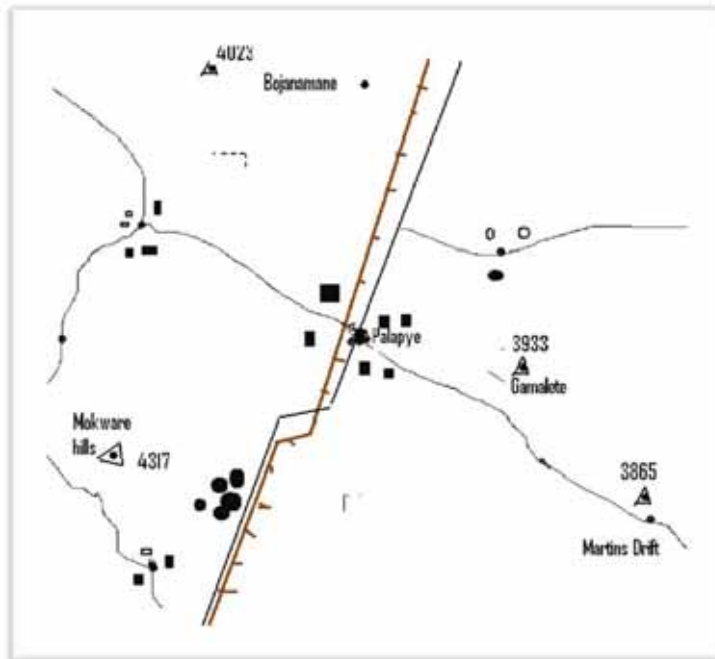


Figure 38: Map of Palapye (Drawn by author)

Give the heights of the trigonometrical beacons found:

- (a) next to Gamalete
- (b) West of Bojanamane
- (c) in the Mokware hills.

To find the heights, first identify the feature then read the height as given.

- (a) The trigonometrical beacon next to Gamalete is 3933m.
- (b) West of Bojanamane it is 4023m
- (c) In the Mokware hills it is 4317m.

(b) Spot height

These are usually measured to the nearest metre. There is no physical evidence of them on the ground. They are represented on maps by the following symbol:



Figure 39: A Spot Height

The symbol above means the spot height given on the map is 3452 metres above sea level. Note that land height or altitude is measured from the sea level that is 0 metres.

(c) Bench marks

Sometimes, land height or altitude is shown on walls of buildings or brass plugs on concrete blocks. These are known as benchmarks. The symbols used are like the following:

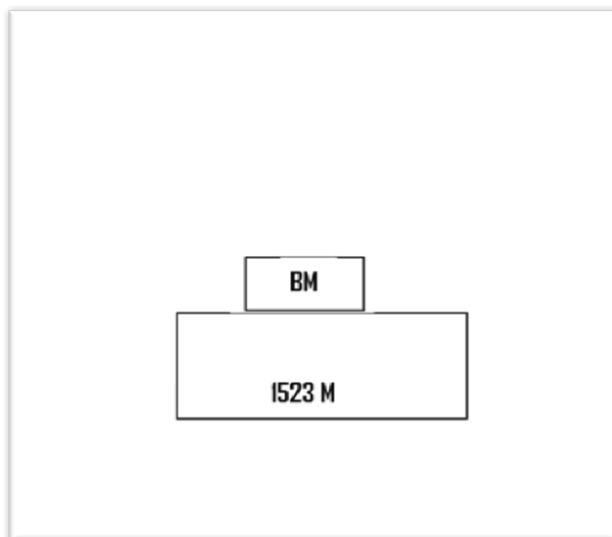


Fig 40: A Bench Mark

The above symbol would mean that the mark on a wall or a concrete block is 1523 metres above sea level (figure 40).

These should have been easy for you because once they were identified, you simply needed to read

off the altitude. You will practise interpreting these later when reading contour maps. Now you need to understand what contours are.

1.6 Contours

Contour lines are the most common way of showing height on topographical maps. Contour lines are lines drawn on a map passing through places of equal height above sea level. If you walk along a contour line you neither gain nor lose elevation. For example, if you walk along contour line QPZ below, you do not gain or lose elevation. You still remain 10 m above sea level.

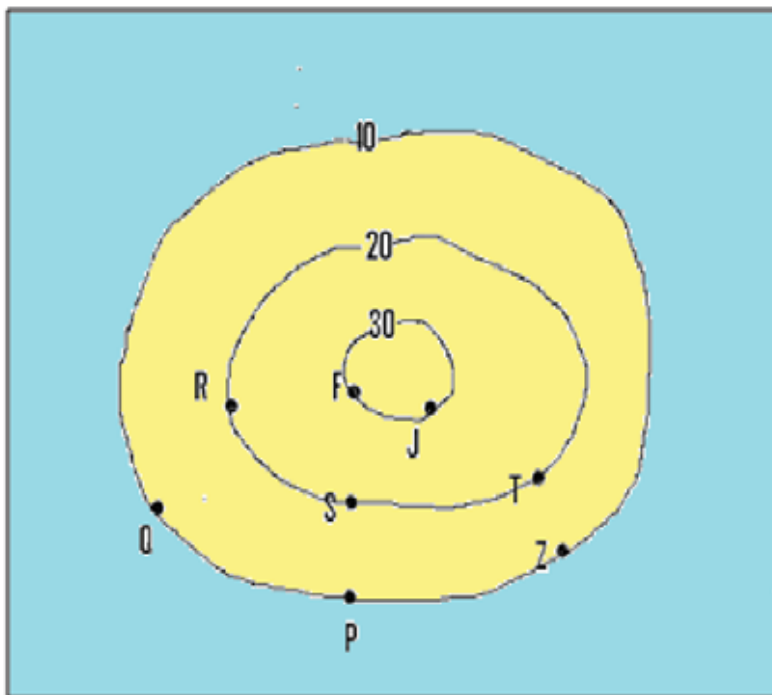


Figure 41: Sample of contour lines (Drawn by the author)

Example 2

Study the diagram given above (Fig 41) showing a conical hill.

Points Q, P and Z lie at the same height above sea level. They are all 10m above sea level. RST also have the same height above sea level. They are all 20m above sea level. If you imagine yourself standing at R, and your friend at S, the two of you will be standing at the same height above sea level.

If you were to join areas with the same height, 10m, QPZ and go around the hill you would probably get a line like the one labelled 10m in Figure 41. If you draw another one joining RST going around the hill, you would probably get a smaller circle labelled 20m in the diagram. Join FJ and all the areas that are 30 metres above sea level going around the hill and you would probably produce a line similar to the small one labelled 30 metres.

What you have produced is roughly what you could see if you were to look at the hill from above.

To understand this better, look at the map of an island given below (Fig.42).

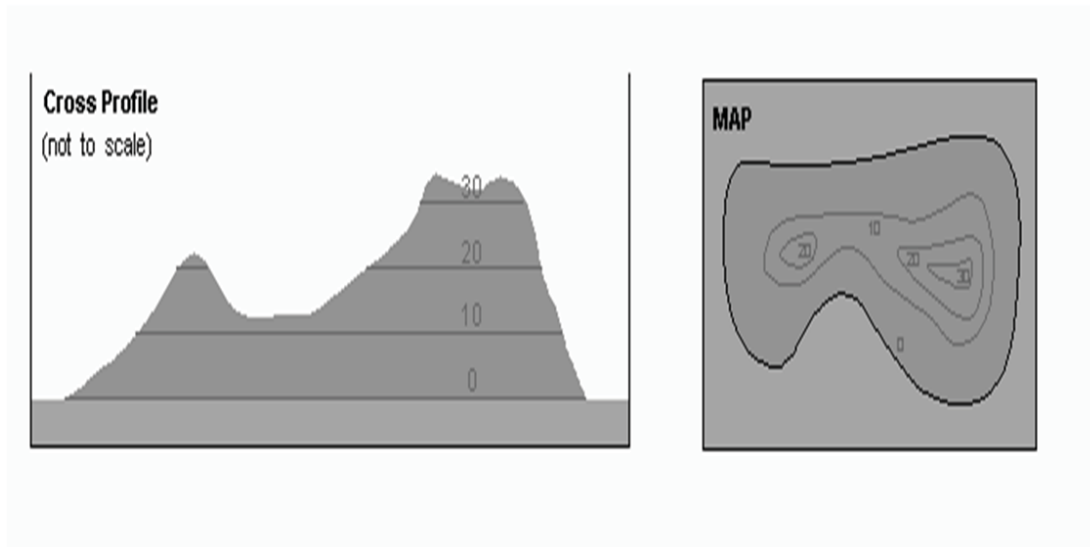


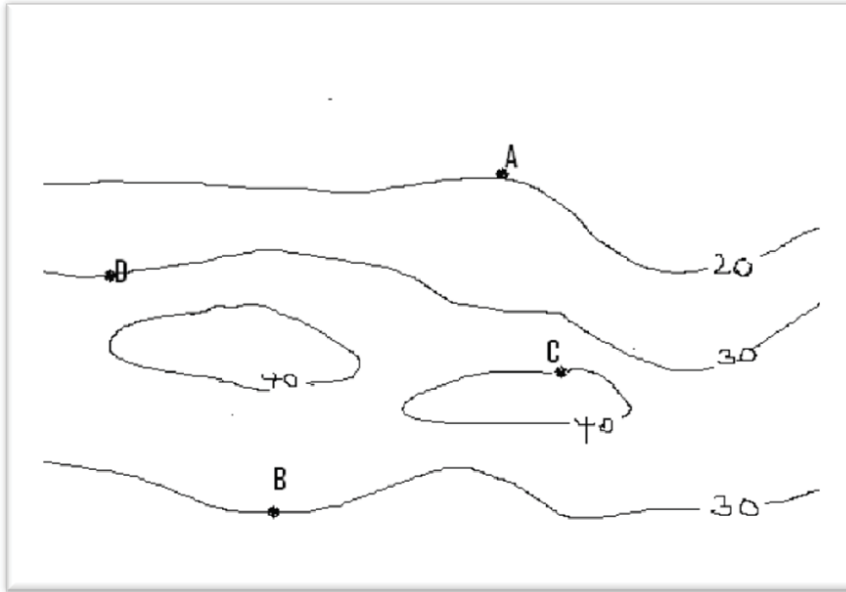
Figure 42: Map of an island downloaded from www.met.utah.edu:8080/.../Topographical%20Maps on 18April, 2011.

Notice that the outermost line is at sea level and marks the shape of the island. The two inner most rings show the two hills. Remember, we said contour lines are lines which join areas with the same height above sea level (ASL). Practise the interpretation of contour lines by doing Activity 2 below.



Activity 2

1. Look at the contour lines given below.



(drawn by the writer)

What is the height of A, B, C and D?

- (a) A is _____
- (b) B is _____
- (c) C is _____
- (d) D is _____

Total 8 Marks.

Feedback

- (a) A is 20 metres above sea level.
- (b) B is 30 metres above sea level.
- (c) C is 40 metres above sea level
- (d) D is 30 metres above sea level.

Again, you need to practise identifying altitude through interpreting the contour lines. This is a skill which only comes through constant practise. The next section broadens and polishes your skill.

1.7 Identifying Major landforms using Contour Lines

Contour lines can help you to recognise major landforms on topographical maps.

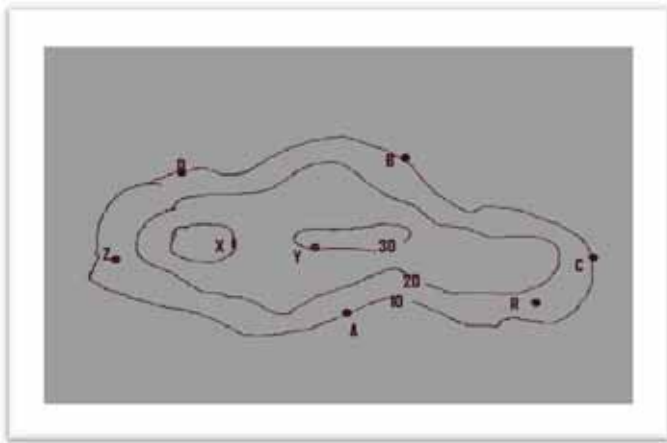
You can tell the different landforms by carefully looking at the contour lines and considering the following:

- (a) The height of the contours. This will tell you if the area is lowland or highland.

(b) The shape of the contours will tell you the shape of the land form. For instance, circular contours tell you that the landform has a circular shape.

(c) The spacing of the contours will tell you about the steepness of the land.

Remember, we said that contour lines join areas with the same height above sea level. Let us apply the concept of altitude as presented in contour lines.



What is the height of X and Y in the above diagram?

The heights of A, B, C and D are all 10m above sea.

The height of X and Y is 30m (A.S.L). Now, what is the height of R?

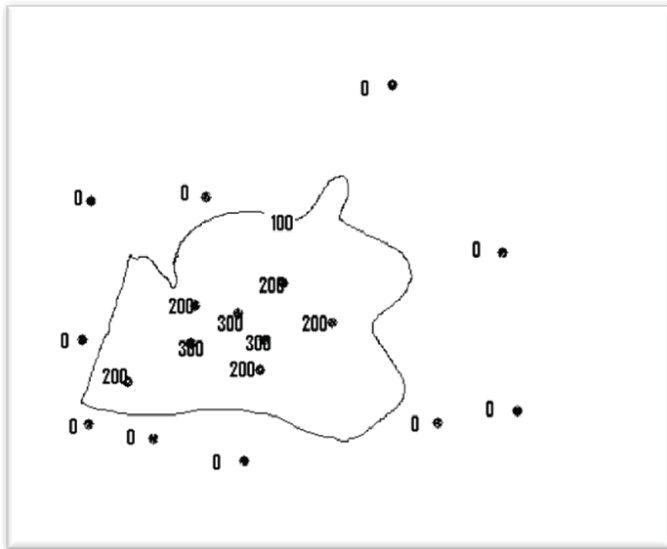
To find R you will first have to find the height between the 10m and 20m contour lines. The difference between two contour lines that follow each other is known as the vertical interval or (V. I.) To calculate the vertical interval between two contour lines, you calculate the difference between two consecutive contour lines.

Example 3

The vertical interval in the diagram is $20\text{m} - 10\text{m} = 10\text{m}$. R lies halfway between 10m and 20m. Which means it is 5m more than 10m that is 15m. R is 15m above sea level. Can you find the height for Z? Probably you got it right. It is also 15m above sea level.

Now try this example on your own.

Below is a diagram of an island. The vertical interval (V.I.) is 100 metres. Draw in the contour lines of the same island at regular intervals of 100metres. The heights are given to you and the 100 metre-contour has already been drawn in.



Remember to draw in the 0 contour line, and the 200 m contour lines. Now you need to practise identifying the various relief features for you to effectively describe the land forms such as types of slopes discussed below.

1.8 Slopes

I am sure you have either walked up or down a slope. A slope means how the land rises or falls. Contour maps usually show how the land rises or falls. Let us study the following slopes.

(a) A gentle slope

This is a slope where the land rises gradually. You can identify a gentle slope in a contour map by its contours that are widely spaced.

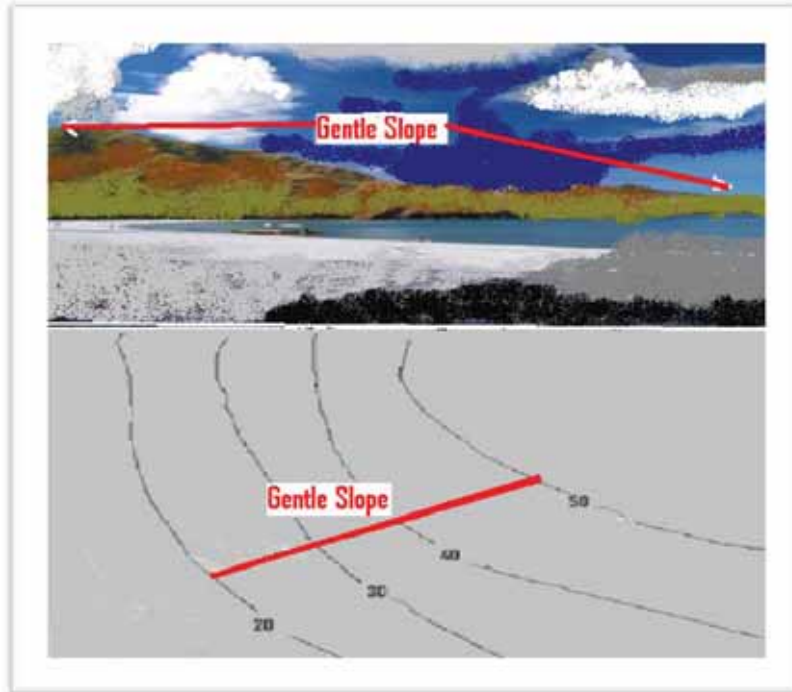


Figure 43: A gentle slope adapted from <http://www.ironwulf.net/wp/wp-content/uploads/2007/05> downloaded on 12/102010

If the steepness of the land is the same from the top to the bottom of the slope, the slope can be referred to as a uniform slope or an even slope.

A steep slope

This is when the land falls or rises sharply. It is described as a steep slope as shown below (Fig.44).

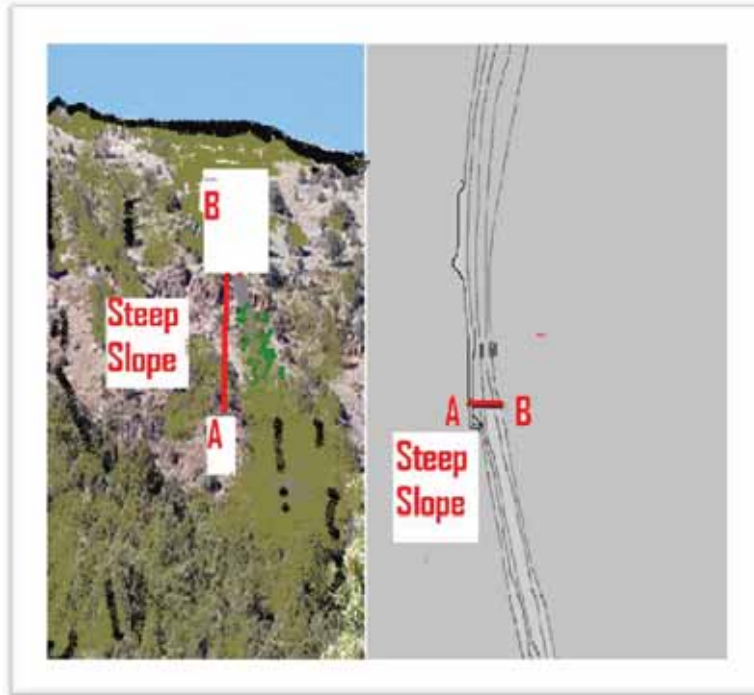


Figure 44: A steep slope adapted from hikinglasvegas.com on 7/12/10

You can identify a steep slope by contour lines that are very close together as shown between A and B in Figure 44. Contour lines, which are very close together, represent a steep slope. Just by looking at the steep slope in Fig 44, what would you say the gradient is? Why?

The contour lines are very close. Hence, it is a very steep slope. I would probably estimate it at 1:1. Only mountain climbers can climb such a steep slope!

(c) A convex slope

Some slopes are very steep at the bottom and gentle at the top. Such slopes are known as convex slopes.

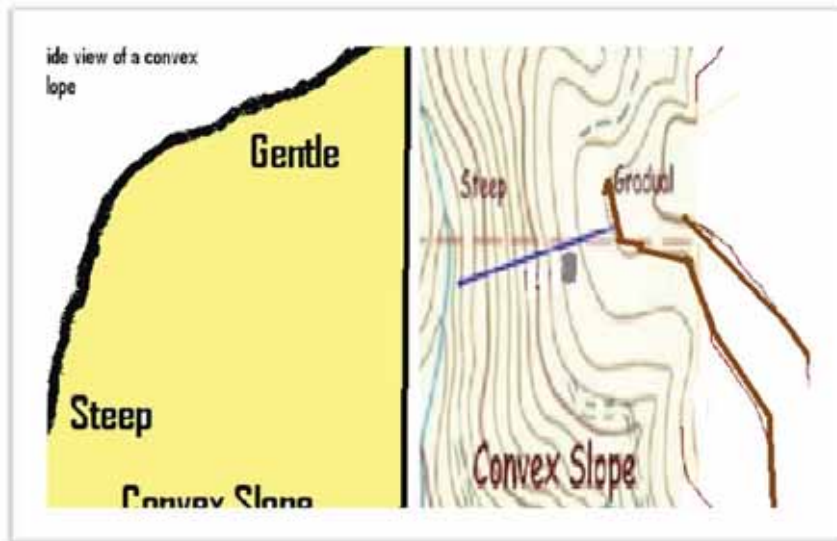


Figure 45: A convex slope adapted from globalsecurity.org on 7/12/10

You can identify a convex slope by contour lines which are very close together on lower ground indicating that the slope is steep at the bottom and wide, spaced contours on higher ground indicating that the slope is gentle as you go higher.

(d) A concave slope

In a concave slope, the land rises gentle at the lower end of the slope and rises steeply at the higher end of the slope.

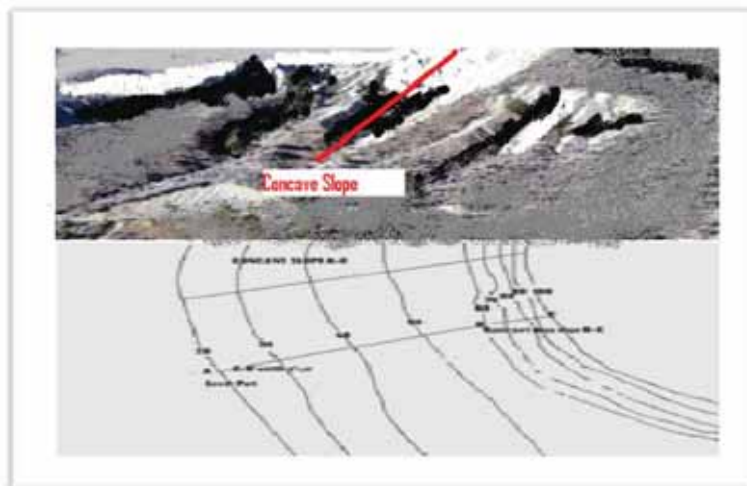


Figure 46: A concave slope adapted from water.epa.gov on 7/12/10

(e) Flat land

Flat areas have no slope and therefore, no contours are shown on a map.

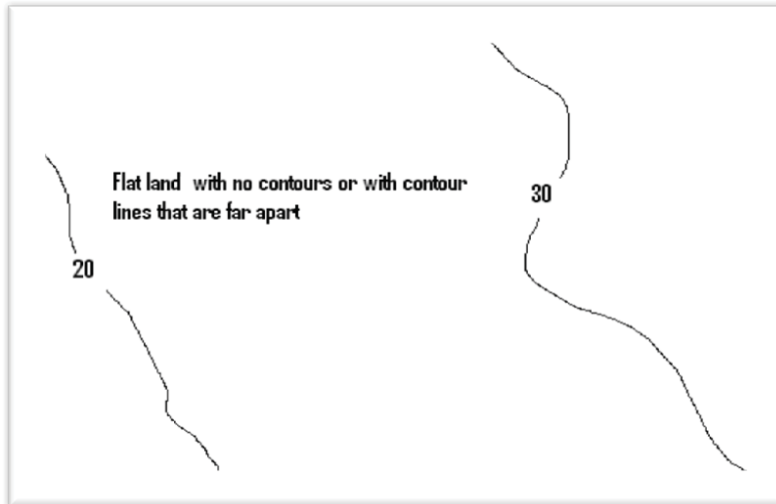


Figure 47: Contours showing flat land

Note that the contour lines are far apart indicating that the land is flat.

Now that you have learnt to identify different types of slopes, try Activity 3 which is meant to consolidate your skills.



Activity 3

1. Study the types of slopes given in the map below.

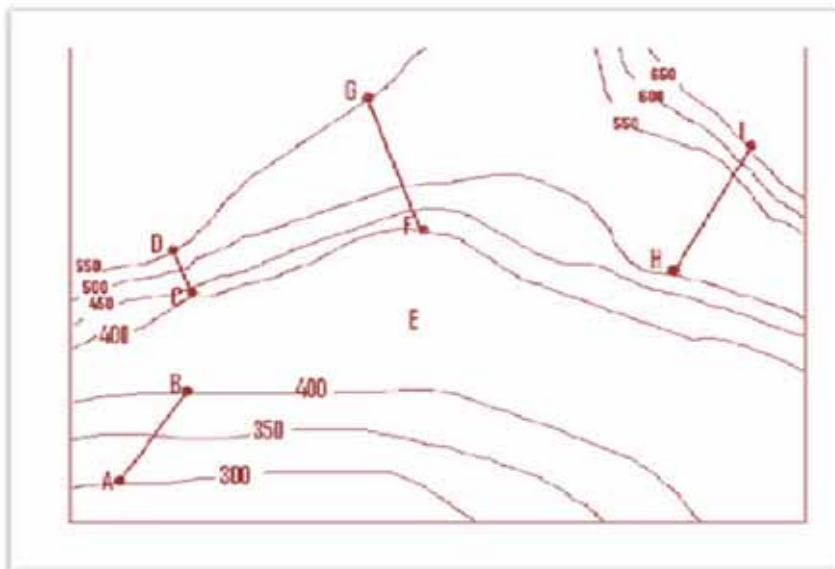


Figure 48: Types of slopes

Fill in the table, the types of slopes shown in the figure above.

Slope	Type
AB	
CD	
E	
FG	
HI	

5 Marks

2. In a paragraph, describe the types of features shown in Figure 48.

5 Marks

3. If you were to build a road, explain how the features shown on the map would guide its location. (5 Marks)

Total = [10 marks]

If you are finished, check the feedback given below.

Feedback

1.

Slope	Type
AB	Gentle slope
CD	Steep slope
E	Flat land
FG	Convex slope
HI	Concave slope

2. You probably mentioned that in the map, the land rises to about 400m above sea level. At

400m it becomes flat at E. The land then rises and terraces up to 550m above sea level. The north western part of the map is marked by a steep slope while the southern part is marked by gentle slope.

3. You probably mentioned that you would be guided by the flatness of the land. You would construct your road along flat areas with no steep slopes.

Slopes often form part of large relief features such as hills and mountains. The next section helps you to understand how some of these features are represented on maps.

1.9 Hills

Before we start, I would like you to describe a hill that is found in your locality or one that you once saw. If you are from Kgalagadi it might be difficult for you to describe what a hill is. In that case, use an atlas to see what it looks like. How would you represent a hill on a map? If you have forgotten, check figure 41. Compare your definition of a hill with mine: “A hill is a small area of land rising higher than the land surrounding it.” Is this what you wrote? Hills are a common feature on Botswana’s landscape, particularly around Kanye and Moshupa. There are many types of hills. The most common one is the rounded hill known as a knoll or a cone shaped hill. It is rounded at the base and has a cone-shaped top or apex.

It stands on its own, surrounded by a large area of flat land. The eastern part of Botswana has many examples of knolls. On a contour map, you can identify it by its circular contours.

(a) A conical hill

A conical hill looks like a cone and is very regular in shape, with a wide base and a narrow top. It has even slopes on all sides and, on a map, it is shown by evenly spaced concentric contour lines. The distinguishing feature is that it tapers at the top.

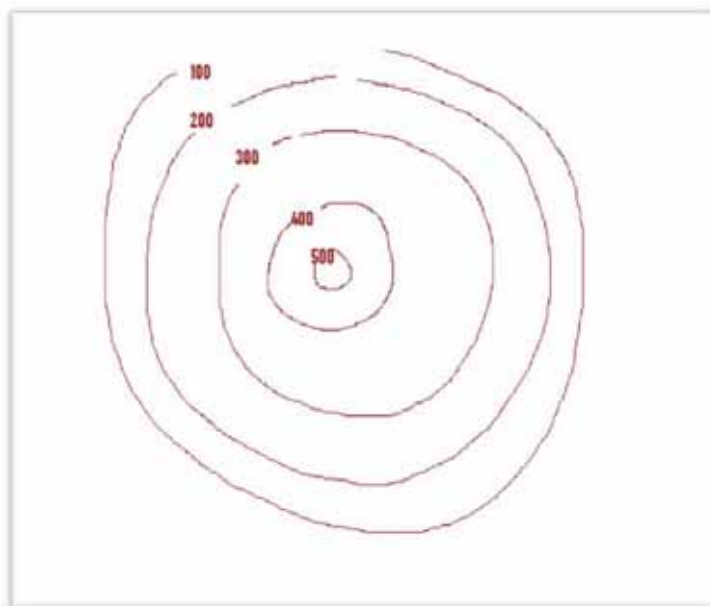


Figure 49: A conical hill

(b) A round-topped hill

A round-topped hill may have regular or irregular sloping sides. Its distinguishing shape is a rounded top. On a map, you can identify it by the highest contour being round.

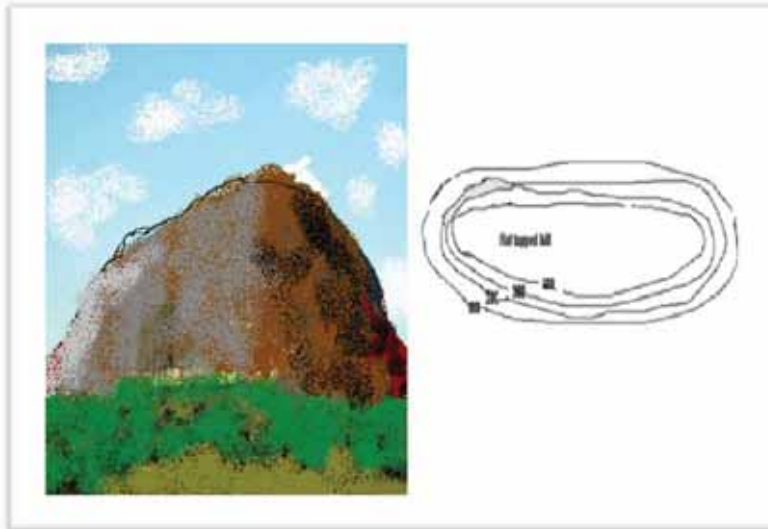


Figure 50: A round-topped hill as shown by the inselberg adapted from <https://.../category/mountain-of-god/> on 7/12/10

Examples of round topped hills are **inselbergs** or **kopjies** which are found in drier areas and are often isolated. A round topped hill does not taper at the top. There is a lot of flat space.

(c) A flat topped hill

In a flat-toppeded hill, the highest contour line encloses a wide open space.



Figure 51: A flat topped hill adapted from traveladventures.org on 7/12/10

Carefully look at the above flat topped hill. In the past, what do you think people would have used it for? Why? Do you know of any hill that was used for that purpose?

People would probably have used it for defence purposes. The sides are very steep and it would be difficult for the enemy to get up the steep slopes. Flat topped hills like Kanye and Thaba Bosio were

used for defence purposes during the pre-colonial era.

(d) A Ridge

A ridge is a long and narrow upland area. It can be a hill ridge or a mountain ridge depending on its height. If it is higher than 100 metres, it is a mountain ridge and if it is lower, then it is a hill ridge.

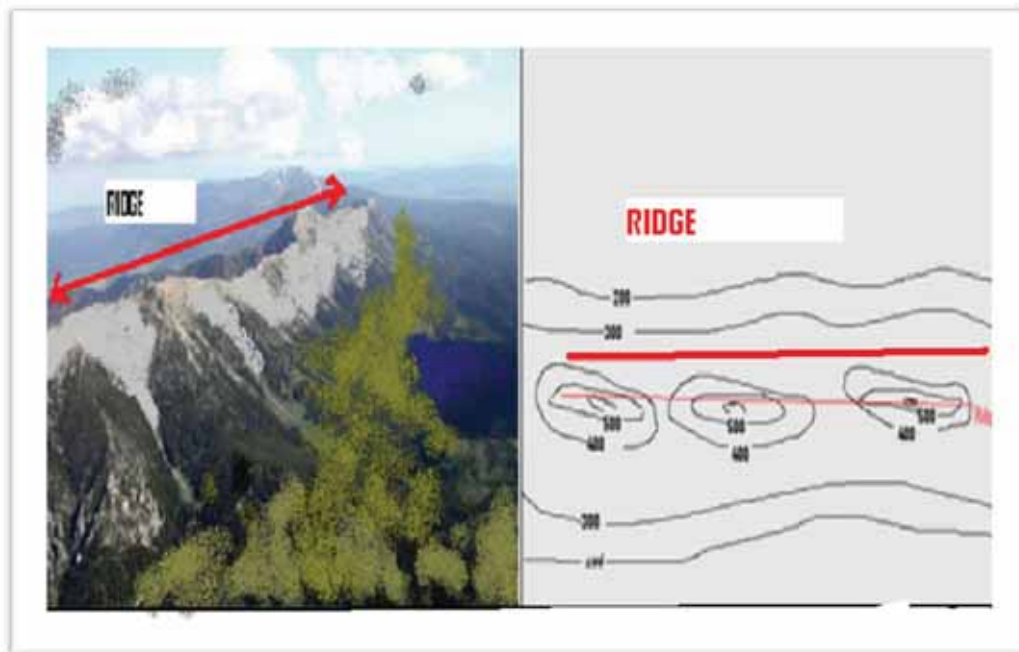


Figure 52: A ridge adapted from blacktriangle.org on 7/12/10

In most cases, the slopes of a ridge are steep as shown in diagram 52. A series of mountains may form a ridge.

e) A plateau

A plateau is a high piece of land that has a flat surface at the top with steep sides on either side.



Figure 53: A plateau adapted from <http://blogs.sitepoint.com/wp-content/uploads/2010/05/plateau.jpg>

The steep sides are sometimes known as the scarp slopes. The gentle slope of an escarpment is known as a dip slope. A plateau with a dip and a scarp slope is known as an escarpment. What do you think could be the importance of an escarpment? It could provide good grazing land accessible from the dip slope and can be used for defence purposes.

(f) A saddle

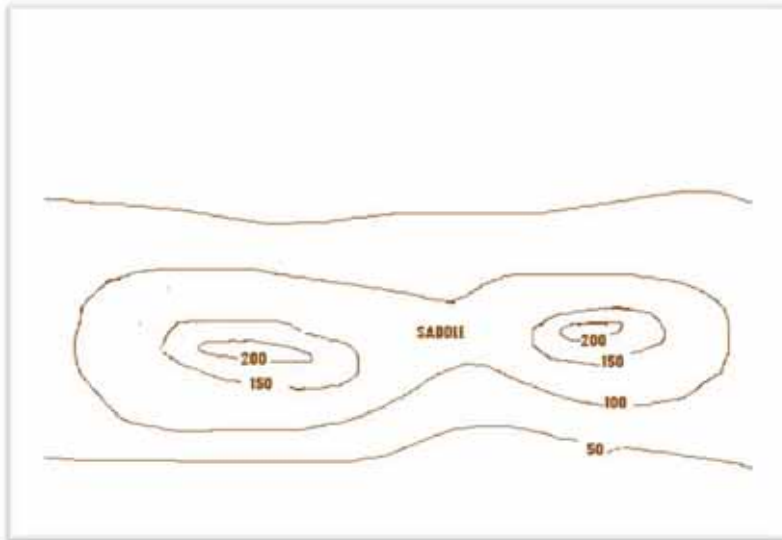
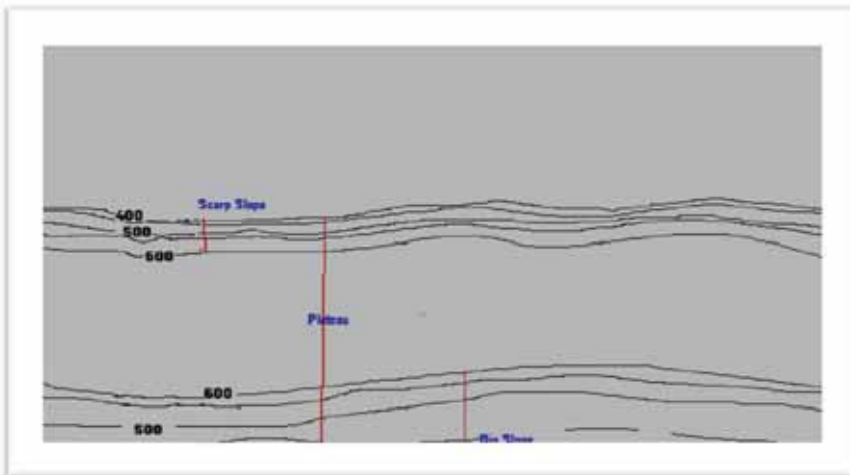


Figure 54: A saddle



This is a low area found between two hills as shown in Figure 54. It is usually at high altitude. What do you think is the importance of a saddle or a col? It provides a pass between the hills. That's where a path could be!

(g) A pass

A pass is low land between high lands. These low lands are usually used as routes for roads or railway lines.

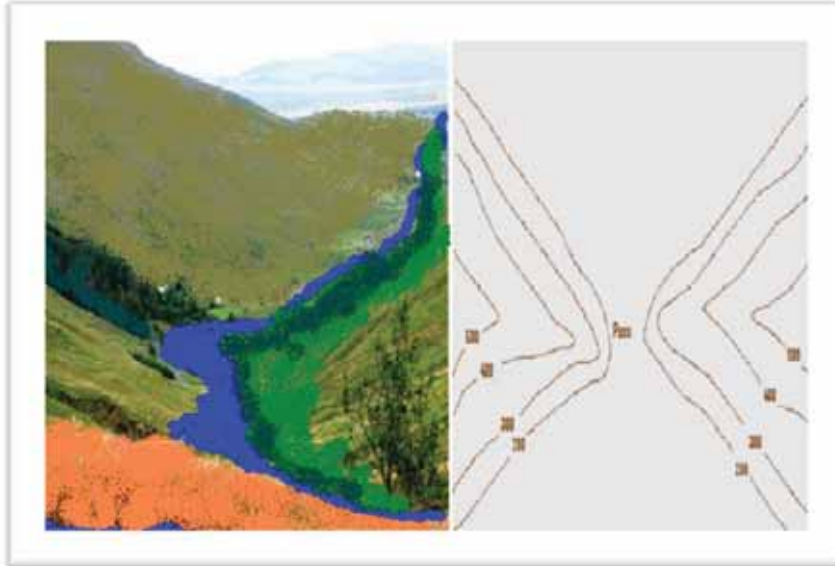


Figure 55: A pass adapted from trekearth.com on 7/12/10

What is the importance of a pass? You probably already knew the correct answer. A pass provides a low lying area where a road or a railway line can be constructed. Some passes can be dammed to provide drinking water and water for irrigation.

(h) A spur

A spur is high land that juts into low land.



Figure 56: A spur downloaded from <http://wpcontent.answcdn.com/wikipedia> on 7/12/10

You can identify a spur by its V-shaped contour lines. The contour lines of a spur point towards low ground as shown in Figure 56. Do not confuse a spur with a valley.

2.0 River Features

There are many landforms that are closely related to rivers such as river valleys, spurs, meanders and many others. We will briefly look at some of them and show you how each one is presented on a topographic map.

(a) A river valley

A valley is a stretch of low land between high land, along which rivers usually flow.

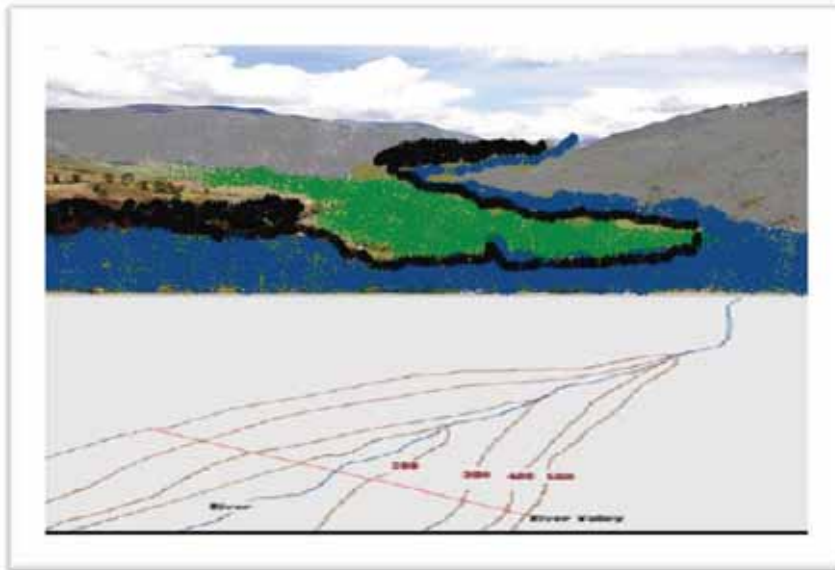


Figure 57: A river valley adapted from blog.visitwales.co.uk on 7/12/10

In a topographic map, you will be able to identify a valley by contour lines which are shaped like the letter 'V.' Note carefully, that the 'V-shaped' part of the contour lines of a river valley points towards high ground (figure 57). At times the contours of a river valley may be 'U' shaped.

(b) A gorge

This is a deep steep sided and narrow valley enclosed by rocky cliffs. In very hard resistant rocks, rivers may cut very narrow, deep steep sided valleys.



Figure 58: A gorge adapted from planetware.com on 7/12/10

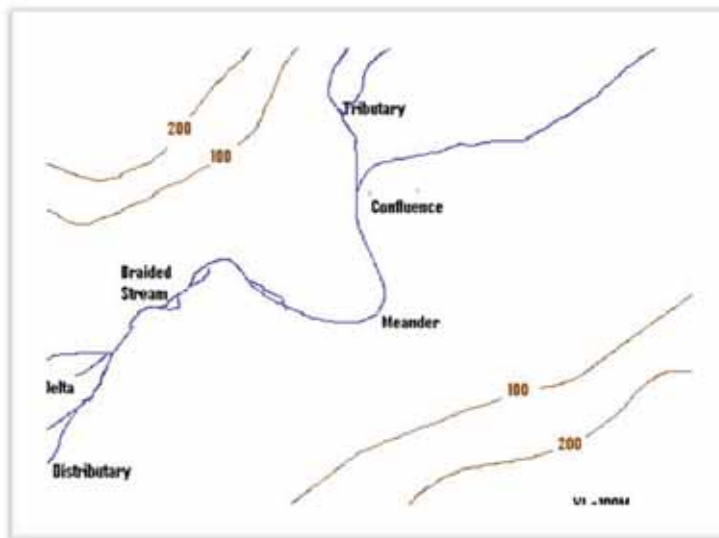
You can identify a gorge by contours that are ‘V-shaped’ and very close together as shown above. There are many other river features that you need to know for you to be able to pass your map paper. Here, as I have pointed out earlier, what you need is to be able to identify the features and explain how they influence human activities.

3.0 Other River Features

You are probably familiar with different types of river features. Can you name some of them? Here are some of them. Many small streams that join a river are called **tributaries**. The point where two main streams join is called a **confluence**. On a flat piece of land, the river usually has large bends, these are known as **meanders**. Some rivers have triangular shaped alluvial deposit where they empty their water when they enter a sea or lake. This landform is known as a **delta**. You may know these, but do you know how they are represented on a map?

Figure 59: River features.

Can you think of a river in Botswana with a delta? It is the Okavango. The Okavango delta is described as an inland delta. The river breaks into many small streams as it enters the lake. These small streams are known as **distributaries**.



Sometimes a river breaks up into two or more channels. The Chobe river breaks up into two streams at Sedudu Island. In this case we say that the river has a **braided** stream. Note that braided streams occur along the course of the river and distributaries occur at the mouth of a river.

Do you know why the delta is so important in

Botswana? In Unit 12 you will learn about tourism. The Okavango delta is a big tourist attraction. For now, practise identifying river features in activity 4.



Activity 4

Study the map given below (Fig.60). It shows un-named river features. Complete table 2 by filling in the names of the features A-F.

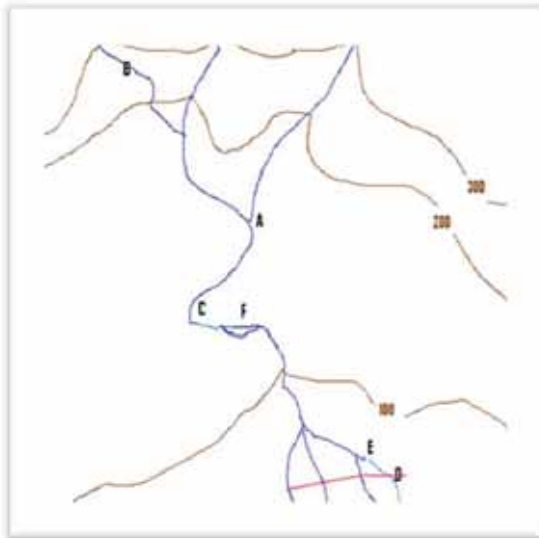


Figure 60: River Features

Label	Name of Feature
A	
B	
C	
D	
E	
F	

Each correct answer carries 2 marks.

Total [12 marks]

Feedback

<i>Label</i>	<i>Name of Feature</i>
<i>A</i>	<i>Confluence</i>
<i>B</i>	<i>Source</i>
<i>C</i>	<i>Meander</i>
<i>D</i>	<i>Delta</i>
<i>E</i>	<i>Distributaries</i>
<i>F</i>	<i>Braided stream</i>

By now you should be able to identify the various river features. These will help you to better interpret maps. Just by looking at the map you will be able to tell what features are represented. When studying maps, you will also be required to describe drainage patterns presented. The section that follows will help you to describe river drainage patterns.

4.0 River Drainage Patterns

Drainage is the water system of an area. The drainage pattern of an area is determined by the relief features in that area. You can determine the water system of an area by looking at the contours.

Drainage patterns can be easily identified in contour maps and are useful for interpreting aerial maps.

Below are some of the most common drainage patterns.

- Study the drainage pattern given in fig. 61. What does the drainage pattern remind you of? It probably resembles branches of a tree.

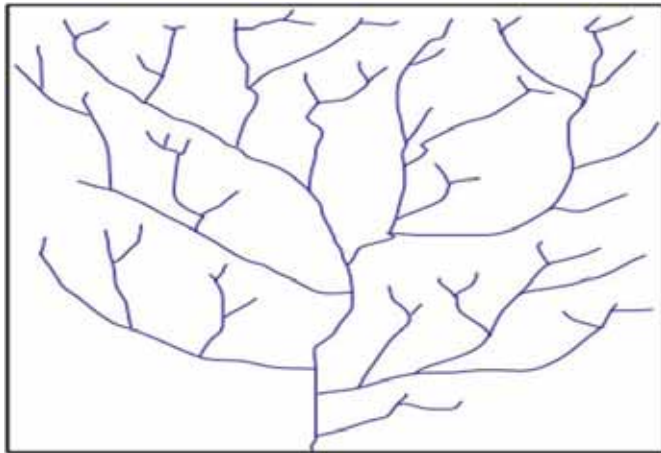


Figure 61: A sample of a dendritic drainage Pattern

Dendritic drainage is where the pattern resembles the branches of a tree. This drainage pattern is commonly found in regions with granite rocks. Rocks found in such a drainage pattern areas tend to be the same.

- Radial drainage where the streams flow outwards from a central point or ridge.

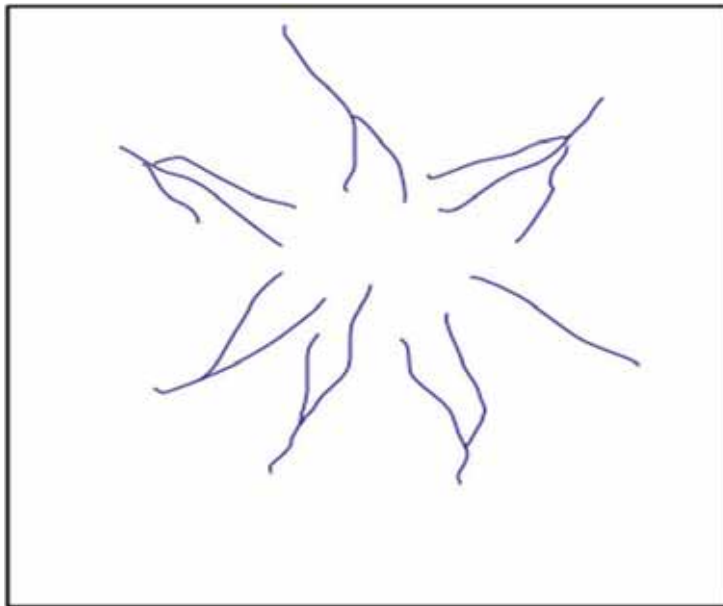


Figure 62: A sample of a radial drainage Pattern

- Trellis drainage where the rivers flow in a rectangular pattern. These are commonly found in severely folded sedimentary rocks.

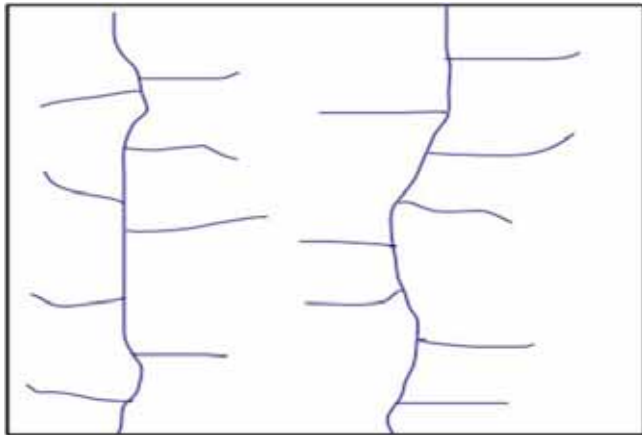


Figure 63: A sample of a trellis drainage Pattern

Parallel secondary streams formed in less resistant rocks.

- Rectilinear pattern where the tributaries join the main rivers at right angles.

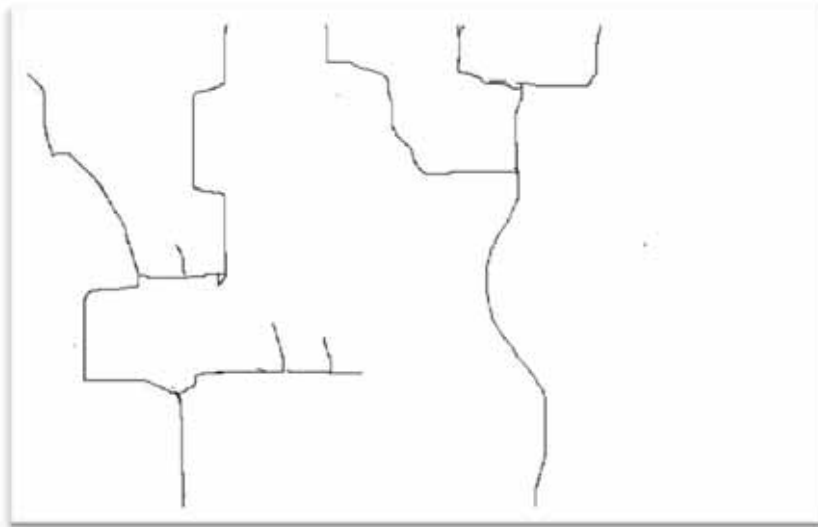


Figure 64: A sample of a rectilinear drainage Pattern

- Meanders and oxbow lakes

When rivers flow through flat land, the flowing speed is slowed down and meanders and oxbow lakes are formed. Look at fig. 65. Which feature do you think is a meander? Which one do you think is an oxbow lake? How was it formed?



Figure 65: A sample of an oxbow lake and a meander adapted from istgeography.wikispaces.com on 7/12/10

You probably cited A as an oxbow lake while B is a meander.

An oxbow lake is formed when a river creates a meander, due to the river's eroding the banks through hydraulic action and abrasion/corrosion. Check the definition of these terms in the vocabulary section of your unit. After a long period of time, the meander becomes extremely curved, and eventually the neck of the meander will touch the opposite side and the river will cut through the neck, cutting off the meander to form the oxbow lake. Note that meanders and ox-bow lakes are some landforms found along a river's course. It is NOT a type of drainage such as radial, trellis and rectilinear we learned above.

- Delta

Use your atlas to find where the Okavango delta is. Fig.66 shows the location of the Okavango delta.

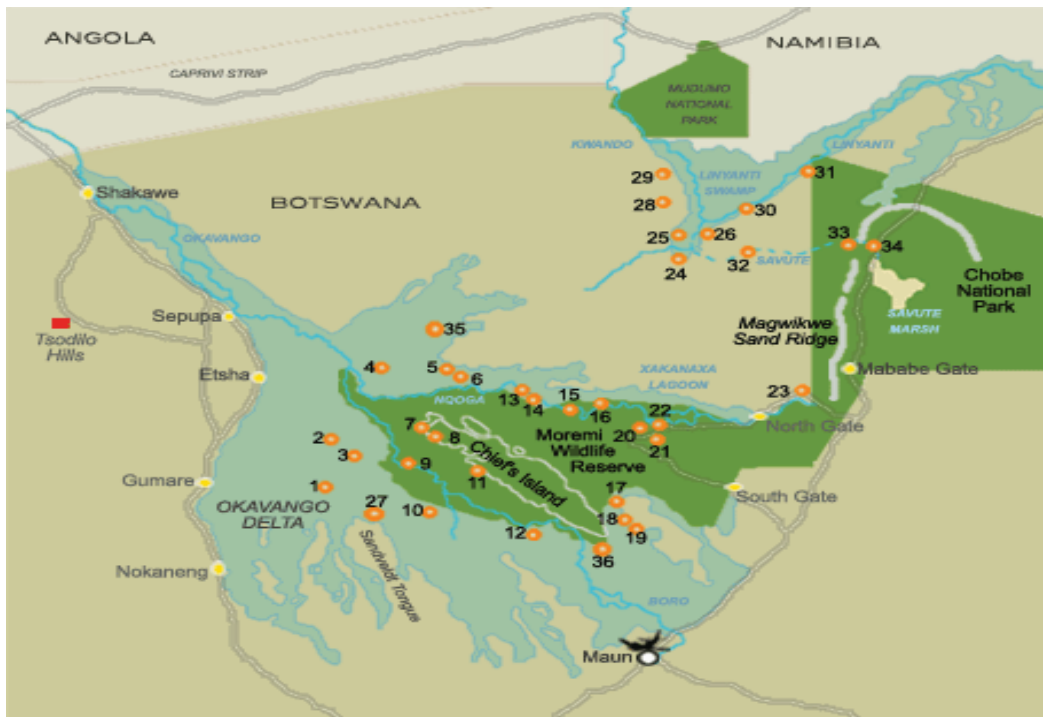


Figure 66: Okavango Delta down loaded from www.thesafaricompany.co.za/Map_Okavango_Delta.htm on 8/12/10

This is a very popular resort centre in Botswana. Can you explain why the Okavango is so important in Botswana? You are probably right! The Okavango delta is a very important tourist attraction in Botswana. It is a sanctuary for a variety of wild life. People come from all over the world to visit the Okavango delta. You should be asking yourself “what is a delta?” Well by looking at figure 66, you should have an idea of what it is by now.

A delta is a landform that is formed at the mouth of a river where that river flows into an ocean, sea, estuary, lake, reservoir, flat arid area, or another river. The Okavango River empties its water into a flat salt pan forming a delta. Another example of a delta is the Nile Delta in Egypt.

5.0 Describing Physical Landscapes

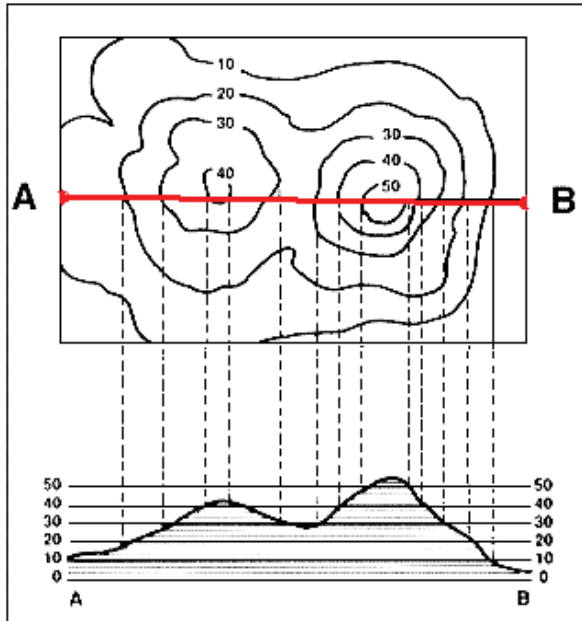
By now you should be able to describe a landscape if you have a topographic map. You should use grid lines, scale and direction to help you make full descriptions. Here are some more tips! Ask yourself the following questions:

- Are there clear physical divisions such as highlands, lowlands, flatlands or undulating lands?
- What are the major physical features in the given map? How are they related to each other?
- What is the drainage patterns like? Are they dendritic, trellis or radial? Where are the rivers flowing to?
- What are the drainage characteristics? Is it the upper course or lower course?
- Can you indicate the position of the various features on a map? Also, can you indicate the height above sea level?

6.0 Drawing Cross Sections

You are now familiar with the language of map reading where we use contour lines to show different land features but, sometimes it can be very difficult to immediately tell what landscape the features represent. We sometimes use a cross section to show how the landscape actually looks like. A cross section will give you a side view or a cut-away of the landscape.

To draw the cross section, I would like you to follow the steps given. Then practise until you master the skill as it will help you to visualise what the landscape looks like!



(Source Adopted from www.met.utah.edu:8080/.../Topographical%20Maps on 7/12/10)

Step 1: Decide on the line of your cross section. In this case your cross section is A-B. Join A and B by a straight line.

Step 2: Lay a straight edged paper along the line **AB**. On the paper, mark the points **A** and **B**.

Step 3: Starting from **A**, carefully mark the points on the straight edged paper where each contour crosses the paper. For example, you will start off by marking 20m, 30m, 40m, 40m etc until you get to **B**. Label the height of each mark that you make on your straight edged paper. (Mark other features such as roads and rivers if they cross the edge of the paper).

Step 4: Either on a clean piece of paper or in your notebook, draw a horizontal line **AB** such that **A – B** is the same length as **AB** in your straight edged paper.

Step 5: Look at the heights you have written on your straight edged paper. Find the lowest and the highest height. In this case it is 20m and 50m respectively. Allow your framework to start at 10m up to 60m. This way you will make sure all heights will be included in your cross section.

Step 6: Decide on a vertical scale. Each interval should not be too wide because the hills and valleys may be exaggerated. Join the points on the vertical scale with fine horizontal lines. For instance 10m on the left of the framework should be joined to 10m on the right of the framework as shown above.

Step 7: Place the straight edge of your marked paper along the bottom of the scale (along 0m) such that **A** and **B** coincide. For each height that you marked along your straight edged paper place a fine dot at the appropriate level. For instance, if there are two 20 m marks on your paper, put two dots on the 20m horizontal line just above each 20m mark. When you have plotted all the marks in all the levels, join the dots with a smooth freehand curve. Do not use a ruler.

Step 8: Label all the features using arrows to point at the features. For example, where there is a river valley, draw an arrow pointing at the appropriate feature in the cross section. Add the title.

Step 9: Colour the cross section green or brown.

You need to practise this many times before you master the skill. The cross section is very important in that it clearly shows you the shape and height of the land. Look for topographic maps and draw your own cross section. If there is a study group, practise with your group.

7.0 Relating Human Activities with Landforms

When studying your maps, you must first identify the landforms. Then find out the human activities in that area. You can do so by studying the key provided. Do you still remember the symbols you used in topic 1? If you have forgotten, go back and check them. The landforms will help you explain why certain areas have been used for particular activities.

Rivers, for instance, can be important for fishing, communication and for tourism. The Chobe is an example of a river in Botswana that is important for watering wildlife. It has become an important tourist centre. It also provides fish and water to the local people.

Flat lands can be important for grazing and cultivation purposes. You must use the key to find out what types of crops are grown. Passes and gaps can provide land for railway lines and roads. Lakes provide a home to wild life species and may attract tourists.

The high ground of river confluences can also be important settlement areas. Cities and towns can develop in river confluences. Nucleated villages usually develop in river confluences with buildings close together. In some cases linear settlements develop along rivers with buildings forming a long line along the river. The rivers provide the settlements with water for domestic use and also for farming purposes.

Mountains can be important for shelter and defence purposes and villages can develop in areas with mountains. For instance, Kanye probably developed where it is for defence purposes. Sometimes mountains can create problems for development. For instance, minerals can be found but it can be very expensive to mine them. Mountains can also make road and rail communications difficult as they form a barrier to route-ways and as a result, roads and rails may be constructed to avoid them. These are just a few activities that are directly affected by landforms. You should be able to use the landforms to explain the human activities in a particular area.

When studying your maps, remember to also find out how the landforms influence human activities.

8.0 Topic Summary

In this topic, you learnt methods of representing landforms such as hachuring, profiles, layer colouring and the use of contour lines. We defined contour lines as lines that join areas of the same height above sea level. Contours can show different types of landforms such as slopes, hills, rivers, lakes and many other landforms. We said the difference between two consecutive contour lines is referred to as the vertical interval. Landforms affect human activities. For instance, we said mountains can affect the construction of roads and railway lines and also settlement patterns can be affected by rivers. Cultivation can also be influenced by the landforms in an area.

This has been a long topic! Congratulations you have finally completed it. First practise those skills that you feel you have not mastered. Then do the self-assessment 4 at the end of the unit. Check if you got the correct answers from the feedback given at the end of the unit. If you have mastered the topic, proceed to the next topic which is the last topic in this unit.

Topic 5: Air Photographs and Satellite Images

Introduction

You have learnt about different types of maps and how to identify some of the landforms represented in maps. We have said that maps show only selected information. For instance it can be on communication, mining, waterways and land use. Photographs show you more details than maps. If you look at a picture of yourself, you will observe that it shows all the features of your image. In this topic, we will learn about different types of photographs and how to interpret them. The ability to interpret photographs will help you to recognise landforms and landscapes and the assessment of the human impact on the environment. Here you will be able to practise several geographical techniques such as sketch map drawing, land use mapping and analysis of drainage patterns and settlements.

Topic Objectives

At the end of the topic, you should be able to:

- state the differences between a map and a photograph
- identify different types of photographs
- interpret photographs and satellite images
- differentiate, between aerial photographs and satellite images.

1.0 Photography

Photography is an art of getting information about an object using a camera. I am sure that you have seen various photographs of yourself, family, friends and buildings. The photographs show you images of the subjects. There are two main types of photographs in Geography. These are ground level photographs and aerial photographs.

1.1 Differences between a Photograph and a Map

Before we look at each of the two types of photographs, it is important that you differentiate between a photograph and a map. The main difference between a map and a photograph is the way in which the land surface details are reproduced. Photographs of the land surface are sometimes taken vertically by a camera carried in high flying aeroplanes. Sometimes photographs are taken at an angle to the ground. Those taken from directly above will show the top part of the features while those taken at an angle to the ground may show side views of the features. Maps on the other hand show land features as viewed from above.

Another major difference between a map and a photograph is that a photograph shows almost all the details while a map shows only a selection of what the map-maker wants to show. A photograph shows a lot of detail. It can therefore be used for many different interpretations. For instance, an agriculturalist can use it for land use; a geologist can use it for finding out the type of rocks in the area, while the miner may use it for identifying mining areas.

A map uses symbols while a photograph shows images of the real object. In maps, the symbols may not be the same as the real objects and may pose problems of identification. Photographs can also

show you how the objects relate to each other. For instance, you can easily identify a relationship in a settlement and the availability of water provided by a nearby river.

1.2 Ground Level Photographs

Let's start off by reflecting on ground level photographs through the activity given below.



Activity 1



Figure: 67 A Sample of a ground level photograph downloaded from <http://rst.gsfc.nasa.gov/Sect5> on 7/12/10

1. Look at the example of a ground level photograph given above. What do you think a ground level photograph is?
2. What are the advantages and disadvantages of ground level photographs?

Feedback

I hope you were able to say that a ground - level photograph is a photo which is taken when the photographer is standing at ground level or close to the ground level.

Ground-level photographs have both advantages and disadvantages as presented in the table below:

Advantages	Disadvantages
Provides a clear instant record of the landscape at a given time	Not all objects can be seen, others can be obscured by those in front
All objects seen by the photographer are recorded	Other objects may be out of focus
Many people are familiar with	Scale may be difficult to judge

ground level photographs	
It provides a visual summary of the landscape at a given time	Is not selective and can be too crowded
Can be used for drawing sketch maps	Presents mainly qualitative information.

A ground level photograph can be viewed from three areas: the **foreground**, the **middle ground** and the **background**. The foreground is the area in front of the photograph. The objects in this area usually appear to be large because of the proximity to the camera. The middle half of the photograph is the part that is referred to as middle ground. Can you identify what is shown in the middle ground of the photo in Figure 68?



Figure 68: A ground level photograph showing soil erosion downloaded from <http://upload.wikimedia.org/commons/7/7b/Erosion> on 7/12/10

You would probably mention the muddy stream in the foreground and the person digging in the middle ground. Then the area that is at the back of the photograph is called the background. Usually, the objects in the background are seen as small because of the longer distance away from the camera. Can you describe what the background of the above photograph shows? It should be the green plants at the back.

When studying photographs, you must also observe the position of the shadows. They will give you an indication of time. If the shadows are long it means probably that the photograph was taken during the morning or late afternoon. Short shadows would indicate that the photograph was taken at about midday.

1.3 Interpreting Ground level Photographs

For you to be able to interpret ground level photographs you need to practise quite a lot. It is a skill and the only way to acquire this skill is through practice.

- The first step is to study the fore, middle and backgrounds of the photo. While you are studying these sections of the photograph write some notes on your observations regarding the important features.
- If you have an atlas or a map, use it to get more details of the area shown in your photograph.
- Trace the important features shown on the photograph so that they keep their relation. You can use this when describing the features and their relationships.
- You can estimate the size of objects by using familiar objects in the photograph. For instance, you can use cars to estimate the size of buildings.
- While looking at landforms, look carefully to see if you can observe their formation. For instance, look for such things as cracked rocks, scree, eroded rocks and many others which may act as pointers to the formation of the given features.
- When you have made notes, then you can carry out a description with diagrams, sketch maps and explanations of what you would have observed.

Now please try this short activity.



Activity 2

1. What is a ground level photograph? [3 marks]

2. Name the **three** sections of a ground level photograph. [3 marks]

(a) _____

(b) _____

(c) _____

3. Give any **two** advantages and disadvantages of a ground level photograph.
[4 marks]

Advantages

(a) _____

(b) _____

Disadvantages

(a) _____

(b) _____

Total = [10 Marks]

Feedback

1. *Ground - level photographs are photos that are taken when the photographer is standing at ground level or close to the ground level.*

2. *The sections are*

(a) *the fore-ground*

(b) *the middle-ground*

(c) *the background*

3. **The advantages are:**

Any two of the following:

- *You can get all the details in a landscape including vegetation, rock types, cultivation, buildings, rivers and mountains, among many others.*

- *Whatever you photograph within the area shows in the photograph unlike in a map where only a selection is shown.*

- *The objects in a ground level photograph look familiar and you can easily recognise them unlike in an aerial photograph or map where objects are seen as if vertically viewed all the time.*

- *It is easier to give a detailed description of a ground photograph than a map.*

The disadvantages are:

- *Some of the objects on the foreground may block those in the background. For instance, a tall building may block the trees behind.*

- *A ground photograph can only show a relatively small area.*

You should be able to describe the features shown in a ground level photograph by now. Remember, we also said there are aerial photographs. I am certain you are now wondering what these are. Or if you know what they are, you should be raring to interpret them!

1.4 Aerial Photographs

There are two main types of aerial photographs. They are the vertical aerial photographs and the oblique aerial photographs. We have already mentioned that oblique aerial photographs are those air photos taken when the photographer was at an angle to the earth surface being photographed. These are often taken at low altitude as shown below (Fig.69).

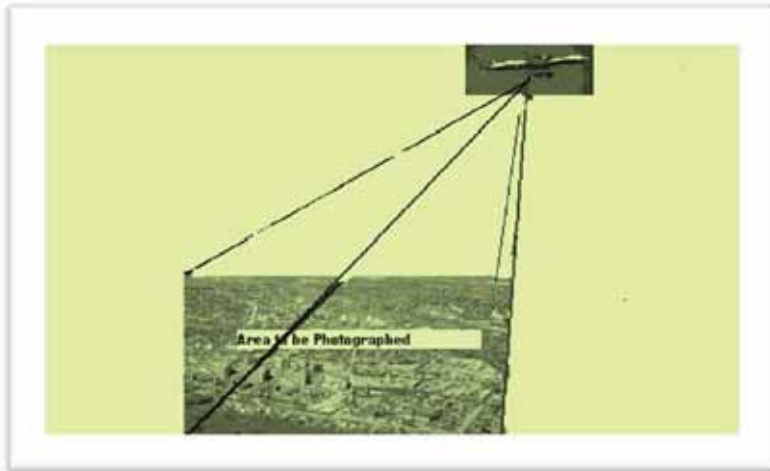


Figure 69: Photographing position in an oblique photograph (Adapted from tpub.com) on 7/12/10

In an oblique aerial photograph, the photographer is taking the picture at an angle.

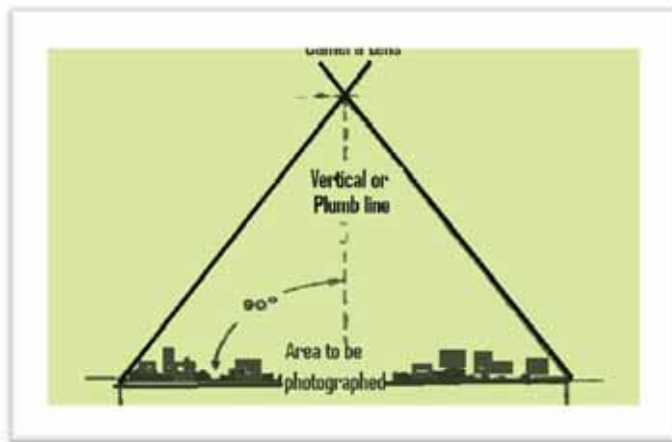


Figure 70: Photographing position in a vertical aerial photograph (Adapted from tpub.com) on 7/12/10

In a vertical aerial photograph, the photographer takes the photo from directly above the area. All shapes will be seen from above just like in a map. The only difference is that the photograph will give you more detail. Notice that those areas that are not directly under the camera will be at an angle.

Now practise the skill of interpreting aerial photographs by doing the activity given below.



Activity 3



Figure 71: An oblique aerial photograph (Downloaded from <http://www.maineimaging.com/images/oblique.jpg> on 7/12/10)

The aerial photograph given above is just meant to help you reflect. It does not contain all the answers to this activity.

1. What do you think are the advantages and disadvantages of aerial photographs?

You probably mentioned some of the following advantages:

- Large land areas covered.
- They can show areas that are not easily accessible from the ground. For instance, an aerial photograph can show areas such as forests, swamps, mountains and other inaccessible areas.
- Can be used successfully for counting moving objects over a limited space of time.

The weaknesses of aerial photographs are that:

- they contain too much detail which may not be even needed making it difficult to interpret them
- they can also be very difficult to interpret if they are not coloured
- aerial photographs can be costly to process.

By now you should be able to state the uses of oblique photographs. Just write those that you know in note book and then proceed to the next section.

1.5 Uses of Oblique Aerial Photographs

The oblique photographs are used especially when studying land use over an area. For instance, they are useful when studying cultivation, mining, and settlements. You may actually use these in the units on farming, mining and other human activities. They will be able to give you both the natural

landscape and the human made features. They will give you details of a larger area than you would get if you were using a ground level photograph.



Figure 72: A sample of an oblique aerial photograph

(Source: <http://upload.wikimedia.org/commons/6/65cattle>) downloaded on 7/12/10

When you are studying an oblique photograph, follow the same procedure as you did when studying the ground level photograph.

Study the oblique photograph in Figure 72, and in your notebook, briefly describe what you see in the foreground, middle ground and background. What are the human activities of this particular area?

I hope you were able to see scanty vegetation in the foreground. The middle ground shows cattle and the cattle herders with some shrub vegetation. The background has mountains. From the photograph you may infer that the human activities are related to cattle rearing.

1.6 Vertical aerial photographs

Study the vertical aerial photograph given below:



Figure 73: An example of vertical aerial photograph of a built up area ([Source : Cyber-Heritage.co.uk](http://Cyber-Heritage.co.uk)) Downloaded on 7/12/10

In your notebook, write down features that are regular and those that appear irregular.

I hope you noticed that those that have regular shapes are roads, buildings and lawns. The irregular ones appear to be forests and other natural features. Notice that in a vertical aerial photograph, everything is seen from above, and you cannot tell how the objects look like from the side. Let me help you to understand how to interpret vertical aerial photographs.

- When studying vertical aerial photographs, shapes of natural features will tend to be irregular while those that are made by people tend to be regular. For instance roads tend to be straight. Can you see the roads on the photograph in Figure 73? Yes, the road is the one that stretches from the south east corner of the photograph to the north east.
- Some areas have particular shapes such as circular ponds, tanks and roundabout for instance. To identify such shapes you need to look carefully and see what is next to that shape. For instance, if it is a round -about, you will be able to see roads leading from it.
- Use some familiar objects to determine the sizes of other objects when no scale is given.
- Observe carefully the shades. Different objects reflect light differently. Here are some guidelines, which may help you identify objects in a black and white vertical aerial photograph

Water shows dark grey or black

Sand shows white

Tarred road shows dark strips

Railway shows lighter strips

Shorter grass will be darker than maize

Dense forest will be darker than thinner forest

Wet ground shows darker tones

- Take particular note of patterns. They usually indicate human created features such as settlements, buildings, streets, cultivation clusters or plantations. Can you see the residential areas in figure 66? They are the ones presented on the eastern part of the photograph.

The important thing for you to do is to practise. Practise as much as possible and these will become familiar to you and you will be able to interpret vertical aerial photographs. When you feel that you are confident in interpreting aerial photographs, proceed to satellite images.

1.7 Satellite Images

These are photographs that are not taken by a camera. Satellites fitted with lenses take the photographs high above the earth's surface. As the earth rotates, the satellite sends images scanned from above.



Figure 67: A satellite image of the earth

(Adapted from [istockphoto.com](https://www.istockphoto.com)) on 7/12/10

This information is decoded by earth stations to produce black and white or colour prints. These are often used for map construction as they show the land configuration more clearly than aerial photographs.

Read the summary and try the self-assessment assignment before you attempt the unit assessment exercise.

2.0 Topic Summary

In this topic you have learnt that there are two main types of photographs. These are ground level

photographs and aerial photographs. The ground level photographs will show you the side of the features. They also show a relatively small area. They show the images as shown in reality. The problem is that sometimes features that are in front of the camera may block those features behind. When studying a photograph we said you should look at the foreground, background and the middle ground. You must make sketch maps, diagrams and describe what you observe. Aerial maps are either vertical aerial photographs or oblique aerial photographs. The vertical photographs show objects as viewed from above while those that are oblique show objects as viewed from an angle. Vertical aerial photographs are difficult to interpret and you need to practice till you master the skill.

Now that you have finished this topic, please try the self-assessment exercise 5. When you have finished the self-assessment exercise, check for the correct answers at the end of this unit. If you have satisfactorily mastered the skills required for this topic, read the unit summary which will give you a summary of the whole unit and then you can try the tutor marked assessment exercise.

Unit summary



Summary

In this unit, you learnt that a map is a diagram that shows on a flat piece of paper, an area of the earth's surface. You identified the main characteristics of a map as the title, key, scale and direction. You also learnt how to measure distance using a scale. There are three types of scale: the linear scale, the representative fraction and the statement scale. You also learnt how to calculate the area of a map. Remember we said if it is a regular shape such as a square, rectangle and triangle, use the usual formula for calculating the area. If the shape is irregular, use a graph paper with squares. We also learnt that a compass is used to find direction. The main cardinal points of a compass are north, south, east and west. You can locate the position of given places on the earth's surface by using lines of latitude and longitude. Lines of latitude are imaginary lines that cut horizontally across the map in an east –west direction. Lines of longitude are imaginary vertical lines that connect the North Pole to the South Pole. Remember, we can also locate a place using the four and six figure grid reference. Another important feature that we learnt in this lesson is contour lines. We said that contour lines are lines that join places of the same height above sea level. Some of the features you learnt include different types of slopes, hills and rivers. Finally, we discussed air and satellite images. Remember we said that photographs give all the details in a feature. Photographs are not selective. We divided photographs into ground level photographs and aerial photographs. Satellite images are photographs that are taken at a great height above the earth's surface that show the land configuration more clearly than aerial photographs.

Now that you have completed this unit, you can now do the Tutor marked Unit Assessment, it gives you the type of questions that are often asked from this unit in most examinations. When you are finished, send your answers to your tutor for marking.



Self-Assessment 1

Time: 30 minutes

Answer the questions below:

1. What is a map?

(1 Mark)

2. The scale of a given map is 1 cm to 2 km. The distance between Kezi and Matopo is given as 40.5 km. What is the distance on the map?

(1Mark)

3. If 1 cm represents 50km, how long would the distance be on the map if a car travelled 150km on the ground?

(1 Mark)

4. If a map has a scale of 1cm to 100 km, say what distance on the ground will be represented by the following:

- (a) 3cm
(b) 0.25cm
(c) 25.0cm
(d) 1.5cm

(4 Marks)

5. Study the communication map of Gaborone given below:

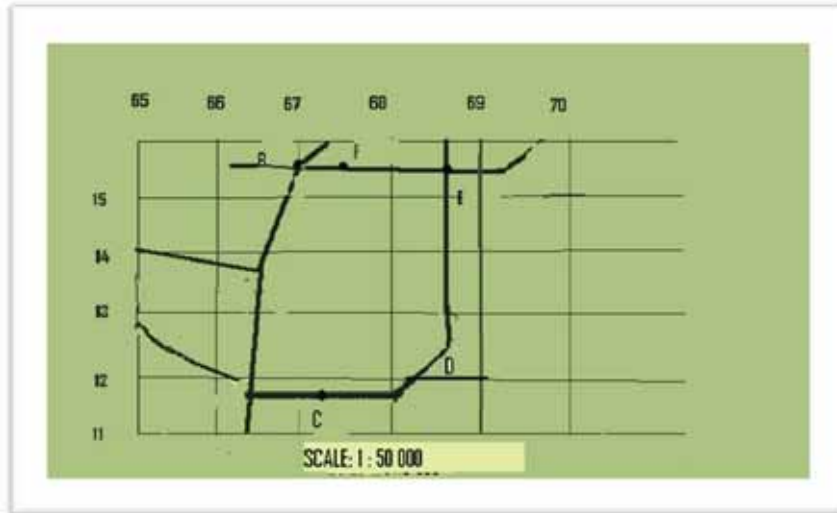


Figure 11 Communication map of Gaborone

(a) What is the actual distance along the outer ring road from D to E?

(2 Marks)

(b) What is the actual distance along the outer ring road from C to D?

(2 Marks)

(c) Find the actual distance along the road from B to F

(2 Marks)

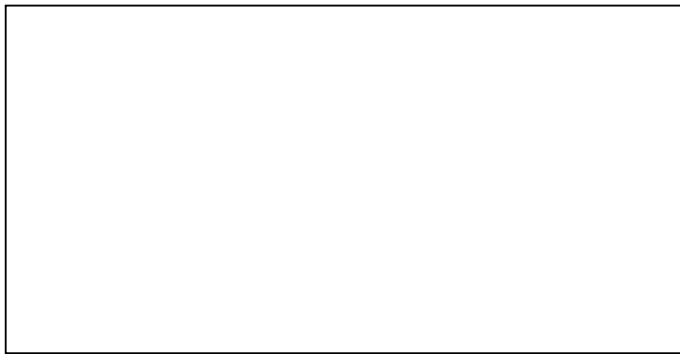
6. Make a plan of your home. You can measure the distances by pacing. Convert the paces into cm. Show the features in your home by drawing symbols. Discuss your plan with your discussion group at your study centre. An alternative would be for you to discuss your plan with your tutor.



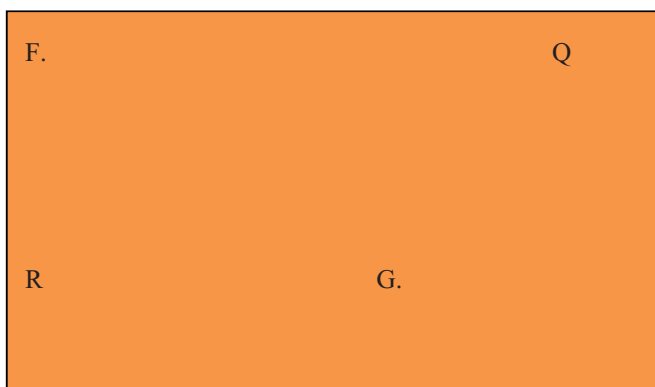
Self-Assessment 2

Time: 15 minutes:

1. In the space provided, draw a well labelled diagram to represent the eight compass points. (4 Marks)



2. Study the diagram given below:



Calculate the bearing of:

- (a) F from G

- (b) R From Q

3. Carefully study the map of Southern Africa given below:



Source: Downloaded from geology.com On 7/12/10

Calculate the bearing from

(a) Cape Town to Gaborone.

(b) Gaborone to Pretoria

(c) Mahalapye to Bulawayo

(d) Francistown to East London

(e) Maun to Bulawayo

(f) Maseru to Kimberly

(g) Maseru to Pretoria



Self-Assessment 3

Time: 20 minutes

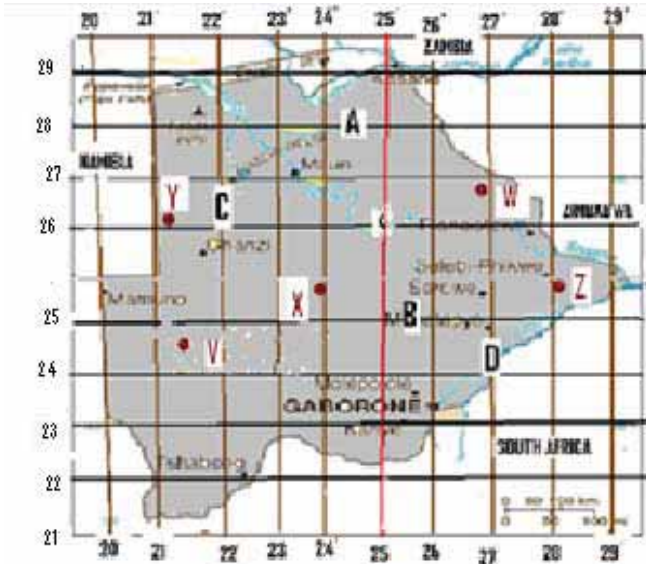
Answer all the questions in this assignment.

1. What are lines of latitude? (2Marks)

2. What is the name of the latitude that divides the earth into two equal halves?
(1 mark)

3. Name any three lines of latitude which you consider as important. (3 Marks)

4. Study the map given below and answer the questions that follow:



i) Use the 4 figure grid reference to locate A,B,C and D

A is _____

B is _____

C is _____

D is _____

i) Use a six figure grid reference for locating positions V, W,X,Y and Z.

V is _____

W is _____

X is _____

Y is _____

Z is _____

The answers to this assignment can be found at the end of the unit. Find out how well you performed on completing this assignment



Self-Assessment 4

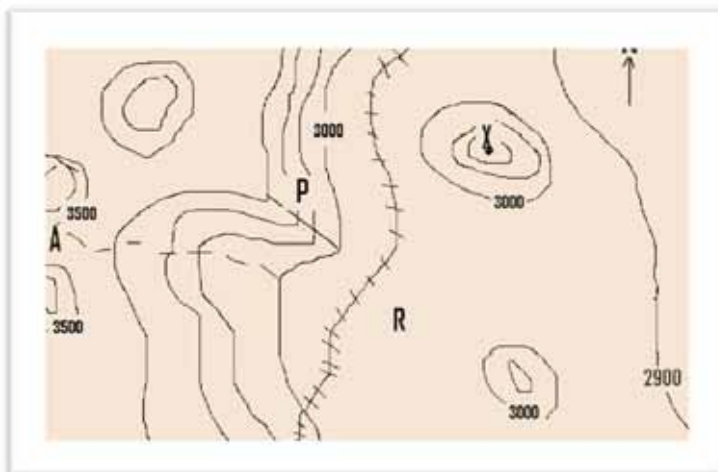
Time: 20 minutes

1. Mention three methods of representing landforms on maps. (3 marks)

2. What are contour lines? (1Mark)

3. What is meant by the term Vertical Interval? (1Mark)

4. Study the map given below and answer the questions that follow:



(a) What is the height of the land at R?

(b) Name the feature at P.

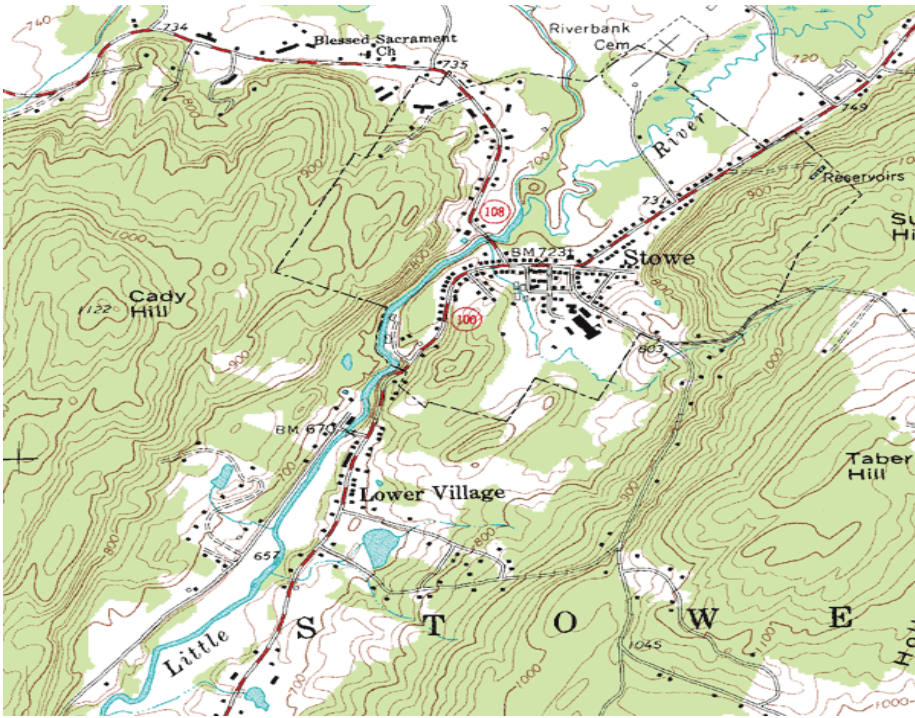
(c) Name the feature at X

(d) What is the feature at A through which the footpath passes?

(e) What human activities would you expect around R?

(5Marks)

5. Describe the landscape in the topographic map below.



(Source: Downloaded from mail.colonial.net on 7/12/ 10)

(6 Marks)

Total 16 Marks

Check for the sample answers at the end of the unit.



Self-Assessment 5

Time: 20 minutes

1. What is a photograph? [2 marks]

2. What are the **three** differences between a photograph and a map? [3 marks]

(a) _____

(b) _____

(c) _____

3. Name any **two** types of photographs. [2 marks]

(a) _____

(b) _____

4. Complete this statement: In an air photograph, all shapes are seen from

[1 mark]

5. Name **two** advantages of air photographs. [2 marks]

(a) _____

(b) _____

6. Study Photograph below Figure 68.



Figure 68: A sample of an aerial view

(Source: <http://jamesyeagerhomebuilders.com/yahoo>) Downloaded on 7/12/10

- (a) What can you see in the foreground of the photograph? [2 marks]

- (b) What are the major human activities in the area shown above? [2 mark]

- (c) What raw material is extracted from this area?

Total = [15 Marks]



Unit Assignment

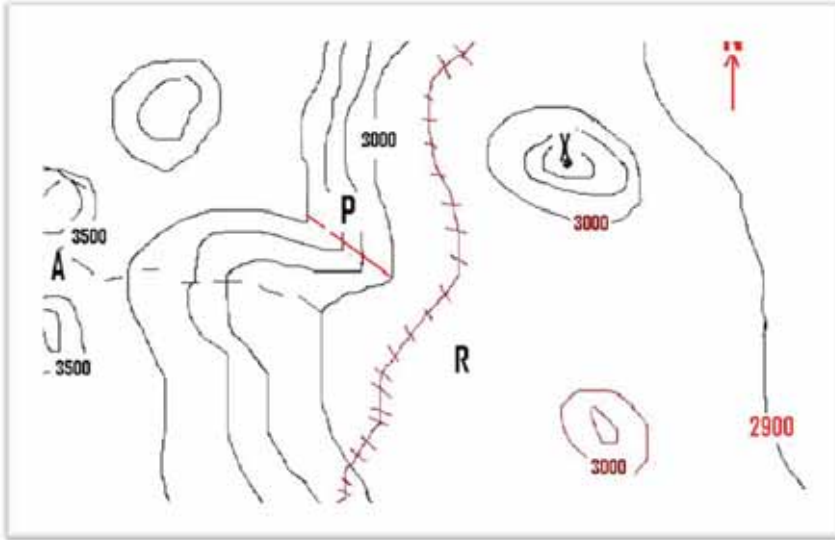
Time: 30 minutes

Answer all the questions.

- 1 What are contour lines? (1 Mark)

- 2 What is meant by the term Vertical Interval? (1 Mark)

- 3 Study the map given below and answer the questions that follow:



(f) What is the height of the land at R? (1 Mark)

(g) Name the feature at P. (1 Mark)

(h) Name the feature at X (1 Mark)

(i) What is the feature at A through which the footpath passes? (1 Mark)

(j) What human activities would you expect around R? (2 Marks)

4. Describe the features presented in the map given above.

5. What are the **three** differences between a photograph and a map? (3 marks)

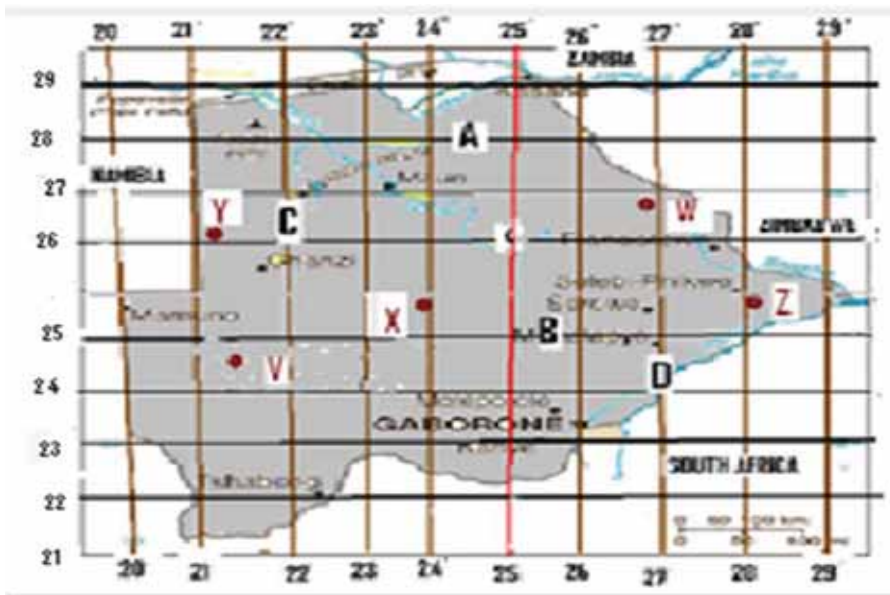
(a) _____

(b) _____

(c) _____

6. What are lines of latitude? (2 Marks)

7. Study the map given below and answer the questions that follow:



ii) Use the 4 figure grid reference to locate A,B,C and D

A is _____

B is _____

C is _____

D is _____

(4 Marks)

iii) Use a six figure grid reference for locating positions V, W,X,Y and Z.

V is _____

W is _____

X is _____

Y is _____

Z is _____

(5 Marks)

8 Study the aerial map given below and answer the questions that follow:



(Source: <http://web.ukoline.co.uk>) down loaded on 7/12/10

(a) Describe what you can see in the fore front of the aerial photo.

(2 marks)

(b) What do you think are the human activities in this area? Why? (2 marks)

3. Find a large scale map of any settlement. If you can't find one then ask for one from your study centre or your tutor.

(a) Describe the relief features shown on the map.

(b) What evidence from the map gives you an indication of the major activities in that settlement?

(c) What factors do you think influenced the location of the settlement?

(d) What could have determined the communication lines in that settlement?

Total = [30 Marks]

When you are finished with this assignment send it to your tutor for marking. If you have mastered the skills in this unit, then you can proceed to Unit 3. Remember to use the skills you learnt from in this topic throughout your course. Good luck!

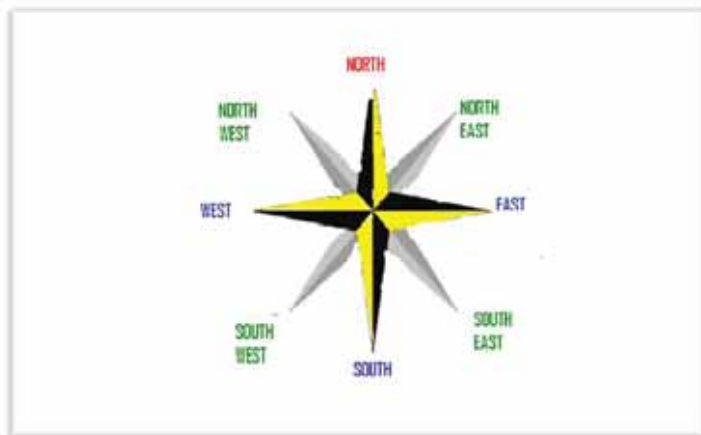
ANSWERS TO ASSIGNMENTS

Answers to Assignment: 1

1. A map is a diagram drawn to a scale representing land on a flat piece of paper.
2. 20.25cm
3. 3 cm
4. (a) 300km
(b) 25km
(c) 2500km
(d) 150km
5. D to E, C to D (May change due to size of the map)
6. The maps will differ from one locality to the other.

Answers to Assignment: 2

1. The compass points or directions as shown below:



2. F from G is 315 degrees north west
R from Q is about 230 degrees south west
4. (a) Cape Town to Gaborone is 45°
(a) Gaborone to Pretoria is 135°
(b) Mahalapye to Bulawayo is 30°
(c) Francistown to east Elizabeth 180°
(d) Maun to Bulawayo 90°

(e) Maseru to Kimberly is 270^0

(f) Maaseru to Pretoria is 360^0

Answers to Assignment 3

1. Lines of latitude are horizontal imaginary lines that increase northwards and southwards from the Equator.

2. It is called the Equator.

3. The important lines of latitude are the Equator, the Tropic of Cancer and the Tropic of Capricorn.

4. (a) A is 2428

B is 2525

C is 2226

D is 2427

(b) V is 215245

W is 289269

X is 239254

Y is 211261

Z is 281254

Answer to Assignment 4

1. Land forms can be represented by contour lines, hachuring, profiles and layer colouring (**any three are correct**).

2. Contours are lines drawn on a map joining areas with the same height above sea level.

3. The vertical interval (V.I) is the difference between two contour lines that follow each other immediately.

4. (a) R is 2900 metres above sea level

(b) P is a Spur

(c) X is a summit or peak of an isolated conical hill

(d) A is a Pass

(e) Cultivation because of the flatness of the land

5. The dominant feature in the map is the ranges that run parallel from the south east to the north. The ranges rise to over 1122meters above sea level. The slopes to the north of the map rise steeply compared to those on the southern part of the country. There is a river valley that separates the two ranges. The river runs from the north east to the south west. The valley provides flat land for settlements between the ranges. In the flat land, the river flows slowly and has resulted in both meanders and oxbow lakes being formed. The roads and railway line runs parallel to the mountain ranges.

(This answer is not an exact answer and you can possibly have differences in your interpretation. What is important is that for you to have based your answers on the given map)

Answers to Assignment 5

1. A photograph is an image produced by a camera.
2. The differences are:
 - (a) The difference between a photograph and a map is that photographs can show land features from an angle or from directly above whereas maps show land features only as viewed from above.
 - (b) A photograph shows almost all the details while a map shows only what the map maker wants to show.
 - (c) A map uses symbols while a photograph shows the actual features.
3. Two types of photographs are (a) ground level photographs and (b) aerial photographs.
4. In an aerial photograph, all shapes are seen from above.
5. Any **two** of the following advantages of an air photograph:
 - They cover larger land areas.
 - They can show areas that are not easily accessible from the ground. For instance, an air photograph can show areas such as forests, swamps, mountains and other in accessible areas.
 - The air photos can be taken within a very short space of time.
 - Air photos have also been used successfully for measuring moving objects over a limited space of time. For instance, traffic can be counted after a single aerial photo captured during the morning rush.
6.
 - (a) The foreground of the photograph shows part of the major road running from northwest to the east. The road passes through plantation areas.
 - (b) The most dominant feature is the road and rail network.
 - (c) The middle ground shows a settlement along the road and rail lines interspaced with plantations.

Answers to the Unit Assignment

1. Contours are lines drawn on a map joining areas with the same height above sea level.
2. The vertical interval (V.I) is the difference between two contour lines that follow each other immediately.
3.
 - (a) R is 3450 metres above sea level
 - (b) P is a Spur
 - (c) X is a summit or peak of an isolated conical hill
 - (d) A is a Pass
 - (e) The land is flat. Most likely there would be crop production and keeping of domestic animals.
4. The land rises to about 300 metres above sea level. The eastern part is flat with isolated round topped hills. The western part is dominated by a spur that juts into the low land. The extreme western part of the map is punctuated by low isolated hills with an altitude between 300-350 metre above the sea level. A railway line runs along the flat land from the south to the north.
5. The differences are:
 - (a) The difference between a photograph and a map is that photographs can show land features from an angle or from directly above whereas maps show land features only as viewed from above.
 - (b) A photograph shows almost all the details while a map shows only what the map maker wants to show.
 - (c) A map uses symbols while a photograph shows the actual features.
6. Lines of latitude are continuous parallel lines running around the globe from east to west. The lines of latitude increase in value from the equator to the poles.
7. A is 2428
B is 2525
C is 2226
D is 2724
E is 215246
W is 269268
X is 255239
Y is 211261
Z is 201255
7. (a) It shows a water reservoir in the foreground with a river valley with truncated spurs that jut into the river valley.

- (b) There is forestry as indicated by the existence of the forest plantation at the background. There can also be crop and livestock farming because of the availability of water and the fairly flat undulating land shown in the background.
8. (a) You will first have to identify the major relief features that dominate the map. It can be hills, rivers, roads, railway lines, settlements etc. State their location and where possible, the altitude above sea level. If there are rivers, state the nature of the drainage and the direction in which the river is flowing.
- (c) If there are settlements see what man made features are shown. This will help you to understand the human activities that are being carried out in that settlement. For instance, if there are plantations this could be an indication that the settlement is a crop producing area. A dip tank and abattoirs can indicate a cattle rearing settlement producing beef cattle. Carefully study the natural relief features as they too can always give you tips on what people in that settlement do. A lake will probably indicate that there could be fishing. What is important for you here is to carefully look for evidence that may tell you what the people in that settlement do.

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Unit 3

Weather Studies

Introduction

Welcome to Unit 3 of the Geography programme. In this unit you will learn about weather. You will learn about different elements of the weather, how they can be observed and measured and how the instruments used in the weather station work. Did you know that the information on the weather is usually broadcast in your national radio station and television? This is meant to help you to better plan your day. What you will learn in this unit is a continuation of the topics you learned about in primary and junior certificate level. If you have not done any of the work we are going to discuss in this unit, do not worry as the unit topics will teach you all that you need to know.

This unit is divided into 5 units. The units include:

Topic One: Weather and Climate

This topic will introduce you to the concept of weather and climate. You will then look closely at ways of measuring and recording both temperature and sunshine. In this topic, we will also discuss factors that influence temperature.

Topic Two: Rainfall

In this topic you will learn more about rainfall. The topic will discuss the processes involved in the formation of rainfall, the various types of rainfall and ways of measuring rainfall. We will conclude the topic by looking at the El Nino and La Nina phenomena. An audio clip is available for supplementing the learning of this phenomenon.

Topic Three: Humidity and Cloud Cover

This topic will expose you to the concept of humidity, relative and absolute humidity as well as ways of measuring humidity in the atmosphere. We will also discuss the concept of cloud cover, and learn how it is measured and recorded.

Topic Four: Winds and Atmospheric Pressure

In this topic you are going to learn more about winds, ways of measuring wind speed and wind direction. We will also look at atmospheric pressure and the various ways of measuring it.

Topic Five: Wind Systems, Weather Charts and Photographs

In this topic you are going to learn about the wind systems where we will look at the low and high pressure cells and zones. We will also look at the wind patterns and ways of interpreting weather charts.

Upon completion of this unit you will be able to:



Outcomes

- explain the difference between weather and climate.
- explain how weather observations are conducted.
- identify different climatic systems of the world.
- Describe El Nino and La Nina phenomena and their effects on people.
- present and interpret weather information in graphics, tables, diagrams, maps and charts.



Time

Time

To complete each topic, you will require 2 hours of studying and doing exercises. Since this unit has a total of 5 topics, you will require 10 hours to complete it. Depending on your work pace, you may take longer or even less time to complete each topic. The 2 hours is inclusive of the topic self-assessment exercise found at the end of the unit. On completion of the unit, you are advised to go straight into the tutor-marked assessment that should take you 45 minutes to complete.

Teaching and Learning Approach

In this unit you will need to observe the changing conditions of weather around you and you will also need to visit your local weather station or a nearby school to observe the weather instruments. You may also visit your local library where you may find books that can help you to better understand the unit. If you have access to the internet you may also find additional information on weather. However, if you are unable to find such materials don't worry because the unit has most of the information that you need. If you are registered with a distance education provider, you are advised to make use of the learner support structures such as study centres, tutorials, radio programmes and counseling. Study centres are very useful because you may have access to additional resources such as books, maps and videos. A study centre can also provide you with an opportunity to meet and discuss the subject with other learners. You

must always remember that your tutors are available to assist you with any difficulties you may experience in this unit.

An audio lesson has been prepared for you on El Niño and La Nina. Make sure you listen to it when you get to that section. In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions. This is meant to give you a chance to demonstrate and enhance your critical thinking skills.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the information relevant to different sections of the topic and form part of your learning. They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. For some of the activities, you will be required to use a notebook. Make sure you have your notebook when studying this unit. On completion of each topic, you are advised to go to the assignment section found at the end of the unit. You are encouraged to do the assignment for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback is provided at the end of the activities and assignment exercises. You are advised to attempt the activities before looking at the feedback provided. If you do not do well in these activities and assignment exercises, please go through the lessons again and find out where you went wrong.

The assignment exercises are followed by an assessment of the whole unit. This should be done after you have satisfactorily completed the unit. Submit your assessment to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback you received from the tutor, then go on to the next unit.

Glossary

Difficult terms or concepts used in this unit have been explained under the terminology section. You should use the dictionary if you come across a difficult term that is not explained in this section.



Atmospheric pressure:	The weight exerted by the gases that make up the atmosphere
Anemometer:	An instrument used for measuring the speed of the wind

Terminology	Aspect:	The relative position of a point to the sun on a slope or part of slope
	Hygrometer:	An instrument used for measuring water vapour
	Humidity:	The amount of water vapour in the atmosphere
	Insolation:	The amount of sunshine energy released by the sun
	Prevailing conditions:	Most commonly occurring event/condition
	Polar Climate:	A kind of climate, which is characterised by very low temperatures resulting in huge amounts of water freezing up everywhere
	Solar radiation:	The heat energy from the sun
	Temperature:	The coldness or hotness of something
	Weather:	The state of the atmosphere at a specific time
	Weather Bureau:	a place or centre where various forms of information on weather from different places is analysed
	Weather forecasting:	The prediction of what the weather in a particular place is going to be

Topic 1: Temperature and Sunshine

Introduction

In this topic you are going to learn more about temperature and sunshine. The topic will start with a look at the difference between weather and climate, then move on to the various elements of weather before getting into the details on temperature and sunshine. In the course of the lesson, you will study the structure of the instruments and how they are used to accurately observe, read and record temperature and sunshine. You will also learn about factors that can lower or increase the temperature of a place.

Topic Objectives

After completing this topic, you should be able to;

- explain the difference between weather and climate
- name the elements of weather
- describe the instruments for measuring temperature and sunshine
- explain how to use the instruments used for measuring temperature and sunshine
- read and interpret information contained in graphs, maps, or tables to calculate the temperature range, average temperature and mean monthly rainfall.
- discuss factors that can lower or raise the temperature of air in specified areas

1.0 Weather and Climate

Before we get into details about temperature and sunshine, let us first revisit the concepts of weather and climate.

1.1 Weather

You probably studied weather in your Geography studies at the junior secondary school level. However, for you to better recall the concept of weather do this simple activity given below.



Activity 1

In your note book make brief notes on the weather based on the simple guiding questions given below:

How is the weather today? Is it hot or cold? Is it calm, cloudy or perhaps windy? Is the sun shining brightly? Look around you; Are people wearing heavy or light clothes? Are there many people out doors? Do they seem to be in a hurry? Look at the trees around. Are the branches swaying because of the wind? Make any other observation that relates to the weather where you are right now.

Feedback

In making your notes, you probably wrote a lot of information about the weather. Your answers may have included any of the following responses:

- *Its cold today or it is chilly and people are wearing very warm clothes.*
- *It's very hot; the temperature has been high for quite some time*

- *It's just fine- not too warm and not too cold, just the right weather to go out for a good stroll in the neighbourhood*
- *It's quite calm with no wind whatsoever.*
- *People are wearing heavy jackets or light summer clothes or they are moving fast to get indoors because a rainstorm is threatening! Others are carrying umbrellas!*

Weather, therefore, can be defined as the conditions of the atmosphere observed for a short period of time from hour to hour or day to day.

Weather plays an important role in our day-to-day activities. For instance, when it is cold, you may put on something warm, when you expect rain you may take along an umbrella and when it is hot, you may put on light clothing. If it's raining, you may decide to keep indoors. All these activities are responses to weather conditions.

Now, let us look closely at the different weather elements.

1.1.2 Weather Elements

Do you still remember the weather elements which you studied in your junior certificate social studies or geography course? Actually, from the activity which you have just done, you can identify some of the weather elements as temperature, rainfall, and sunshine. Other elements would include humidity, wind direction, air pressure, wind speed and cloud cover. Each of these weather elements is measured using a particular instrument. Do you still remember them? Try Activity 2 given below.



Activity 2

Fill in the blank spaces in the table given below:

Weather element	Instrument
-----	Thermometer
Humidity	-----
-----	Rain gauge
Wind direction	-----
-----	An anemometer
Sun shine	-----
Cloud cover	-----

-----	Barometer
-------	-----------

Feedback

You probably found the activity fairly easy to do. Look at the completed table below showing weather elements and the instruments used for measuring them to check your answer.

Weather element	Instrument
Temperature	Thermometer
Humidity	Hygrometer
Rainfall	Rain gauge
Wind direction	Wind vane
Wind speed	An anemometer
Sun shine	Sunshine recorder
Cloud cover	Observation (using naked eyes)
Atmospheric pressure	Barometer

Fig 1: Instruments used for measuring weather elements

How well did you do? If you were not able to complete all the blank spaces accurately, go over figure 1 and make sure that you know all the weather elements and the instruments that are used to measure each one of them.

You can visit the nearest weather station to see some of these instruments. Information on weather is recorded at a **weather station**. The people who collect this information are called **meteorologists**. The information on weather is recorded daily in different weather stations and sent to the **Weather Bureau** where it is analysed to make weather forecasts. The expected weather conditions are then announced on television or over the radio. This is important since it helps people prepare to meet the challenges of the expected weather conditions. Amongst the people who find information on weather very useful are aeroplane pilots, farmers, ship navigators and travellers.

Study figure 2 which shows an example of a weather observation record sheet.

<p>Daily Weather Record Name of School-Ramotswa Sen Secondary Weather for the month: Novemeber,2010 Recorders:Kagiso Motsamai</p>
--

Date	Temperature		Wind	Rain	Dry Bulb	Wet Bulb	Relative Humidity	Description of the Weather	Symbols
	Max ⁰ C	Min ⁰ C	Direction	mm	⁰ C	⁰ C	%		
1 st Nov	30 ⁰	18 ⁰	west	20mm	18 ⁰	37 ⁰	80	<i>Cloudy and hot all day</i>	
2 nd Nov	25 ⁰	10 ⁰	South West	0mm	37 ⁰	31 ⁰	60	<i>Windy and cloudy all day</i>	

Fig 2: A weather observation record sheet

The information recorded in the above weather chart shows the minimum and maximum temperature, wind, humidity and rainfall. A written verbal description is often added summarising the day's weather conditions. Symbols for cloud cover, wind strength and direction may also be included. For instance, in the above chart the maximum temperature on the 1st November was recorded as 30⁰C while the minimum temperature was 18⁰C and the wind was blowing from the west to the east. The weather on that day was hot and cloudy with a westerly wind blowing. Do you think you can think of an appropriate weather symbol for these conditions?

Now that you have an idea as to what weather is, in the next section we will introduce you to the concept of climate. What do you think the term climate means? Well read the next section for an answer.

1.2 Climate

Climate, unlike weather, is the average conditions of the atmosphere when observed and recorded over a long period of time, up to 30 years. For example, the climate of Botswana can be described as semi-arid. This sums up the average conditions of the climate of Botswana throughout the year. The two most important aspects of climate are temperature and rainfall. For you to better understand climate study the climatic figures of Maun and Tsabong in the table below.

	J	F	M	A	M	J	J	A	S	O	N	D
Maun	26	26	26	24	21	18	18	21	25	28	28	27
Tsabong	28	28	26	22	17	14	13	16	21	25	26	27

Fig 3: Mean maximum temperature figures for Maun and Tsabong (1959-1980) (Adapted from <http://www.weatheronline.co.uk> on 9/5/11)

From the table above you can see that there are little variations in temperature between Tsabong

and Maun. Temperatures are generally high from September to March. The lowest temperatures are recorded between May and July. A similar table can be drawn to show the average rainfall for the two towns over the same period of time.

Information on climate can also be recorded in **climatic maps and graphs**. The maps show large geographic areas with similar climatic conditions. A climate graph uses bars to show total monthly rainfall and a line is used to show average monthly temperature.

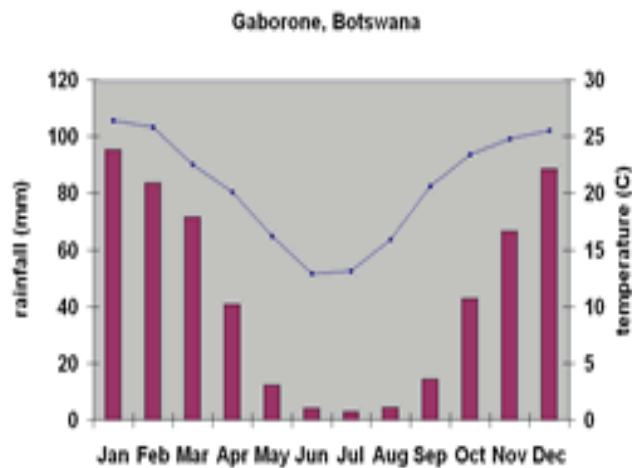


Fig 4: A climate graph of Gaborone (Downloaded from <http://www.tour.tk/pics/weather/gaborone-climate-chart.gif> on 9/5/11)

Figure 4 gives a clear picture of the climate of Gaborone in graphical form. Gaborone receives most of its rainfall in summer. The least rainfall is in July and the highest in January. The highest temperature is recorded during the months of November to March.

The world can be divided into climatic regions. Look at the map in figure 5 to get an idea of some of the broad climatic regions in the world.

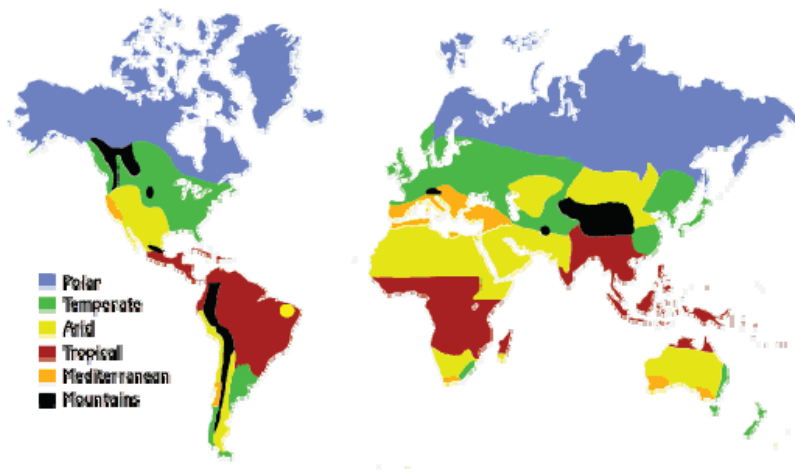


Fig 5: World climatic regions (Downloaded from <http://www.metoffice.gov.uk/education/teachers/images/worldclimate.gif> on 9/5/11)

In the above map, you can see that the tropical regions lie along the Equator and are bordered by arid regions. The Mediterranean Regions lie outside the tropics while the polar regions cover the poles. It is important to note that climatic regions are separated by broad zones where the characteristics of one region blend and merge with those of the other. These zones of convergence are called **transitional zones**. On maps these zones are shown by lines which separate one region from the next.

You have now learnt a bit about both weather and climate. Before we move any further with the topic, attempt activity 3 below to test your understanding.



Activity 3

1. What is meant by weather?[1 mark]

2. Name the place where weather observation is made every day? [1 mark]

3. What name is given to people who collect information about weather?[1 mark]

-
4. Where do the recorders send the information once it has been collected and recorded?[1 mark]

5. Explain briefly the difference between weather and climate. [1 mark]

6. Name the two most important determinants of climate? [2 marks]

Total = [7 marks]

Feedback

Here are the answers to the exercise you have just completed.

1. *The state of the atmosphere for a short period of time*
2. *Weather station*
3. *Meteorologists*
4. *The National Weather Bureau*
5. *The difference between weather and climate is found by looking at the length of time of the observation. Weather observations are made for a shorter period of time, whilst climate is for longer, approximately thirty years.*
6. *Temperature and rainfall*

The content you have covered so far allows us now to look at the details on the elements of weather beginning with temperature and sunshine. We will start by looking at temperature and ways of measuring and recording it.

2.0 Measuring and Recording Temperature

I would like to start off by asking you how you are feeling today. Is it hot or cold where you are

right now? Remember, temperature refers to the warmness or coldness of something, be it you, the air we breathe or the food we eat. In this case we are interested in the warmness or coldness of the air around us. Temperature is measured by using a **thermometer**. There are different types of thermometers that are used for different purposes. Here we are more concerned with thermometers designed for measuring the **highest and the lowest temperatures of the day**. The **maximum thermometer** is used for measuring the highest temperatures while the **minimum thermometer** is used for measuring the lowest temperature. The diagram on figure 6 is an example of a thermometer.

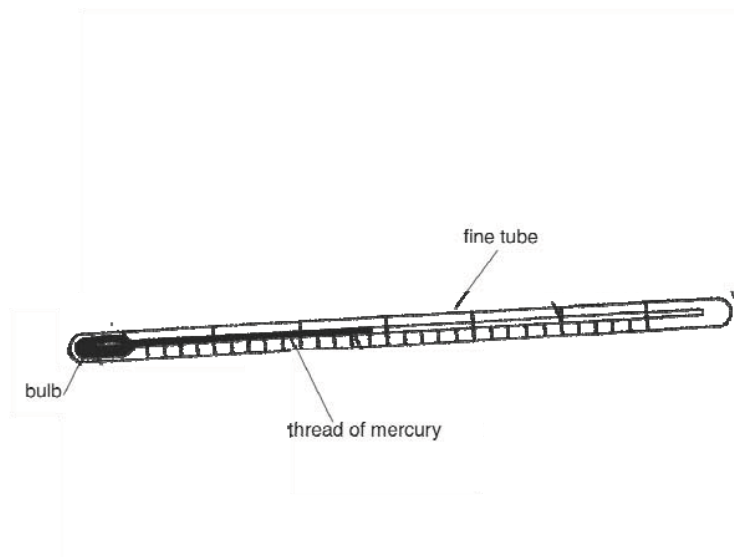


Fig 6: A simple mercury thermometer

In the next section we will see how this thermometer works. Remember we said that there are two types of thermometers for measuring air temperature. These are the minimum and the maximum thermometers. Let us now see how the maximum thermometer works.

2.1 The Maximum Thermometer

The maximum thermometer is made of a hollow glass-tube straw-like glass with markings along its length. The glass has a bulb for storing mercury and is closed at both ends. The maximum thermometer is filled with **mercury** because **mercury has a high boiling point** and may not change to vapour if temperature rises. Inside the glass tube is a metal index. When the temperature rises, the mercury expands and pushes the metal index upwards. When the temperature falls, mercury contracts and falls down the glass tube. The index however remains at the highest temperature reached on that day. Remember the glass tube is marked in degrees

Celsius and the position of the metal index can be read from these markings. Figure 7 is a diagram of a maximum thermometer.

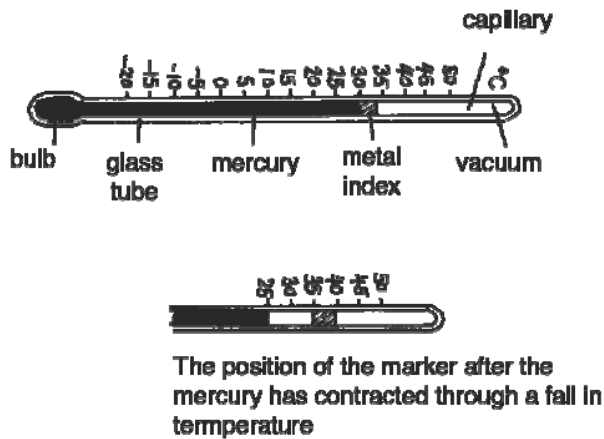


Fig 7: A maximum thermometer

The maximum temperature in the thermometer in figure 7 is 30°C. After reading the temperature, the metal index has to be re-set either by shaking the thermometer or by using a magnet to draw it back to the mercury surface.

Now that you know how a maximum thermometer works. How do you think the minimum thermometer works?

2.2 A Minimum Thermometer

A minimum thermometer is similar to the maximum thermometer. However, instead of using mercury, a minimum thermometer uses **alcohol**. The reason is that alcohol has a very **low freezing point** and may not freeze when it becomes very cold. This makes it suitable for measuring very low temperatures. Figure 8 shows how a minimum thermometer looks like.

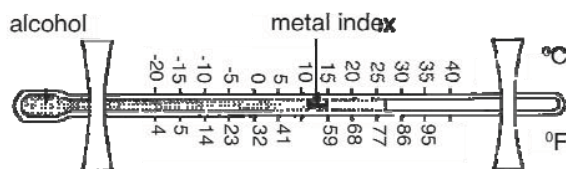


Fig 8: A minimum thermometer

When the temperature falls, the alcohol contracts and pulls the metal index with it towards the bulb. You take the reading at the point of the index nearest to the meniscus (surface of the alcohol). In figure 8, the reading is 15°C.

2.3 A Six's Thermometer

Both the minimum and maximum thermometers may be combined to make a single instrument called the Six's thermometer. It is often referred to as the minimum and maximum thermometer. Figure 9 below shows a Six's thermometer.

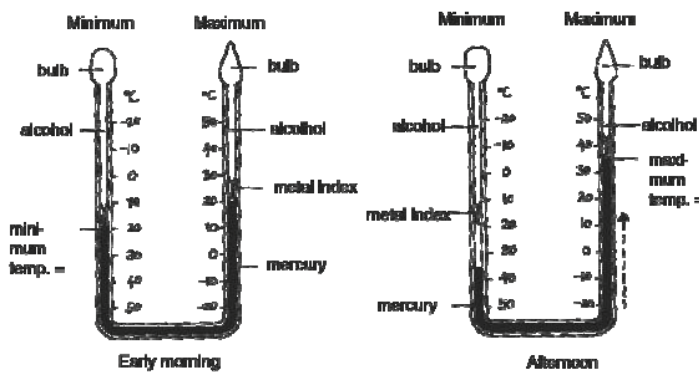


Fig 9: A minimum and maximum thermometer

Look carefully at the diagram in figure 9. Note that the Six's thermometer is U-shaped. And that it contains mercury and alcohol. The metal indexes mark, the maximum and minimum temperatures. As the temperature rises the alcohol expands and pushes the mercury up the capillary tubing. The mercury in turn pushes the metal index up on one side of the tube. As the temperature falls, the alcohol contracts and the mercury moves along the tube in the opposite direction leaving the metal index to mark the highest temperature of the day. The metal index on the other arm of the tube marks the minimum temperature, which is the furthest point the mercury moved as the temperature fell.

2.4 Calculating temperature

The reading from the two thermometers can be used to calculate the **average daily temperature** and the **daily range of temperature**. To calculate the daily temperature range, get readings for the highest temperature from the maximum thermometer and the lowest temperature from the minimum thermometer. Subtract the reading of the minimum thermometer

from that of the maximum thermometer. The difference you get is the **temperature range**.

Example 1

Maximum temperature	21°C
Minimum temperature	10°C
Temperature range	21 - 10
Answer:	11°C.

The temperature range for the day is therefore 11°C. You can also find the temperature range for a month by subtracting the lowest temperature from the highest of the month.

To calculate the daily average temperature, you get the reading for both maximum and minimum thermometers and add them together. Divide the answer for the combined readings by 2. What you get is **the average temperature**.

Example 2

Maximum thermometer	35°C
Minimum thermometer	20°C
Average temperature	$(35^{\circ}\text{C} + 20^{\circ}\text{C})/2$
Average temperature	55°C/2
Answer	27.5°C

The average temperature for the day is therefore 27.5°C. The average temperature for both the month and year is calculated the same way by finding the lowest average temperature and adding it to highest average temperature. Then you divide what you added (days or months) by the number of days for that month, to get the monthly average and for the year by the months.

Now that you have learned about measuring and recording temperature let's see how much you have learnt by doing the activity below.



Activity 4

1. What is meant by temperature? [1 mark]

2. Name the **two** thermometers used to measure air temperature. [2 marks]

3. What liquid is used in (a) the maximum and (b) minimum thermometers? [2 marks]

a.

b.

4. Explain how you calculate the average daily temperature. [3 marks]

Feedback

Here is the feedback to the activity, which you have just completed.

- 1. Temperature refers to how hot or cold the object is.*
- 2. Minimum and maximum thermometers.*
- 3. (a) mercury (b) alcohol*
- 4. You get the reading for both maximum and minimum thermometers. Add the two readings together divide the answer for the combined readings by 2. What you get is **the average temperature**.*

Now you can proceed to the next session on factors influencing temperature.

3.0 Factors Influencing Temperature

You have probably realised that different places have different temperatures and that the temperatures of some places change from time to time. For instance you must have realised that it is cooler at night and warmer during the day. The temperature of a place depends on some or all the following factors:

- Latitude
- Altitude
- Distance from the sea
- Winds
- Cloud cover and humidity
- Aspect
- Length of day
- Ocean currents.

Let's now discuss how each of these factors affects temperature. Let's start with Latitude.

3.1 Latitude

In your previous unit, you learned about latitude. Do you still remember what it is? Latitude describes the position of a place north or south of the equator. It is very hot at the equator. The temperature gradually decreases northwards and southwards from the equator. Figure 10 explains why this happens.

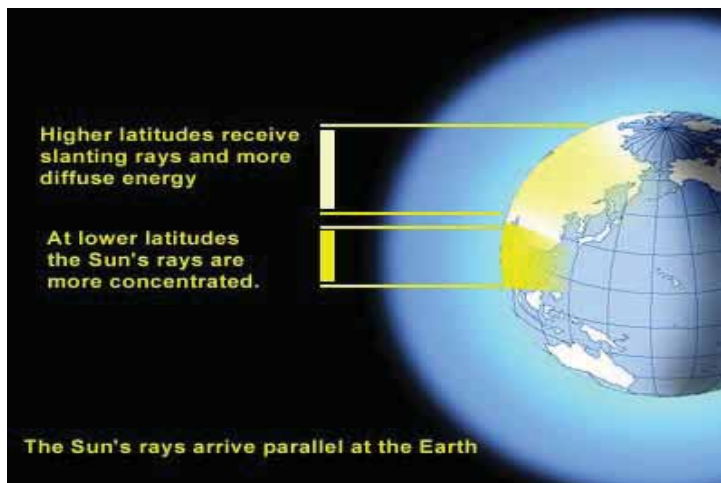


Fig 10: Insolation at different latitudes (Downloaded from <http://minerva.union.edu/failing/pics/insolation.jpg> 9/5/11)

Notice that the same amount of heat is released from the sun to all latitudes. At the equator, the sun rays travels through less atmosphere and is concentrated on a small surface area. This causes higher temperatures at the equator. As you move away from the equator, the sun's rays have to travel through more atmosphere and has to heat a large surface area because of the earth's curvature. This causes lower temperatures as one moves away from the equator. That is why the north and the south poles are frozen.

Another way in which latitude affects climate is in relation to the revolution of the earth around the sun. From your Junior Certificate Geography, you are probably aware that the earth revolves around the sun. During its orbit, the mid-day sun is overhead the Tropic of Cancer on the 21st of June. When this happens areas in the northern hemisphere get more solar radiation than those in the southern hemisphere. For this reason it is summer in the northern hemisphere whilst it is winter in the southern hemisphere. This scenario is reversed on the 22nd of December when the sun is overhead along the Tropic of Capricorn. The southern hemisphere would experience hot summers and the northern hemisphere will be experiencing cold winters.

Now let us look at altitude and how it affects temperature. Do you know that a person at the top of a hill is at high altitude than the one below?

3.2. Altitude

Altitude is the height above sea level. The higher a place is the cooler it will be. This explains why there is snow on top of some of the high mountains. The temperature of the air drops by 6.5° C for every 1000m rise in elevation. This is referred to as the normal lapse rate. Temperature drops because the air at high altitudes is rarefied (have less dust and vapour). Dust and water vapour prevent heat from escaping, but at high altitudes where these are lacking the heat quickly escapes and temperatures go down.

Height (in Metres)	Temperature (in degrees Celsius)
0	30
1000	23.5
2000	17.0
3000	11.5
4000	5.0
5000	-1.5

Fig 11: The normal lapse rate

Figure 11 shows that temperatures drop with an increase in altitude. The temperature at sea level is 30 degrees but by the time one reaches the height of 5000 metres, the temperature would have dropped to about -1.5 degrees.

Now let us turn our focus to how distance from the sea affects temperature.

3.3 Distance from the Sea

The distance away from the sea may influence temperature since sea and land areas do not receive and lose heat at equal rates. During the day, areas near the sea may experience lower temperatures than those further away from the sea because water heats up more slowly than land. A person further inland will feel hotter because land absorbs heat quickly and radiates it to the air around faster than the sea. This situation changes at night. Land areas lose heat quickly during the night so someone further inland feels colder than the one closer to the sea at night since the sea releases the heat trapped during the day more slowly. Therefore, the sea keeps coastal areas cooler in summer and warmer in winter. Inland areas on the other hand have a high temperature range. Areas close to the sea have maritime climate while those that are far away from the sea have continental climate.

Another factor that influences temperature is wind. In what way do you think wind affect temperature? To get the answer to this question read the next section.

3.4 Wind

Depending on the wind blowing in your locality you may feel either hot or cold. This is determined by the origin of the wind blowing into your area. If the prevailing wind blowing over your area comes from cold regions like the poles, then you will experience low temperatures. However, if the winds come from hot regions like tropical areas, then you will experience high temperatures.

Now think about how clouds and moisture in the atmosphere (humidity) affect temperature. Do you think that it becomes cooler or hotter when there are clouds? Read the next section to find out.

3.5 Cloud cover and humidity

Cloud cover can block out incoming heat from the sun (solar radiation) reducing day temperatures. At night cloud cover prevents heat from leaving the earth's surface making the night warmer. Areas with thick cloud cover have little difference between day and night temperatures but areas with no cloud cover record large differences between day and night temperatures.

3.6. Aspect

Aspect is the direction in which the land faces. The midday sun is always overhead at the equator but areas that are far from the equator get the midday sun at an angle. For such areas the slope that is directly facing the midday sun will get more heat. For this reason, the north facing slope in the southern hemisphere, will receive more heat than the south facing slope. In the northern hemisphere, the south facing slope will get more heat than the north facing slope. Now read how ocean currents affect temperature.

3.7 Ocean currents

Ocean currents may also affect temperature. Cold currents flow from cold regions and lower summer temperatures in coastal regions as onshore winds blow into these areas. Similarly warm ocean currents flow from the tropics towards the poles and bring warm weather to coastal regions. Figure 12 shows the ocean currents which influence temperature in Southern Africa.



Fig 12: Ocean currents in Southern Africa (Downloaded from <http://www.pbs.org/edens/namib/images/map1.gif> on 9/5/11)

The cold Benguela currents for instance bring cooler conditions along the west coasts of southern Africa while the Agulhas brings warmer conditions to the eastern coast of Southern Africa.

3.7 Length of day

The number of sunshine hours for people at different points (latitude) on earth is not always the same. For instance, a place at the Equator may receive 12 hours of sunshine in the summer whilst a place in Antarctica may receive only 6 hours of sunshine. A place with a longer period of sunshine will have more heat than the one with few hours of sunshine.

Now that we have fully discussed the factors that influence temperature, attempt activity 5 that follows to see how much you have learnt.



Activity 5

1. Name any four factors that may influence the temperature of an area. [4 marks]

2. Explain how winds may influence the temperature of a place. [2 marks]

3. Explain how the length of day is determined by the relationship between the location of a place on earth and its latitude. [2 marks]

4. Describe how oceans may bring warmth or coldness to areas close to the coast. [2 marks]

5. Explain how altitude may encourage formation of snow on the tops of high mountains. [2 marks]

Total = [12 marks]

Feedback

Here is feedback to the exercise you have just completed.

1. *Altitude*

- Aspect
- Length of day
- Winds
- Ocean currents
- Latitude
- Cloud cover & humidity
- Distance from the sea.

2. Winds originate from different areas of the world. Some originate over deserts or continents and will be dry. Others originate over the sea and contain a lot of moisture, yet others originate from polar areas and can be very cold. The type of wind blowing into an area therefore influences the conditions of weather in the sense that it may bring heating or cooling effects to that area.

The movement of such winds into other areas will usually change slightly to adapt to the prevailing conditions within or brought by the wind. So a hot dry air makes a place feel hot and dry.

3. Due to the round shape of the earth, and the fact that the closest place to the sun is at the equator for most of the year, we find that if the sun moves into the northern hemisphere, areas in the tropical and temperate latitudes in the south receive lesser and lesser sunshine. This is because the amount received has to be spread over a larger area due to the crescent shape of the earth facing up to the sun. As you move further away from the sun the places in the lower latitudes in the south get tucked out of sight under the shadow of the equator. This results in such areas having less exposure to sunlight and so having a shorter length of day compared to areas at the equator or above it.

4. Areas close to the coast on the west margin of continents tend to be cooler since any wind blowing onshore and passing over the cold currents is cooled considerably. An opposite development occurs on the eastern margins when onshore winds blow from the east. Since they pass over warm ocean currents the winds are warmed and they bring this warmth to the coastal areas closest to them.

5. When air ascends a mountain it loses temperature at a rate of 6.5°C per 1000m. As a parcel of air ascends it will be cooled down sufficiently to below dew point, giving rise to super cooled water particles, ice and eventually snow at the tops of mountains.

Now that you have learnt about temperature we need to discuss another element of weather that is closely associated with temperature, which is sunshine.

4.0 Measuring and Recording Sunshine

In Botswana and Africa in general, there is plenty sunshine. Have you ever wondered how we

can measure this abundant sunshine? Well, in this section you will learn how to measure and record sunshine. Sunshine is the light energy produced when the sun shines or when the sun appears in the sky.

The amount of sunshine a place receives can be measured on a daily basis. A sunshine recorder is used to record the amount of sunshine in hours that an area receives each day. It is made up of a spherical glass ball held up at both ends by a curved metal plate. To use the instrument you place light sensitive paper under the spherical glass ball and onto the curved metal plate base. When the sunlight shines, it is concentrated into the metal frame by the glass ball. The light will then burn a line across the paper as the sun moves across the sky during the day. The information on the paper is later collected and read off or recorded in hours and minutes. Figure 13 shows how a sunshine recorder looks like:

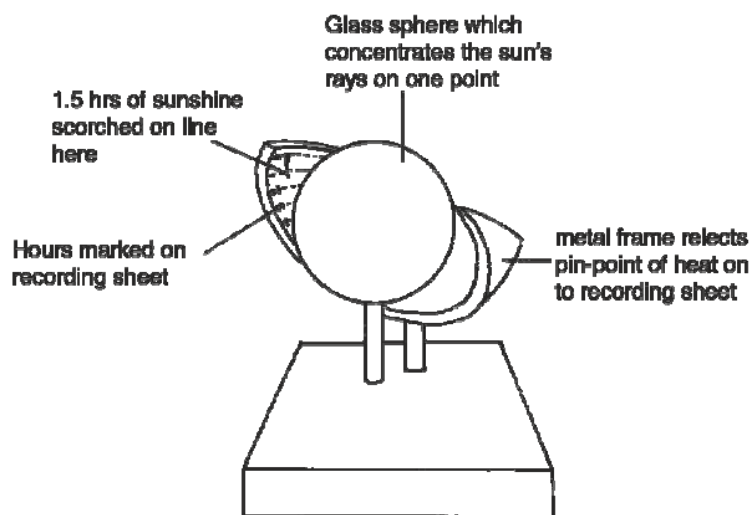


Fig 13: A sunshine recorder (Down loaded from www.geographyhigh.connectfree.co.uk/cs3.gif on 9/5/11)

Notice the metal frame, the glass ball and a paper graduated in hours. The part of the paper scotched by the sun in figure 13 is 1.5 hours, which means that on that particular day at that place the sun shined only for one and a half hours.

Now that you have learnt about sunshine attempt activity 6 on measuring sunshine to see how much you have understood.



Activity 6

1. Explain what sunshine refers to. [1 mark]

2. What is recorded when we observe sunshine in a weather station? [1 mark]

3. Name the instrument used to record sunshine. [1 mark]

4. Mention two things, which can happen when an area receives excessive amounts of solar radiation. [2 marks]

5. Describe briefly how the instrument used to record sunshine works. [3 marks]

Total [8 Marks]

Feedback

Now find out how well you did in this short activity.

1. *Sunshine is the light energy produced by solar radiation.*
2. *The amount of sunshine hours a place receives.*
3. *The sunshine recorder.*
4. *Drought, excessive evaporation causing dams, rivers to dry up,
People may suffer from sunstroke or develop sunburn.*
5. *The glass sphere concentrates light onto the light sensitive paper. The concentrated light burns a line on the paper. The paper is later retrieved and the hours worked out by reading the amount of hours etched onto the paper.*

5.0 Summary



Summary

In this topic you have learnt that weather refers to the state of the atmosphere as observed over a short period of time. Climate on the other hand is a cumulative record of weather observed over a long period of time. You have also learnt about temperature and sunshine and how they can be measured. You also learnt how the readings obtained might be used to come up with different calculations such as finding temperature range. You have learnt about factors, which influence the temperature of places around the world. You will need to use the information you have learnt in this topic to do the assignments at the end of the unit. Feedback is also provided to correct you.

In the next topic we will be looking at yet another weather element which is rainfall. During the course of that topic you will realize that temperature that we have discussed in this topic is closely related to rainfall.

Topic 2: Rainfall

Introduction

In this topic you are going to learn about atmospheric processes that bring about rain. You will learn how rainfall is measured and recorded. You will also learn about different types of rainfall and how they are formed. You have probably heard about El Nino and La Nina and how they affect rainfall patterns in Southern Africa. In this topic you will learn about these two events, which affects rainfall patterns in Southern Africa usually resulting in either extended droughts or excessive rains. An audio clip is provided to enhance your learning of the El Nino and La Nina events.

Topic Objectives

After completing this lesson, you should be able to:

- explain what rainfall is
- describe how to use a rain gauge for measuring rainfall
- read and interpret information contained in graphs, maps or tables to calculate the mean monthly rainfall, mean annual rainfall and annual rainfall totals.
- explain how rainfall occurs
 - describe the formation of frontal, convectional and relief rainfall
 - explain la Nina and El Nino and the walker circulation

- discuss the effects of El Nino and La Nina on people.

1.0 Rainfall

You certainly know what rain is from your personal experiences and previous learning. Rain refers to the droplets of water, which fall from the sky. These are formed when condensation occurs and the temperature of the air drops down to dew point (temperature necessary to change water vapour into water droplets). The water droplets that form produce a visible mass of water known as clouds. As the water droplets grow bigger they become too heavy to be suspended in the air and fall down as rain.

1.1 The formation of rainfall

Let us now attempt to answer the question "how does water that is rain go up into the sky?" For rainfall to occur, there should be **warm moist air** and a medium that will force the air to rise. The medium could be convection **currents** or a **mountain** lying at right angles to the path of the wind or the **meeting of air masses** of different density and temperature. This is the initial process of rain formation. Figure 14 shows the factors that make air rise. "A" shows air being forced into the sky by a mountain, "B" shows convectional currents whilst "C" shows warm air rising over cold air.

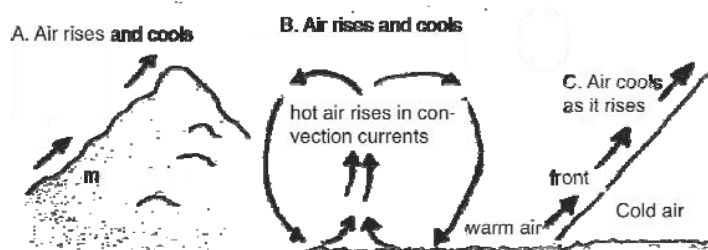


Fig 14: Factors that make air rise

As the air rises, it expands and absorbs even more moisture. At high altitude the rising air loses most of its heat and starts to contract. Further cooling of this air causes it to reach its dew point. The moisture it contains then changes into water droplets which grow into clouds and as the air reaches saturation, the now heavy water droplets fall down as raindrops.

To see how much you have learnt so far and also drawing knowledge from your past experiences, attempt Activity 1 that follows.



Activity 1

1. What is rainfall? [1 mark]

2. How are raindrops formed? [1 mark]

3. State three things, which can cause moist air to rise leading to the formation of rain. [3 marks]

4. What do you call the state of air when it can absorb no more moisture?[1 mark]

Total = [6 Marks]

Feedback

Now look at the correct answers below and see how well you performed.

1. *Rainfall is the water droplets that fall from the sky when water vapour in the air condenses to form water droplets which grow bigger as the air gets saturated until they can*

stay up no more.

2. *Raindrops are formed through the process of condensation when water vapour changes into liquid water droplets that aggregate to form water droplets or rain drops.*
3. *Mountain barrier, convection currents, meeting of air masses.*
4. *Saturation*

We have already discussed the three ways by which warm air rises that eventually leads to the formation of rainfall. These three ways are closely linked to the various types of rainfall that we are going to discuss in the next section.

2.0 Types of Rainfall

There are three types of rainfall namely:

- Convectional rainfall
- Relief rainfall
- Frontal rainfall.

You will note that the names of the rainfall types correspond with the medium which forced the moist air to rise and give rise to the formation of rain that we have just discussed. Let's start by looking at convectional rainfall.

2.1 Convectional rainfall

This type of rainfall as its name suggest is closely linked with convectional currents. It occurs mainly in summer when the ground surface is heated greatly during the day. The heat from the ground then heats the air above it by conduction. Hot air is light in weight and therefore rises as a result of convection currents. When the air is heated it absorbs large amounts of moisture mostly released by transpiration from the trees and evaporation from the lakes, pans, dams and rivers. As the air rises it cools and condensation takes place at dew point temperature. As air condenses it forms clouds. The small droplets of water join together and become bigger. Rain falls when the droplets of water are too big to be suspended in the air.

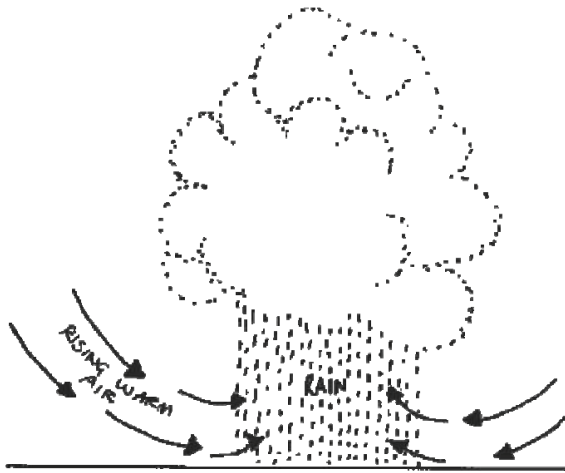


Fig 15: Convectional rainfall

In figure 15, the arrows indicate the rising warm air by convectional currents after being heated by the sun. Convectional rainfall usually comes in the afternoon and is accompanied by lightning and thunder. Torrential rains usually follow. The clouds formed are large black clouds that can rise high up the sky called cumulonimbus clouds. Sometimes the super cooled water droplets at the top of the clouds are converted to ice crystals, which fall back to the ground as hail.

Now let us focus on relief rainfall. In what way do you think relief rainfall is formed? To find answers to this question read the section that follows.

2.2 Relief rainfall

This type of rainfall occurs in areas where there are high mountains. It is common where warm and moist air blows over the sea onto the land areas. Relief rainfall is formed when warm and moist air blowing from the sea is forced to rise by a mountain that lies on its path. As moist air rises it cools, condensation takes place, clouds are formed and rain falls.

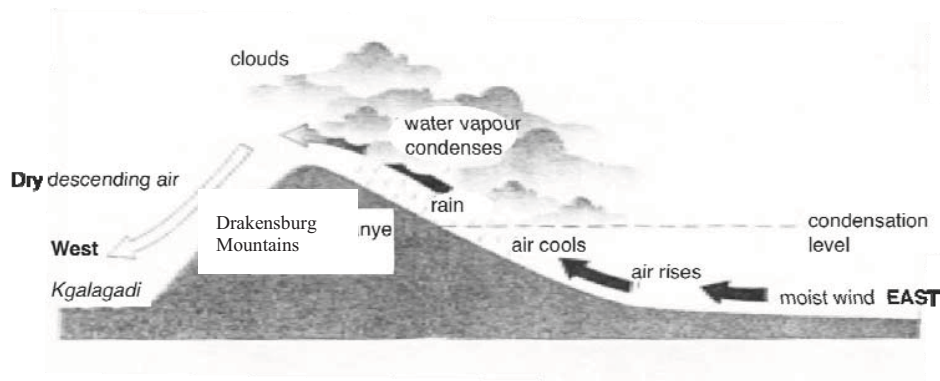


Fig 16: Relief rainfall

Figure 16 shows warm and moist air blowing from the Indian Ocean in the east. This moist air is forced to rise by the Drakensberg Mountain that lies on its path. As it rises it cools, condenses, clouds are formed and rain falls. The eastern side receives more rainfall than the western side of the Drakensberg. Rainfall is high on the side of the mountain facing the direction of the winds. This area is called the **windward side** of the mountain. Once air crosses the mountain, it descends and loses moisture. This side of the mountain is called the **rainshadow** or **leeward side** and normally receives less rainfall than the windward side. The Kgalagadi Desert for example receives very little rain because it is in the rain shadow or leeward side of the mountain.

Now that you have learnt about the two types of rainfall, relief and conventional, it is now time to look at the third type called frontal rainfall.

2.3 Frontal rainfall

This type of rainfall occurs in areas like the temperate regions where cold air from the poles meets with warm air from the tropics. The warm air, which is lighter in weight, is made to rise by the cold heavy air which will creep under it. The point where the two air masses meet is called a **front**. The warm front is the point in front of the warm air and the cold front is the point in front of the cold air where the two air masses meet. Look carefully at figure 17, as it gives a diagrammatic picture of frontal rainfall.

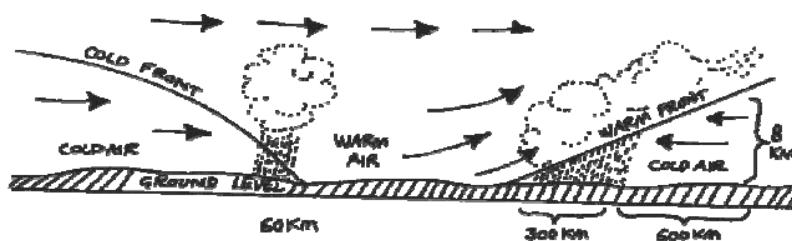


Fig 17: Frontal rainfall

Warm air which is blowing from the left, meets cold air that is blowing from the right. Notice that warm air rises above cold air and rain falls where the two air masses meet. Frontal rainfall is associated with nimbostratus clouds and takes a relatively long time and covers a larger area compared to convectional rainfall. This type of rainfall occurs in the northern part of Botswana. The area where warm and cold air converges is called the Inter Tropical Convergence Zone.

Now that you are familiar with the various types of rainfall, it is time to attempt the activity that follows to find out how much you have learnt and understood.



Activity 2

1. Explain briefly how frontal rainfall occurs. [4 marks]

2. Explain why the windward side of a mountain tends to receive more rain than the leeward side. [4 marks]

Total [8 Marks]

Feedback

Here are the answers for the activity, which you have just completed.

1. *Frontal rainfall occurs when the following conditions exist.*
 - *Two air forms (cold and warm) meet*
 - *The cold air forces the warm air to rise*
 - *The warm air cools and condenses to form rain drops.*

The rain falls in two parts with a period of calm in between.

2. The windward side of the mountain receives most of the moisture from the sea.

The moisture rises on the windward side and condenses.

The leeward side receives little moisture since it was used up on the windward side.

Air descends and gives little rain or no rain.

Now that you have learnt about the different types of rainfall, let us now focus on how rainfall is measured. Do you remember the instrument that is used to measure rainfall? Read more about it in the next section.

3.0 Measuring rainfall

Rainfall is measured using an instrument called a **rain gauge** as shown in figure 18.

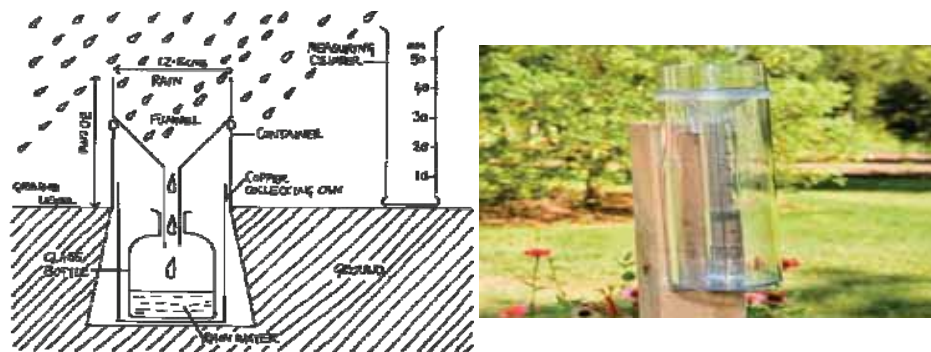


Fig 18: A rain gauge (Adapted from <http://www.compleatnaturalist.com/images/Prof%20Rain%20Gauge.jpg> downloaded on 9/5/11)

It is made up of a cylindrical copper container with a smaller can inside which is often known as a collecting jar. The outer jar is covered at the top with a funnel which fits into the collecting jar. If the collecting jar overflows the water falls into the outer container. The water that has split into the outer container must also be added to the water collected from the inner jar and measured. Figure 18 shows a rain gauge. Notice that the rain droplet that collects through the funnel goes into the glass bottle. Notice also that the glass bottle is surrounded by the copper collecting can to collect water when the glass overflows. The rain water collected will be measured using the measuring cylinder on the right that is graduated in millimetres.

The rain gauge must be located in an open area so that it is not sheltered by trees. In some areas

the rain gauge is placed on a pole about 1m or so from the ground. In some cases the rain gauge is sunk (dug) into the ground with at least 30cm of the can protruding above the surface of the ground. The increased height ensures that no water splashes from the ground into the rain gauge.

3.1 How to use a rain gauge

When measuring rainfall, the following procedures must be followed.

- First pour off all the water collected in the rain gauge into a measuring cylinder or beaker
- Put the beaker/measuring cylinder on a flat and level surface
- Bring your eyes to the level of the meniscus (surface) and take your reading at bottom of the meniscus.

3.2 Calculating Rainfall Figures

Information on rainfall and temperature can be presented in the form of graphs or tables. The records of rainfall over an extended period may be used to calculate the **annual rainfall**, mean **monthly rainfall** and **mean annual rainfall** figures. Study the rainfall figures for Tsabong given in figure 19.

	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall in mm	51	53	55	25	10	5	0	0	5	10	20	25

Fig 19: Rainfall figures for Tsabong (Adapted from <http://www.weatheronline.co.uk> on 9/5/11)

- To calculate the **annual rainfall** for Tsabong you add all the monthly rainfall totals. The total annual rainfall for Tsabong in 2010 was 259mm.
- To calculate the **mean monthly rainfall** for Tsabong you add all the monthly rainfall totals. Divide the annual total by the number of months in a year. The mean monthly rainfall for Tsabong was $(259/12) = 21.5\text{mm}$.
- To get the **mean annual rainfall** figures you add up all the totals for each year and divide by the number of years.

3.3 Presenting information on rainfall

The information for rainfall of one place can also be shown using graphs like the one shown in figure 20.

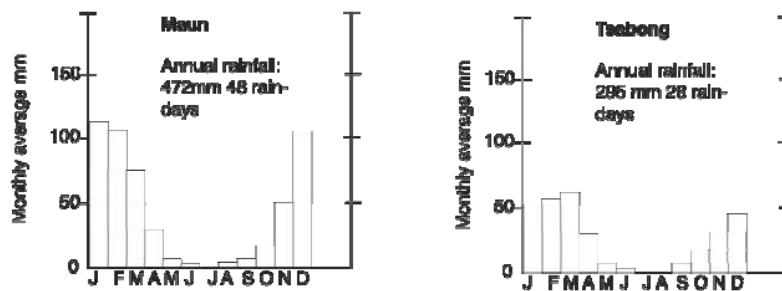


Fig 20: Monthly rainfall for Tsabong and Maun (Adapted from <http://www.weatheronline.co.uk> on 9/5/11)

Notice that Tsabong and Maun receive the highest rainfall between November and March and the lowest rainfall in the months of June, July and August. If you have problems interpreting these charts, go to Unit 10 on research methods. There is a section on data presentation which may better help you understand data presented in graphic and chart form.

Information on rainfall can also be shown using maps with **isohyets**. Isohyets are lines in a map joining areas, which have the same annual rainfall. The map shown in figure 20 shows the distribution of rainfall in Botswana.

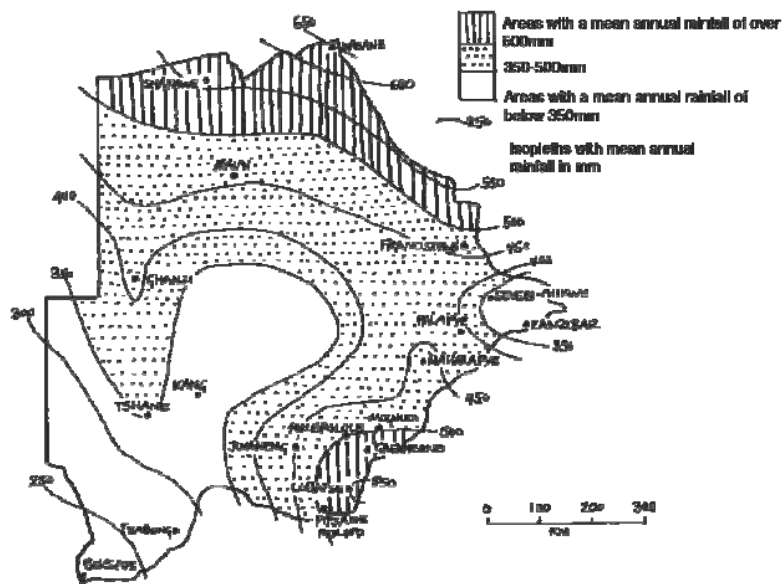


Fig 20: An isohyet map of Botswana showing rainfall distribution (*Adapted from http://www.info.bw/~mettest/bulletins/data/bulletin_0210/rain_mean_ifm.gif on 10 May 2011*)

Notice for instance, that the map indicates that Francistown gets the same annual rainfall as Maun. They both lie about the same position around the 460 mm line.

Now that you have discussed the way in which rainfall is measured, it is time to end this section by attempting activity 3 that follows.



Activity 3

1. Name an instrument used for measuring rainfall.[1 mark]

2. Draw a well-labelled diagram of the instrument in 1 above.[4 marks]

3. Describe the procedure you would follow to correctly measure the amount of water received in a rain gauge. [2 marks]

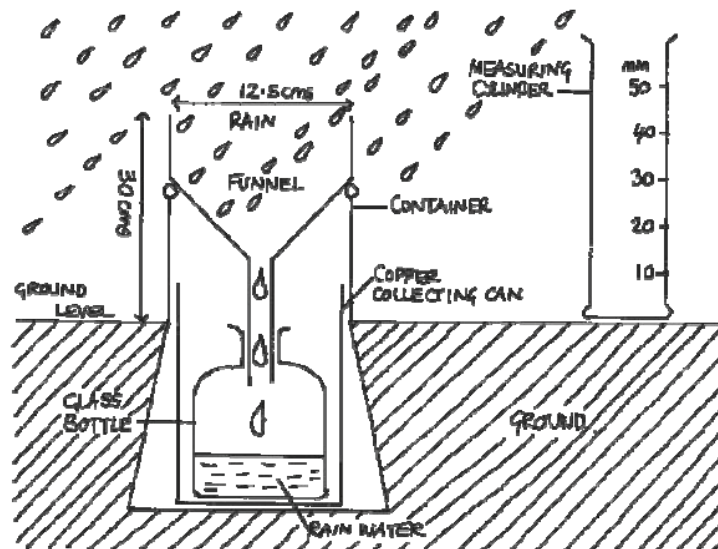
4. Explain how you would calculate the mean monthly rainfall. [2 marks]

Total Marks [10]

Feedback

Here are the answers for the activity you have just completed.

1. A rain gauge
2. A rain gauge



3. *When measuring rainfall, the following procedures must be followed.*

First pour off all the water collected in the rain gauge into a measuring cylinder or beaker.

Put the beaker/measuring cylinder on a flat and level surface.

Bring your eyes to the level of the meniscus (surface) and take your reading at bottom of the meniscus.

4. *Add all the monthly rainfall totals, then divide by the number of months.*

If you live in Southern Africa, you are aware that there are times when we have good rains and there are times when we have droughts. It has been observed that these trends are associated with what is called El Niño and La Niña. Let's read more about these in the next section.

4.0 El Nino and La Nina

Before you learn more about El Nino and La Nina, you need to listen to the **audio** clip on the topic. Play the audio lesson. After listening to the audio, you can then continue with your study of the sub-topics. This audio has been supplied to you as part of the learning package of this unit. Programme 1 of this audio relates to this section of the topic. You may take notes as you listen to the audio. If you are reading this topic from a computer, double click on the **04 Track 1.wma** icon below



04 Track 1.wma



Note it!

From the audio, you learnt that El Nino and La Nina refer to the effects of the changes in the temperature of the sea and their influence on the weather conditions over land areas. When air rises over the continents during summer, cooler moist air from the sea moves in to replace it. The air which moves away over the continents eventually descends over the sea. As it descends it accumulates moisture and blows back to the continents. The circular movement of air between the continents and oceans described above is known as the **walker circulation**. The winds which blow from over the seas known as the **trade winds** bring in moisture and rain to the continents.



Activity 4

You learnt about the walker circular movement of air between the continents and oceans. How is this circulation changed during the El Nino? What causes this change?

Feedback

I hope this activity was easy for you as the answer is clearly provided in the audio clip. Compare the answer below to what you have written.

During El Nino periods this circulation is changed. Instead of air mostly rising above the continents in summer, it rises above the seas. Why this happens is not exactly known but it is believed that the heating effects of volcanic eruptions, which cause the temperature of the sea to rise, cause it. The high temperatures over the seas create huge low-pressure areas (especially in the Pacific Area). The rising of air over the sea now reverses the walker circulation described above and changes in weather patterns occur which bring low rainfall to areas in Southern Africa and the Sahel. This leads to drought in these areas.

La Nina (or Lamina) is the reverse of the El Nino and it tends to enhance the walker circulation bringing in more moisture which usually leads to floods in Southern Africa.

We have learnt that in an El Niño year, the Walker circulation is reversed while in a la Niña year the Walker circulation is enhanced. What then are the effects of both El Niño and La Niña? The next two sections attempt to answer this question.

4.1 Effects of El Nino

In the audio Pedro and Mpho mentioned the effects of El Nino. Go through this part of the audio and attempt activity 5



Activity 5

1. According to Mpho what are the effects of El Nino in Botswana?

Feedback

Hope you have made a good attempt. Check the answer below.

El Nino usually results in severe droughts particularly in Southern Africa. It can cause crops to die and livestock to starve since there will be little growth of vegetation. This may increase wind erosion creating vast tracts of wasteland.

4.2 Effects of La Nina

From Pedro, you learnt that La Nina bring floods which kills people and animals. The heavy rains may damage property and infrastructure such as houses, roads, railway lines, electric cables and bridges. This interferes with transport and telecommunications and the distribution of essential items of trade between places. It may also lead to the outbreak of water borne diseases such as malaria and cholera. Water logging and leaching of soils occur and soil erosion occurs in many areas. Governments lose a lot of money repairing the broken infrastructure.

To see how much you have learnt and understood about La Nina and El Nino, try activity 6 that follows. You may go through the audio again before attempting this activity.



Activity 6

1. Explain the walker circulation. [2 marks]

2. Explain how El Nino occurs. [2 marks]

3. Name at least three negative effects of (a) El Nino and (b) La Nina[6 marks]

(a)

(b)

Total = [10 marks]

Feedback

I hope you found this activity simple. Look at the answers to the Activity that you have just completed.

How well did you do?

1. *This is the circulation of air that results from land areas heating quicker than sea*

areas, causing air to rise over warm land areas and sink over the cooler seas. The cool air with moisture from the sea moves in to replace the warm rising air over land. This brings lots of rain to land areas.

2. *El Nino is a reversal of what has been described above. Here air rises over the seas, which have high temperatures than land areas. This results in the interference with the existing walker circulation leading to low moisture when cold air descends around coastal areas and the interior. This brings about drought conditions. La Nina on the other hand creates a situation that strengthens air circulation and brings more moisture to land areas causing floods.*

3. (a) *El Nino - Drought, crops will die, livestock may starve since there will be little growth.*

(b) *La Nina - They can cause decline in agriculture.*

Now read over the summary provided below. It will help you consolidate your understanding of the topic.



5.0 Summary

You have learnt about different types of rainfall and how it is formed. You learnt how a rain gauge is used to measure the amount of rainfall and that the information obtained can be used to calculate annual rainfall or mean monthly rainfall. You also learnt that the walker circulation leads to La Nina (Lamina) and El Nino. You also looked at the possible effects these can bring to areas where they are experienced.

You will need to use the information you have learnt in this topic to do the assignment at the end of the unit. Feedback is also provided to guide you. In the next topic we are going to look at two more of the weather elements. These are humidity and cloud cover. You will realise that these two weather elements are closely linked to rainfall and temperature.

Topic 3: Humidity and Cloud Cover

Introduction

Cloud cover probably sounds more familiar to you than humidity. In this topic you are going to learn about both humidity and cloud cover. You will also learn how these elements are measured and recorded. Lastly, you will learn about different types of clouds and how the information obtained on these elements may be used.

Topic Objectives

At the end of this topic you should be able to:

- to measure humidity and cloud cover
- use humidity tables to calculate relative humidity.
- identify and describe the different types of clouds.

1.0 Humidity and Cloud Cover

Humidity refers to the amount of water vapour in the air. Do you know what water vapour is? Have you ever observed water boiling from a kettle? Look at figure 21 below.

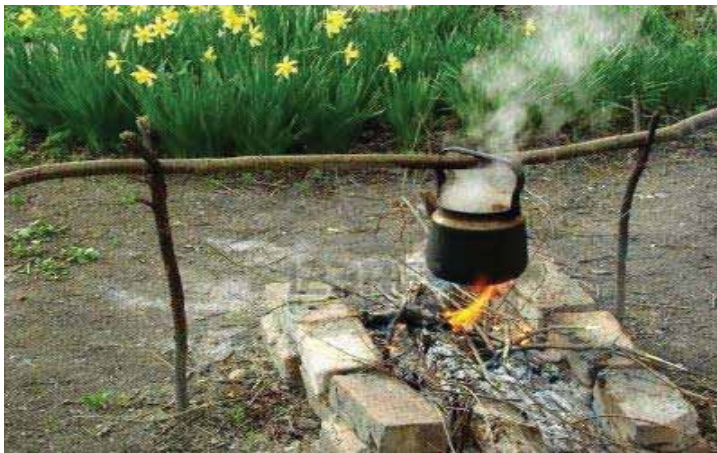


Fig. 21 Water vapour coming out of a kettle spout (Downloaded from <http://us.123rf.com/400wm/400/400/DLeonis/DLeonis1004/DLeonis100400063/6870341-boiling-water-in-old-sooty-kettle-on-the-hiking-campfire.jpg> on 23/5/11)

You can see a whitish gas coming out of the spout of the kettle that is being heated over the fire. When water is heated it changes into a gaseous state known as water vapour. Ordinarily water in this state is very difficult to see using your naked eye. You may at times see it but this only occurs when the temperature of air drops to the **dew point** or below at which the water vapour condenses or changes into water droplets. Some of the water droplets can be very tiny. Can you think of examples of tiny water droplets, which you have seen? Most likely you mentioned examples such as mist or fog. In some cases the water droplets may grow until they are visible and can be touched such as when rain is falling.

1.1 Absolute and relative humidity

Like other elements of the weather we have studied earlier on, water vapour in the air can also be measured. The amount that the air can hold is determined by the temperature of the air. When the temperature is low the air absorbs less moisture (water vapour) than when it is warmer. The ability of air to absorb water vapour is doubled for every rise in temperature of about 11°C. Study figure 22. Notice that the volume of moisture the air can hold increases with the increasing temperature.

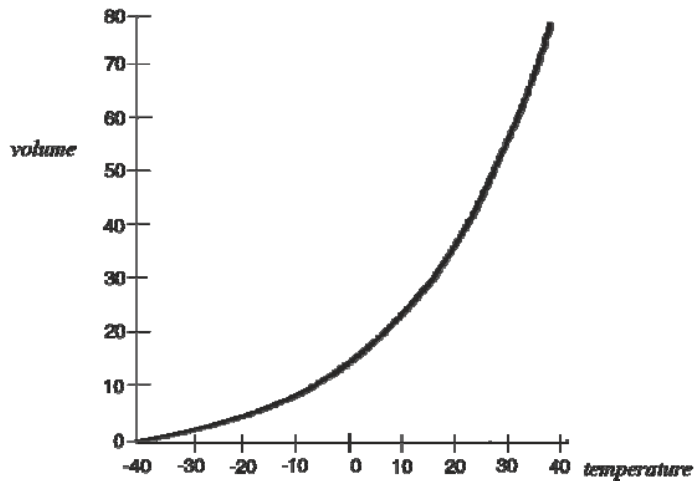


Fig 22: Humidity and air temperature

The amount of water vapour contained in a given volume of air at a certain temperature is known as absolute humidity. Relative humidity is the ratio between absolute humidity of a given mass of air and the maximum amount of water vapour that it can hold at the same temperature. It is expressed as a percentage. When the air cannot hold any more water vapour (when its relative humidity is 100%), it is said to be **saturated**.

Now that you have an idea of what humidity is, try this activity to see how much you have learnt. Remember that when you are not satisfied with your performance you should always go back and review what you have learnt.



Activity 1

1. What is humidity? [1 mark]

2. Name two forms in which water may occur. [2 marks]

3. At what temperature interval would the ability of air to absorb more moisture increase?[1 mark]

4. Explain the meaning of absolute humidity. [1 mark]

5. Explain the difference between relative humidity and absolute humidity. [3 marks]

Total [8 Marks]

Feedback

Now check how well you performed in the activity from the feedback given below.

- 1. Humidity refers to the moistness of air or the moisture contained by air.*
- 2. Water vapour, ice particles and water droplets.*
- 3. 11°C*
- 4. Absolute humidity is the amount of water vapour present in air at a given time.*
- 5. Relative humidity is the amount of moisture in the air expressed as a percentage of the amount of moisture the air can hold at that temperature.*

Humidity, like all other elements of the weather can be measured or observed. In the next section we are going to discuss how humidity is measured.

1.2 Measuring humidity

We mentioned previously that the amount of water vapour in the air is measurable. Can you guess how it is done? You may already know how this is done from visiting your local weather station or from reading books in your local library. To measure humidity you need two instruments: the wet and dry bulb thermometers or a hygrometer. These instruments are filled with mercury and therefore similar to the minimum and maximum thermometer, which has been discussed in the previous lesson. Study the hygrometers shown in figure 23.

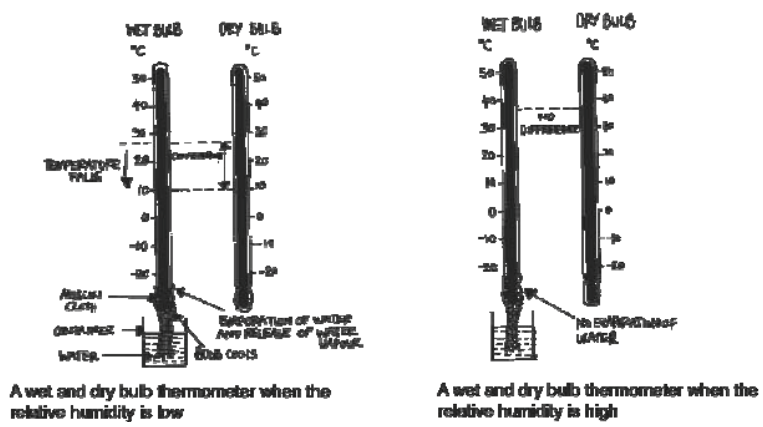


Fig 23: A wet and dry bulb thermometer

One of the thermometers has a **muslin** cloth wrapped around its bulb and dipped into a container of water. When water evaporates from the muslin clothes, it lowers the temperature of the bulb and thus reduces the temperature reading in the wet bulb thermometer. On the other hand, the dry bulb thermometer records the temperature of the air. When the air is saturated and there is no evaporation, the two thermometers will show the same reading. Remember, if the air is not saturated, water from the muslin will cool the wet bulb forcing it to show a lower reading. The reading from the wet bulb is subtracted from the reading from the dry bulb. This number is known as the **wet bulb depression**.

To get the relative humidity you need to use a table known as the **hygrometric table** (shown in figure 24). This table gives you the wet bulb depression and the dry bulb air temperature readings. To read the relative humidity, read the value of the dry bulb thermometer and move to where it cross-references with the wet bulb depression. The percentage given is the relative humidity.

Dry Bulb Reading (Degrees Celsius)	Depression of wet bulb						
	1	2	3	4	5	6	7
30	92%	86%	79%	73%	67%	61%	55%
25	92%	84%	77%	70%	63%	57%	50%
20	91%	83%	74%	66%	59%	51%	44%

Fig 24: A hygrometric table

If, for instance the dry bulb records 25°C and the wet bulb records 20°C, the difference between

the two bulbs (wet bulb depression) is 5°C. The relative humidity as read from the table will be 63%. Therefore the difference in the readings of the two thermometers gives us an indication of how much humidity the air contains. When there is no difference between the readings humidity is very high and the air is **saturated**. A small difference means humidity is quite high and a large difference means humidity is low.

We have defined humidity as the amount of moisture in the air. Closely related to moisture in the air is cloud cover. What is cloud cover and how is it measured? For answers read through the next section.

2.0 Cloud Cover

Clouds are the visible masses of condensed water vapour that appear in the sky when the humidity in the air changes from a gas to liquid. A cloud is composed mainly of billions of tiny water droplets of about the same size. Air currents cause the movement we often see in clouds. The height of clouds in the sky is similarly determined by the rising and falling currents.

Clouds are made up of water droplets, ice particles or both. Mist and fog is made up of water droplets and in this respect they are a type of cloud, but unlike the ordinary cloud they form very close to the earth's surface. You may have wished to touch clouds on certain occasions when they float past in your area because they look so beautiful. You may have imagined how it looks like if you are aboard an aeroplane as it flies through the clouds. In actuality, you have experienced all these things when you entered or passed through heavy mist or fog.

2.1 Types of clouds

You have probably seen clouds in the sky and noticed that they do not look all the same. There are different types of clouds. The types of cloud, height, shape and movement can help predict weather conditions over an area. Clouds may be classified according to their appearance, form and height. There are four groups as can be seen in figure 4. These are high clouds (between 6000 and 12000), middle clouds (2100 - 6000m), low clouds (below 2100m) and clouds of great vertical extent (1500 - 9000m)

Type of clouds	Examples
High clouds	<ul style="list-style-type: none"> • Cirrus • Cirrocumulus • Cirrostratus

Middle clouds	<ul style="list-style-type: none"> • Altocumulus • Altostratus
Low clouds	<ul style="list-style-type: none"> • Stratocumulus • Nimbostratus • Stratus
Clouds of great vertical extent	<ul style="list-style-type: none"> • Cumulus • Cumulonimbus

Fig 25: Types of clouds

How then do we measure and record cloud cover? Read through the next section to find out.

2.2 Measuring and recording cloud cover

Cloud cover is expressed in eights (oktas). One okta represents approximately one eighth of the sky covered with cloud. If half of the sky were covered by cloud you would probably say $\frac{1}{2}$ the sky is covered by cloud. The symbols in figure 26 are used for recording cloud cover.

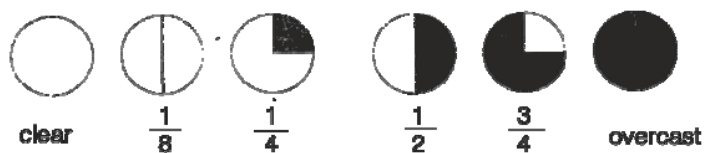


Fig 26: Symbols used for recording cloud cover

Now that you know more about cloud cover, try the next activity to see how much you have understood.



Activity 2

1. What is responsible for the apparent movement of clouds in the sky? [1 mark]

2. How do clouds form?[2 marks]

3. Give examples of clouds that form at the ground surface? [2 mark]

4. What is the unit of measure for cloud cover?[1 mark]

Total [6 marks]

Feedback

Answers to this activity are given below.

1. *Air currents*
2. *They form when the rising water vapour cools and condenses into tiny droplets of water at dew point temperature.*
3. *Mist and fog*
4. *Okta*



3.0 Summary

In this topic, you learnt about humidity and cloud cover. You learnt that the temperature of air in a given area might affect humidity. You also learnt that humidity is present in the atmosphere and that it is measured using a hygrometer. You have also learnt about the formation of clouds, types of clouds and how they are measured and recorded. You will need to use the information you have learnt in this topic to do the assignment at the end of the unit. Do the assignment and read the feedback which is also provided to you to help correct any mistakes you have made before you proceed to the next topic.

In the next topic we will be looking at yet more elements of weather. Here we will be looking closely at winds and atmospheric pressure.

Topic 4: Winds and Atmospheric Pressure

Introduction

By now you should be familiar with most of the weather elements. So far we have discussed temperature, sunshine, rainfall, humidity and cloud cover. In this lesson you will learn about winds and atmospheric pressure. The recording of these elements helps us to organise our social and economic activities. For instance, cloud cover can determine whether we go out or not, while wind can help decide the direction in which planes take off or land. In this lesson you are going to learn about what causes the movement of the wind and how this movement is measured both in terms of direction and speed. You will also learn how the instruments used for measuring wind speed and direction work. Furthermore, you will also learn about atmospheric pressure and what is used to observe it.

Topic Objectives

At the end of this lesson you should be able to:

- describe wind direction looking at the wind vane
- use a cup anemometer to measure wind speed
- explain what atmospheric pressure is
- describe the instruments used to measure wind speed, wind direction and atmospheric pressure
- interpret information provided in a synoptic or isobaric chart relating to pressure

1.0 Winds and Atmospheric Pressure

I know that at one time or another you have seen dust, branches and papers being blown up, trees swaying or the flag flying high because of a strong wind. Thus, from your previous experiences you know something about winds and pressure. If you puncture an inflated balloon you will notice air coming out under pressure. When air is blowing from one point to another it follows a noticeable path, called the **wind direction**. The direction of the wind is named by looking at where the wind blows from. When air moves, the rate at which it passes over a stationery point on the surface of the earth can be measured. This is called the **wind speed**. The wind has weight and the weight the wind exerts on the earth's surface is called atmospheric pressure.

Let us now look closely at wind direction and the instrument used to measure it.

1.1 Wind Direction

The differences in temperature causes unequal heating which leads to the movement of air between places. The word wind refers to the movement of air from areas of high pressure to areas of low pressure. Winds are named after the directions from which they come like the South East Trade Winds, the North East Trade Winds, the Easterlies and the Westerlies. All these indicate the direction from which the wind blows. The wind sock and the wind vane are instruments used for recording wind direction. We are now going to discuss these instruments in details.

(a) Wind sock

Study figure 27 which shows a wind sock. A windsock aligns itself by flowing flag-like in the direction where the wind is going. It is mainly used to guide aeroplanes when they land or take off at the airport.

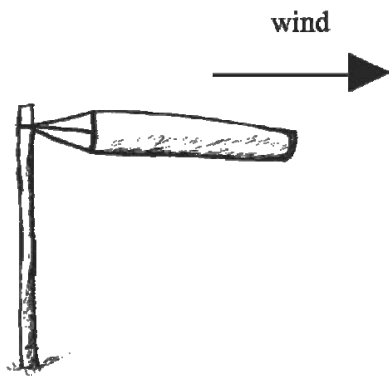


Fig 27: A wind sock

(b) The wind vane

Study the diagram in figure 28 which shows a wind vane. The wind vane is an instrument made up of horizontal arms pointing in the four main compass directions. At the centre of the arms is a freely rotating vertical shaft, which has a horizontal arrow on top.

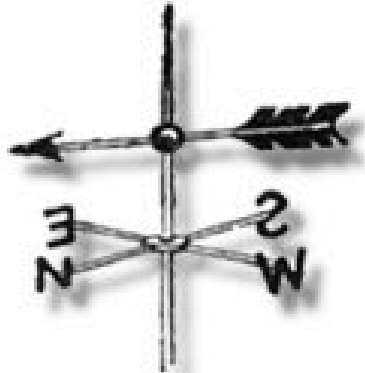


Fig 28: A wind vane (Downloaded from <http://school.discovereducation.com/lessonplans/images/activities/weatherstation/windvane.jpg> on 23/5/11)

When wind blows, the arrow moves until it points in the direction from which the wind is blowing.

Now let us look at wind speed and the instrument used to measure it. The following section discusses this content in detail.

1.2 Wind speed

Wind speed near the surface is measured using an instrument called a **cup anemometer**. Study figure 29 which shows a diagram of an anemometer. A cup anemometer is made of hollow cups mounted on a vertical pole.

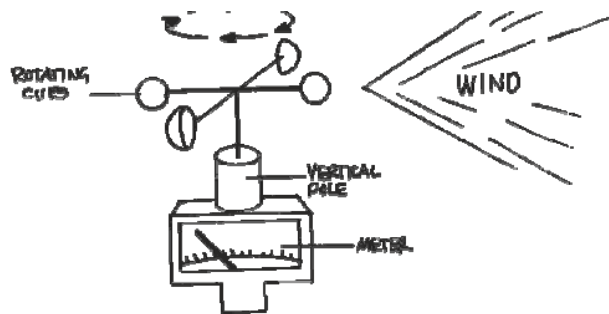


Fig 29: A cup anemometer

The cups catch the wind on their open sides. As the resistance it offers to the wind pushes around each cup, the next cup lines up to take its place. This starts a rotational movement, which is measured by a meter, connected to the freely rotating shaft.

Wind speed can also be recorded using the Beaufort scale, which describes the effects of wind on observable objects like trees, building and the general surroundings. Study figure 30 which shows the Beaufort scale. Read through the Beaufort scale and see if you can relate it to what

happens in your area when the wind is blowing.

Scale no.	Speed (knots)	Description of wind	Effects of the winds (features observed).
0	0	Calm	Smokes rises vertically.
1	1-3	Light air	Direction is shown by the way smoke drifts.
2	4-6	Light breeze	Leaves rustle, wind is felt on the face the vanes of the wind vane move.
3	7-11	Gentle breeze	Light flags blow out in the wind.
4	12-16	Moderate breeze	Dust and loose paper blow about, small branches are moved.
5	17-21	Fresh breeze	Small trees in leaf begin to sway.
6	22-26	Strong breeze	Whistling is heard in telegraph wires, large branches are set in motion, difficult to open umbrellas.
7	27-32	Moderate gale	Difficult to walk against the wind, whole trees set in motion.
8	33-39	Fresh gale	Twigs are broken off trees.
9	40-46	Strong gale	Slight structural damage to buildings occur.
10	47-55	Whole gale	Trees are uprooted and considerable structural damage to buildings occur.
11	56-63	Storm	Widespread damage occurs.
12	Over 64	Hurricane	Widespread devastation occurs in some tropical regions.

Fig 30: The Beaufort scale Adapted from
[http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/circulation/img33_Beaufort NOAA.gif](http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/circulation/img33_Beaufort_NOAA.gif)
 downloaded on 23/5/11

Now that you know more about winds, try the next activity to see how much you have understood.



Activity 1

1. What do we call the path followed by air when it moves from one place to another?[1 mark]

2. How is wind direction measured?[1 mark]

3. Name the instrument used to measure the wind speed?[1 mark]

4. Describe briefly how the instrument used for measuring wind speed works.[3 marks]

5. Name the unit of measure used for wind on weather charts. [1 mark]

Total = [7 marks]

Feedback

Find out how well you have mastered this section by checking the answers given below.

1. *Wind direction.*

2. *By using a wind vane.*

3. *A cup anemometer.*

4. *Blowing winds force cups to rotate, the rotating movement is linked to a meter that records speed.*

5. *Knots*

You have gone through the section on winds and ways of measuring the wind. Let us now move

on to atmospheric pressure and ways of measuring it. What instrument is used to measure atmospheric pressure? How does that instrument work? To find answers to these questions read the section that follows.

2.0 Atmospheric Pressure

Atmospheric pressure is another element of weather. It refers to **the weight of air over the surface of the earth**. The atmosphere consists of a mixture of gases, which are confined by the ground or sea from below and by the force of gravity, thus preventing them from escaping. Atmospheric pressure changes daily as a result of changes in the weather conditions over an area. The pressure of air above the surface is concentrated mainly in a layer that is about 5.5 km thick. Above this level, air pressure starts to decrease rapidly since there are fewer gases of different qualities.

A general cross-section taken vertically would show that the greatest concentration of all types of gases or air is found close to the surface of the earth. There is a marked decrease in these gases as you go higher. The thin air is usually called **rarefied air**. This simply means air that is lighter and has few impurities.

It is important to note that air pressure as an element of weather, can also be measured. The instrument used for measuring atmospheric pressure is a barometer. There are different types of barometers. Details of the barometer are given in the section that follows.

2.1 A mercury barometer

A mercury barometer is made up of a long capillary glass tubing sealed at one end and filled with mercury. The capillary tubing is inverted over a bowl of mercury. Figure 31 shows a simple mercury barometer. Notice the long capillary tube and a bowl of mercury.

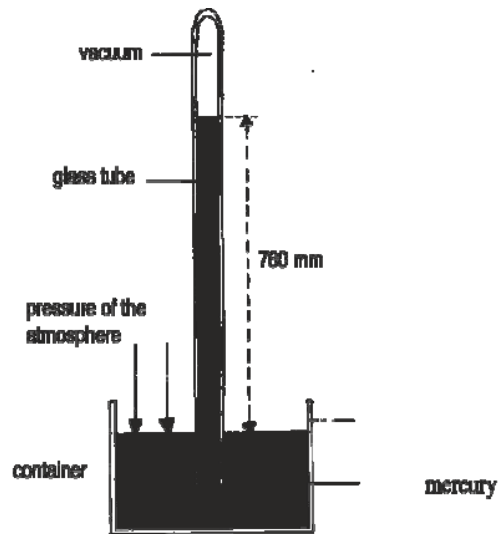


Fig 31: A mercury barometer

When air pressure increases it pushes onto the mercury in the bowl forcing the mercury to rise up the capillary glass tubing. When air pressure is reduced there is less pressure on the mercury in the bowl allowing the mercury to flow down the tube. A scale placed against the test tube helps you read the amount of air pressure acting on the surface.

2.2 An aneroid barometer

An aneroid barometer consists of a metal box with very little air, which is very sensitive to changes in atmospheric pressure. Any slight change in atmospheric pressure causes the box to expand or contract. Most of the air in the thin flexible metal box has been pumped out. When air pressure increases, the box collapses or is pushed inwards. This movement causes a lever attached to the box to move up a scale to show increased barometer pressure. You can see the box and the lever shown in figure 32.

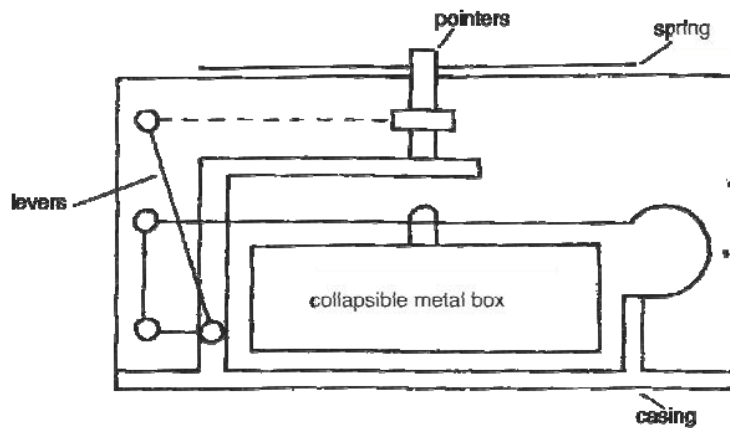


Fig 32: An aneroid barometer

When pressure is reduced, the box fills out and the lever moves down the scale. Since the aneroid barometer is portable, it can easily be carried around for use in outdoor pressure recordings. An aneroid barometer may be modified slightly to come up with other innovative instruments used in measuring atmospheric pressure such as the barograph and the altimeter. These two will be discussed in the next two sections.

2.3 An altimeter

An altimeter (figure 33) measures the decrease or increase in the atmospheric pressure as one ascends above the surface of the earth.



Fig 33: An altimeter Downloaded from <http://geometrytech3.wikispaces.com/file> on 23/5/11

An altimeter is mostly used by mariners at sea and aviation personnel when flying aeroplanes.

2.4 The barograph

Another instrument, which is derived from the barometer, is the barograph. The barograph is an improvement on the aneroid barometer. Instead of a fixed scale, there is a revolving drum (cylinder) to which is attached graph paper (scale) which records changes in the atmospheric pressure for a number of days in a week. The revolving cylinder works on a clock (watch) mechanism and keeps the barograph working. The changes in pressure are recorded by an arm (initially the pointer mechanism of a barometer) which now has a pencil attached to it and placed against the graph paper. Figure 34 shows a diagram of a barograph.

Rotating cylinder with marked paper

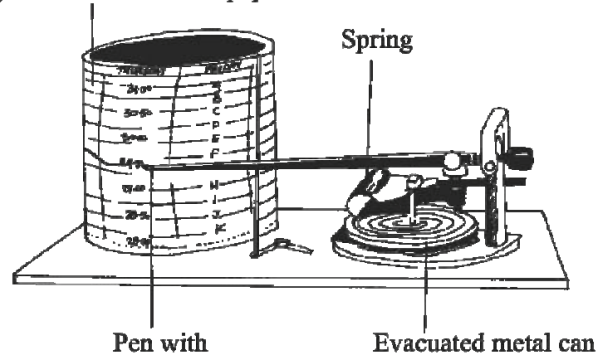


Fig 34: A barograph

The above structure is usually mounted in a glass casing. Carefully look at the barograph given above. Notice the similarities between the barograph and the aneroid barometer.

Now that you have learnt about atmospheric pressure, it is time to do an activity based on it. Try the next activity to see how much you have understood.



Activity 2

State whether the statement is true or false.

- (a) Air pressure can be measured _____
(True/False) [1mark]

(b) Air has no weight _____
(True/False) [1mark]

2. Mention two instruments, which may be used to measure air pressure. [2 marks]

3. Explain briefly how a mercury barometer works. [2 marks]

4. Name two users who may need, on a daily basis information about air pressure. [2 marks]

Total = [8 marks]

Feedback

Now check for the correct answers for the activity you have just completed below.

1. (a) True (b) False
2. Mercury barometer, Aneroid barometer, Barograph, Altimeter.
3. When air pressure increases it pushes onto the surface of the mercury in the bowl causing the mercury in the glass tube to rise. When air pressure decreases it exerts less pressure on the surface of mercury causing the mercury in the glass tube to fall.
4. Aviation people, Mariners (Navigators), Meteorologists.

Information on air pressure is used to predict the occurrence of weather conditions such as **cyclones** and **depressions**, and the movement of wind patterns. Changes in air pressure on a daily basis are caused by temperature and humidity. You will realise that the more water vapour a parcel of air contains the more lighter it becomes. Initially, this may sound wrong but it can be easily explained. When water is present in a volume of air it pushes out an equal volume of dry air to occupy that space. But water vapour is lighter than the dry air it displaces and so the volume of air remains the same but the weight is reduced.

The information is also used to make **isobaric maps**. Isobaric maps are maps drawn by joining areas, which have equal readings (amounts) of air pressure. They show us areas of low pressure and high pressure and they can be used to find the pressure gradient. Pressure gradient refers to changes in movement of wind (speed) between two isobars. When the isobars are close together

wind speed is high and the pressure gradient is said to be high.



3.0 Summary

In this topic you have learnt measuring and recording wind direction and wind speed and how the information may be used. You have also learnt that information on wind direction and speed can be presented in symbols to make synoptic charts.

In regards to air pressure you learnt that air has weight which it exerts over the ground and that it can be measured using a barometer. You also learnt that pressure can be affected by changes in the temperature of the atmosphere and land areas. Lastly you learnt about the instruments used to measure atmospheric pressure and how they work.

To reinforce what you have learnt, do the relevant assignment at the end of the unit. Feedback is also provided to correct you.

In the next topic we are going to look at the wind systems and various pressure belts. This section is very closely linked to what we discussed in the topic of winds and air pressure. We will close our discussion on weather elements by looking at the weather charts and photographs.

Topic 5: Wind Systems, Weather Charts and Photographs

Introduction

In this topic you are going to learn what causes wind to move from one place to another. You will also learn about the effects of rotation on winds, the types of wind systems in the world and how they move. You will also learn more about synoptic charts and weather photographs.

Topic Objectives

At the end of this topic you should be able to:

- explain why air moves from one place to another
- describe the movements of wind systems on earth
- read information contained in a synoptic chart or weather photograph.

1.0 Wind Systems

You have probably felt and seen the effects of air when it moves in the areas around you. You

may even have been affected by the wind, which at times causes damage to property. Can you think of any such damages? You probably mentioned damage to houses, trees being uprooted and influx of storms and floods in your area. But do you know what wind is? It is something you feel, see and hear every day. Do you think you can describe it?

If you said that wind is the movement of air from a **high-pressure area** to a **low-pressure area**, then you are correct. The development of pressure cells influences the movement of the wind. I am sure that at this point you are curious to know what pressure cells are.

1.1 Low and High Pressure Cells

A pressure cell develops in an area where there is either warm air rising or cold air descending (coming down) continuously in an area. Rising warm air creates less weight above the surface of the earth. So an area where air rises has a lesser weight of air above it and it is referred to as an area of **low pressure**. On the other hand, a **high-pressure** cell will be found in an area where **cold heavy air descends** over an area of the ground. The accumulation of air above the ground increases the weight of air over such an area which is then known as a high-pressure area. Study figure 35 showing low and high-pressure cells.

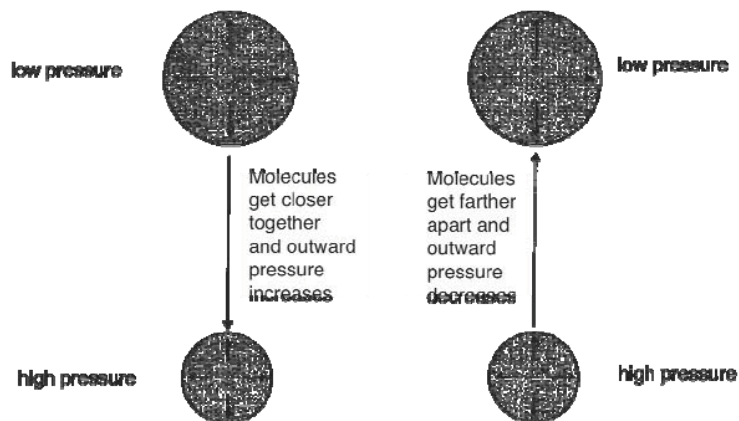


Fig 35: High and low pressure cells

Note the behaviour of molecules contracting at high pressure and expanding at low pressure.

Now, let us look closely at how low or high pressure zones are formed.

1.2 Formation of High and Low Pressure Zones

The movement of warm and light air upwards and outwards from a source area creates more space for air from surrounding areas to fill in. This space is usually filled or occupied by air moving in from areas which have a lot of cold heavy air. Figure 36 shows how this process occurs.

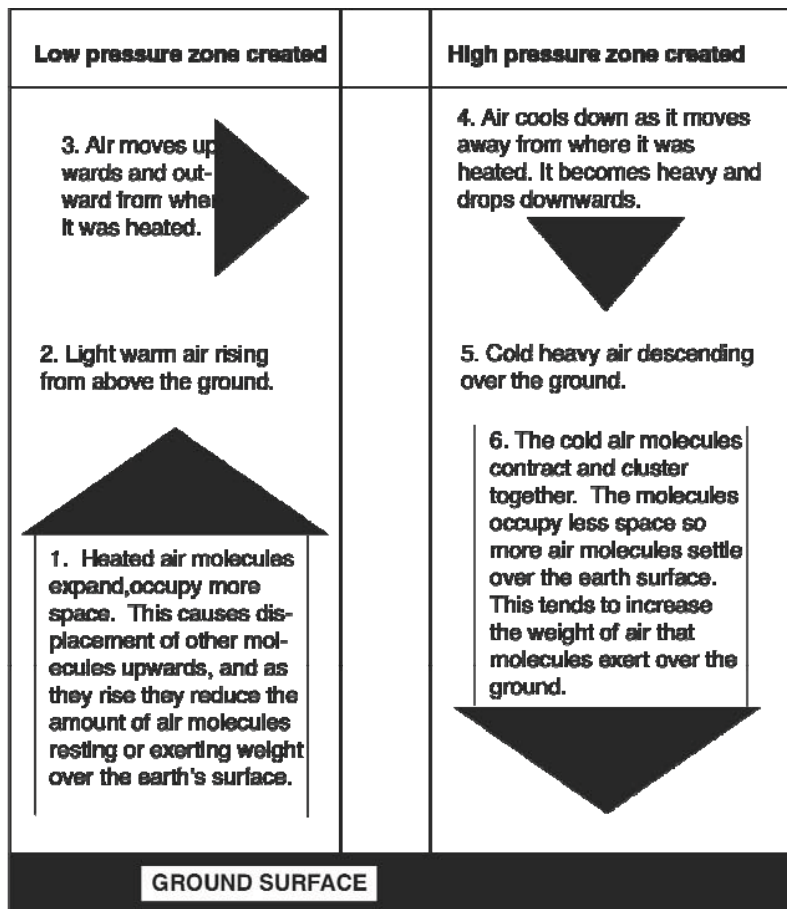


Fig 36: The formation of low and high pressure zones

You have learnt about pressure in this topic and in the previous topic as well. Before we go on and discuss the world pressure zones, attempt activity 1 that follows to test your skills and see how much you have learnt.



Activity 1

1. What is wind? [1 mark]

2. Name the sense organs that can be used to detect wind. [1 mark]

3. Explain the formation of [2 marks]

(a) a low-pressure cell

(b) a high pressure cell

4. Describe the movement of wind. [1 mark]

Total = [5Marks]

Feedback

Here is feedback. Check for the correct answers.

1. *The movement of air (air in motion) from a high-pressure zone to a low- pressure zone.*
2. (a) *Hearing (ear), Touch (feel), Eyes (sight).*
(b) *A low pressure is an area on the earth's surface where warm air is rising and moving away from that area.*
3. *A high pressure is an area on the ground where cold air is descending on that area.*
4. *From high pressure (cold areas) to a low pressure (warm areas).*

I hope that activity went well for you. Let's now read more about world pressure zones.

1.3 World pressure zones

Figure 37 is a simplified model of where the pressure belts (zones) on earth are found. You would probably have assumed that air will rise from hot areas such as the equator creating a low pressure zone (belt) and move across the sky and drop at the poles where it is very cold creating a high pressure zone. The air would then migrate from the poles along the ground and end up at the equator where it will be re-heated and caused rise to complete what would be the expected circulation of air on earth.

The movement of wind and the development of wind patterns do not really follow the simplified models described above. This is because the earth rotates and the rotation pushes the wind away from following a straight path from one point to another. As a result we get a different picture of how wind patterns develop on earth as can be seen in figure 37. The curving arrows indicate the deflection of winds caused by rotation of the earth.

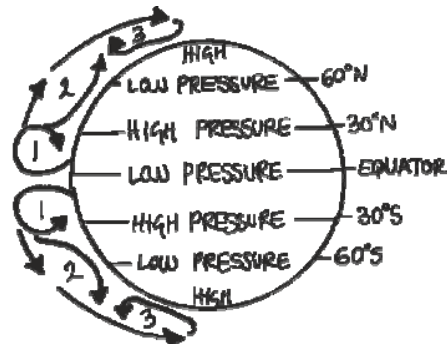


Fig 37: World pressure belts

Rotation, as already mentioned before, causes wind to be deflected to the left in the northern hemisphere and to the right in the southern hemisphere. This is because the rotation is from west to east in relation to a fixed point. The force, which deflects air, is called the **coriolis force**.

Now let us move on and see how pressure zones affect wind systems in the world.

2.0 Wind Patterns

We have already noted that the unequal heating of the atmosphere and earth surfaces result in

the development of high and low pressure systems. Some areas on earth have a dominant pressure system. Some of the areas with a dominant pressure system are:

- the equator which has a permanent low-pressure belt
- the horse latitude at about 30° south of the equator with a high-pressure zone (also called the sub-tropical high pressure zone)
- the temperate latitudes at about 60° with a low-pressure zone (also called sub-polar low pressure zone)
- the polar latitudes at around 90° that have a high-pressure belt.

Remember that we said the equator is an area of low-pressure. From the equator pressure belts alternate, that is from low to high then low again. When warm air rises at the equator in the Northern hemisphere it is turned right or eastward, and in the southern hemisphere, it is turned left, also eastward.

As latitude increases, the coriolis force also increases. By the time the rising air reaches 30° latitude it is moving almost due east. This gives rise to winds known as the north easterly and south easterly trade winds. They each blow from the sub-tropical high pressure created by air piling from above at latitude 30° into the permanent low pressure found at the Equator. The piling up of cold air at 30° latitude is caused by the fact that as air moves it crosses latitudes that are getting shorter and it has to occupy less space. As a result, it contracts and its pressure rises.

From 30° latitude (sub-tropical regions) the warm air moves into the temperate areas north and south of the equator. This gives rise to winds known as the southwest winds in the northern hemisphere and in the southern hemisphere they are called the northwest winds.

The cold winds which move from the low latitudes in the polar high pressure belt at about latitude 90° north and south of the equator into the south polar low region (temperature region) at 60° north and south meet with the warm air from latitude 30° north and south. The air from 30° and 90° meet at 60° and rise. In the north the incoming cold polar air is called the north east wind and in the south it is called the southeast wind. We therefore have three major wind systems in each hemisphere.

In the north these are:

- North East Polar Winds (from 90° to 60° N)
- The South West Winds (from 30° N to 60° N)
- The North East Trade Winds (From 30° N to 0° N).

In the south these are:

- The South East Polar Winds (from 90°S to 60°S)
- The North West Winds (from 30°S to 60°S)
- The South East Trade Winds (from 30°S to 0°S).

Look at figure 38. It will help you get a better understanding of wind patterns.

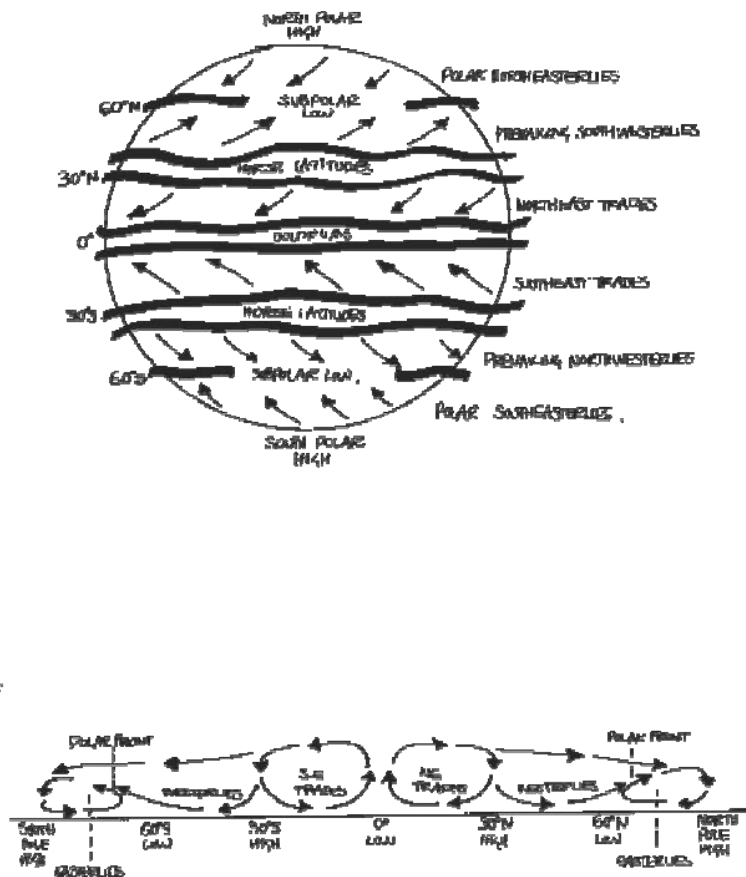


Fig 38: World wind patterns

Notice that trade winds blow into the doldrums from both sides of the equator. Since the trade winds converge here, the area where it all happens is known as the **Inter Tropical Convergence Zone (ITCZ)**. The location of the doldrums belt changes with seasons. This also changes the location of the ITCZ. When the northern hemisphere experiences summer the doldrums area moves a bit further into the north causing the southern hemisphere's tropical region to move slightly across the equator into the northern region.

To consolidate the content you have learnt so far, let us now attempt activity 2 that follows.



Activity 2

1. Explain briefly how winds would blow over the surface of the earth if the earth did not rotate. [2 marks]

2. How does unequal heating affect the movement you described in your answer above? [2 marks]

3. Explain why the region around latitudes 60°N and S is called the sub-polar low-pressure zone. [2 marks]

4. Explain why the region around latitudes 30°N and S is called the sub-tropical high. [2 marks]

Total = [8 marks]

Feedback

Look at the feedback below and see how well you performed. Remember the information in the feedback forms part of your notes. Read it carefully.

1. *The wind would rise over the equator and move into the polar region. Then it would move from the polar areas into the equator again. If the two surfaces, the equator and the polar were both hot (equator) and cold (polar) at the same time then the high pressure created at the poles would spill air into low pressure areas at the equator.*

2. *Rotation and surface heating can influence air pressure. When warm air travels across latitudes (parallels) which are getting shorter it contracts and its pressure increases since it has to occupy less space. In contrast, when cold air travels from the poles across parallels that are getting longer it expands and has less weight since it can now occupy a larger space. The scenario described above has led to the developments of alternating belts of high and low pressure, by interposing the sub-tropical high pressure zone between the equator and latitude 60°N/S. Instead of having two distinct opposing pressure belts we now have more than one in each hemisphere at corresponding intervals (latitudes).*
3. *The reason is because the area was mainly created by the influx of cold polar air into the warmer temperate zone, itself created by the influx of warm air from latitudes 30°N. The two air masses meet creating what is known as a front, and since the cold polar air tends to influence the overall direction and temperature of air in this region, mainly a cold region or polar region is formed.*
4. *The air moving from the equator is cooled in an area that is generally a warm sector; the tropical region, and so it is like creating a sub-region within a larger region. The sub- refers mainly to the fact that a smaller region has occurred within a larger region. The name given is determined by the larger geographic area where the smaller region has been created.*

Now that we have discussed the wind systems and their pressure systems, we need to move on and look at ways of interpreting synoptic charts.

3.0 Synoptic Charts

For each element of weather observed there are relevant symbols that are used when making weather maps. Study the symbols shown in the chart below.

Standard symbols used on weather charts					
Symbol	Precipitation	Symbol	Cloud cover	Symbol	Wind speed
	Drizzle		Clear sky		Calm
	Shower		One oktas		1-2 knots
	Rain		Two oktas		5 knots
	Snow		Three oktas		10 knots
	Hail		Four oktas		15 knots
	Thunderstorm		Five oktas		20 knots
	Heavy rain		Six oktas		50 knots or more
	Sleet		Seven oktas		
	Snow shower		Eight oktas		
	Mist		Sky obscured		
	Fog				

Fig: 39 A synoptic Chart (Down loaded from http://1.bp.blogspot.com/_cgI0mqeCmD4 on 23/5/11)

The symbols are fairly easy to follow and master but, if you have difficulties in recalling them, you don't have to worry. Most synoptic maps have a key that will tell you what each symbol used in the map means.

Maps which have symbols of weather superimposed above them are referred to as synoptic charts. This is because they give the status of weather conditions in an area. Every synoptic weather map has a key as stated above. Usually:

- each weather station is marked with a circle
- the maximum temperature for the day is usually shown to the left above the weather station and the minimum temperature is shown to the left below the station.
- the wind direction is shown by means of an arrow pointing in the direction from which the wind is blowing. The arrow head is the circle showing the weather station.
- the short lines on the wind arrow show wind speed. Each long line represents 10 knots and each short line represents 5 knots.
- the cloud cover is indicated inside the weather station in eights (oktas) as shown in figure 39. There are special symbols, which are used to show precipitation as shown in figure 39. If you learn these symbols you will find it easier to interpret weather maps.

To test how much you have learnt on synoptic charts. Attempt activity 3 that follows;



Activity 3

Study the synoptic symbols recorded at a weather station and answer the questions that follow.

30



1. How much of the sky was covered by clouds? [1 mark]

2. What was the maximum temperature for that day? [1 mark]

3. In which direction did the wind blow from? [1 mark]

4. At what speed was the wind blowing?[1 mark]

Total = [4 marks]

Feedback

I hope you did well. Here are the answers to the activity which you have just completed.

1. *There were no clouds on that day.*
2. *It was 30 degrees Celsius.*
3. *From the east.*
4. *1-2 knots.*

Now that we have learnt about synoptic charts, let us now move on to weather photographs. What do you think weather photographs are? To find out more read the section that follows.

4.0 Weather Photographs

What are weather photos? Weather photographs are remote sensing images taken by satellite cameras, using radar waves. Radar echoes form images like television pictures on the radarscope. Therefore 'pictures' may be seen of thunderstorms, hurricanes and other areas of heavy precipitation. The images are formed when radar echoes are reflected from different forms of precipitation such as snow, water droplets or ice crystals. Combined with other information on weather, the pictures can then be used to make weather maps of an area. Figure 40 shows an interpretation of a weather photograph that has been converted into a synoptic map.

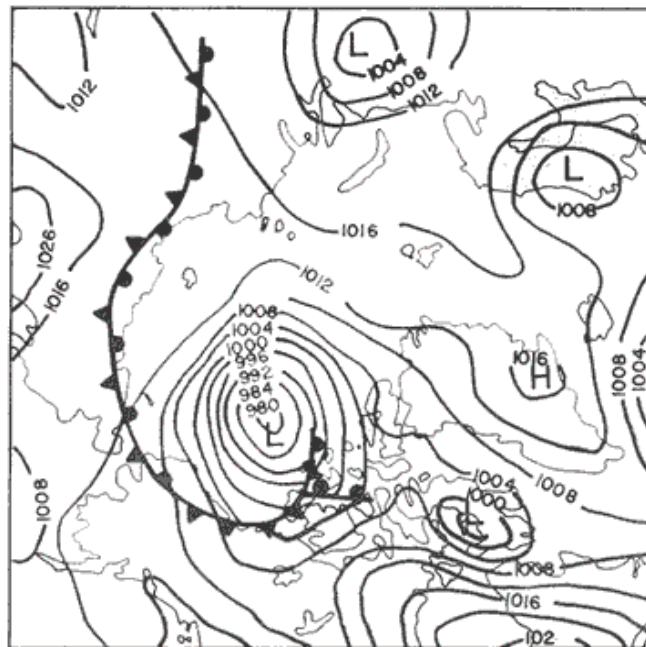


Fig 9: An interpretation of weather photograph - low pressure system

The above synoptic map was derived from a weather photograph showing a low pressure

system. The isobars shown connect points which share the same **atmospheric (air) pressure**. The closer the isobars, the stronger the winds are. Rainfall is sometimes determined by referring to the isobars on the synoptic chart. Low pressure systems and cold and warm fronts as shown in figure 40 are usually a good indication of rain. While synoptic charts do not distinguish between the different types of winds, some do show wind direction and wind speed.

Now read the topic summary given below to consolidate your understanding.



5.0 Summary

In this topic you have learnt that wind circulation results from the movement of air from high pressure to low-pressure areas. You have also learnt that the movement of wind across the earth surface is not a simple two-way process whereby air moves straight from the equator to the poles and from the poles into the equator.

You learnt that when the earth rotates (moving from west to east) air in the north is pushed to the right and in the south it is pushed to the left. You learnt that as air moves across latitudes, which are decreasing, it increases in pressure and the reverse occurs when it moves across increasing latitudes. You have learnt about the development of wind systems and the movement of the ITCZ. Finally, you learnt about how to interpret synoptic charts and weather photographs.

There is an assignment for this topic at the end of unit. Please make sure that you do that assignment. Feedback for it is provided in that same section.

Unit summary



Summary

In this unit you were introduced to weather studies. You learnt a lot about the various weather elements of temperature, sunshine, rainfall, humidity, cloud cover, winds and atmospheric pressure. We looked at how these elements are measured and recorded. We also looked at the factors behind some of these elements and their associated processes such as el Niño and la Nina. To round up this unit and see how much you have learnt and understood, go to the assessment section at the end of this unit. When you have finished the assessment exercise post it to the learner support centre for marking by your tutor. Make sure that you act on the comments and corrections made by the tutor.

Assignments

Assignment exercises are provided in this section. Make sure that you attempt all the questions. For you to come up with a well written assignment you will need to consult as many sources as possible. Feedback is provided below.

Topic One: Weather and Climate

1. Discuss ways in which altitude, aspect and ocean currents influence temperature?

Topic Two: Rainfall

1. With the aid of well labelled diagram/diagrams, explain how rainfall is formed.

Topic Three: Humidity and Cloud Cover

1. Why is the wet bulb thermometer wrapped in muslin?
2. Use the humidity table provided to measure the humidity of the two areas where:
 - (a) Dry bulb thermometer is 20°C when the wet bulb reads 18°C
 - (b) The reading for a dry bulb is 30°C when that of a wet bulb is 23°C

D							
Dry Bulb Reading (Degrees Celsius)	Depression of wet bulb						
	1	2	3	4	5	6	7
30	92%	86%	79%	73%	67%	61%	55%
25	92%	84%	77%	70%	63%	57%	50%
20	91%	83%	74%	66%	59%	51%	44%

Topic Four: Winds and Atmospheric Pressure

1. Draw a wind vane and explain how it works.

Topic Five: Wind Systems, Weather Charts and Photographs

1. Discuss the process involved in the formation of a low and a high pressure zone

Feedback

Topic 1

Altitude

- The higher a place is the cooler it will be.
- The temperature of the air drops by 6.5° C for every increase of 1000m (the normal lapse rate).
- Air at high altitudes is rarefied (have less dust and vapour) and temperature quickly escapes.

Aspect

- Areas that are far from the equator get the midday sun at an angle.
- For such areas the slope that is directly facing the midday sun will get more heat.
- In the southern hemisphere the north facing slope will receive more heat than the south facing slope.
- In the northern hemisphere, the south facing slope will get more heat than the north facing slope.

Ocean currents

- Cold ocean currents flowing from cold regions lower summer temperatures in coastal regions
- Onshore winds blow over cold currents bring cold temperatures to coastal areas.
- Warm ocean currents blow from the tropics towards the poles
- Onshore winds blowing over warm currents bring warm temperatures to coastal regions.

Topic 2

Rainfall is formed when water vapour which rises by convection, relief and frontal methods is changed into water droplets by condensation. During condensation small particles of water are formed which in turn develop into clouds. More infusion of moisture helps the water droplets to grow until saturation occurs when the air can absorb no more moisture. The water-droplets grow and fall down when they exceed the weight of air, giving rain.

Topic 3

1. Wet bulb in muslin

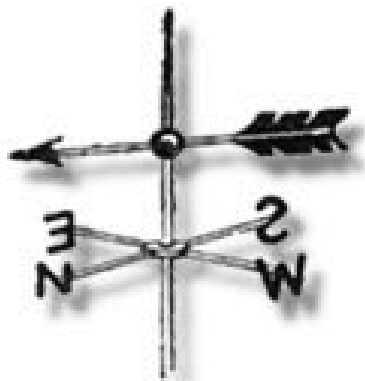
- So that it can show different readings from the dry bulb when humidity is low
- When humidity is low the wet muslin will cool the wet bulb thermometer and it will show different temperature
- When humidity is high all thermometers will be exposed to more or less the same conditions and will show the same temperature

2. Humidity

- (a) 83%
- (b) 55%

Topic 4

A Wind Vane



The wind vane is an instrument made up of horizontal arms pointing in the four main compass directions. At the centre of the arms is a freely rotating vertical shaft, which has a horizontal arrow on top. When wind blows, the arrow moves until it points at the direction from which the wind is blowing.

Topic 5

- Heated air expands, loses weight and rises
- Expanding and rising air create an area of low pressure
- It move upwards and outward from where it was heated
- As it moves away it cools becomes heavy and drops
- Cold heavy air descends on the ground
- Descending air creates an area of high pressure

Assessment



Time: 45 Minutes

Now that you have completed this unit, attempt the self-assessment exercise below. Make sure you spend some time on it since it is meant to help you understand the unit fully. If you do not find it easy at first, go over the unit again and then re-do it. Feedback is provided at the end to guide you.

1. Explain briefly the difference between weather and climate.
[2 marks]
2. Design a table. In one column write **four** weather elements. On the other column write the instruments used to record/measure or observe them.
[8 marks]
3. What are the units used to record sunshine?[1 mark]
4. Explain the following terms: (a) Temperature, (b) Thermometer, (c) Temperature range and (d) Altitude [4 marks]
5. Describe how you would calculate the average daily temperature. [2 marks]
6. Describe the formation of convectional rainfall.[5 marks]
7. Name **two** types of rainfall other than the one mentioned above. [2 marks]
8. Mention **three** possible effects of both El Nino and La Nina on the socio-economic development of a country. [3 marks]
9. Explain the following terms: (a) Isohyets, (b) Rain gauge and (c) Front
[3 marks]
10. What is rainfall? [1 mark]
11. How would you use a rain gauge accurately to measure rainfall?
[4 marks]
12. Explain what happens to the readings in the wet and dry bulb thermometers if air is saturated.
[1 marks]
13. Explain how cloud cover may influence the temperature of an area.
[5 marks]
14. Explain the following concepts: (a) Humidity, (b) Dew point temperature and (c) Saturation

- [3 marks]
15. Name the instrument used for measuring humidity .[1 mark]
16. Which **one** of the following has the greatest vertical extend? [1 marks]
- (a) Cirrocumulus (c) Cirrus
- (b) Stratus (d) Cumulonimbus
17. There are **four** types of clouds according to appearance and height. These are:[4 marks]
18. What term is used to describe a situation where the whole of the sky is covered by clouds?
[3 marks]
19. Name the instrument used for measuring wind speed.
[1 mark]
20. Name any **two** instruments, which are used to measure atmospheric pressure.
[2 marks]
21. Name the units of measurement used to record pressure.
[1 mark]
22. What is an isobar? [1 mark]
23. Explain briefly how temperature affects pressure.[2 marks]
24. What causes movement of air? [2 marks]
25. Explain the difference between a high pressure and a low- pressure zone. [2 marks]
26. Why do winds get turned to the right in the north and left in the south? [1 mark]
27. What is the I.T.C.Z and what does it stand for. [2 marks]
28. What do we call a weather map produced using weather symbols?
[1 mark]

Total = [66 Marks]

Feedback To the Unit Assignment

1. *Weather is the state of the atmosphere observed over a short period, (24 hours or daily) whilst climate is the state of weather recorded over a long period of time (30 years).*

Element	Method of observation or measure
<i>Rainfall</i>	<i>Rain gauge</i>
<i>Humidity</i>	<i>Hygrometer/wet and dry bulb thermometers</i>
<i>Pressure</i>	<i>Mercury or aneroid barometer</i>
<i>Clouds</i>	<i>Eyes</i>
<i>Sunshine</i>	<i>Sunshine recorder</i>
<i>Temperature</i>	<i>Sixes or maximum and minimum thermometers</i>
<i>Wind direction</i>	<i>Wind vane</i>
<i>Wind speed</i>	<i>Anemometer</i>

3. *Hours and minutes*

4. (a) *The coldness or hotness of air or an object.*

(b) *An instrument for measuring temperature.*

(c) *The difference between the maximum temperature and the minimum temperature.*

(d) *The height of a place above sea level.*

5. *Add the maximum and the minimum temperatures and divide by 2.*

6. *Conventional rainfall is formed when the ground is greatly heated during the day especially in summer in the interior of continents. The warm air rising above the ground collects moisture and is forced up quickly by convection currents that result from the circulation of air between the ground and the sky. The water vapour in the air is cooled; water droplets occur and give rain. During condensation the water droplets give a lot of energy as they fall. This energy produces electrical discharges that cause thunder and lightning.*

7. *Relief and Frontal*

8. *The effects of El Nino and La Nina of human activity are many. They can cause*

increase of poverty, decline in agricultural production, floods and destruction of property and loss of life.

9. (a) *A line joining areas with the same amount of rainfall.*
(b) *An instrument used for measuring rainfall.*
(c) *The point where the two air masses of different temperatures meet.*
10. *It is raindrops that fall from the clouds.*
11. *When measuring rainfall, the following procedures must be followed.*
- *First pour off all the water collected in the rain gauge into a measuring cylinder or beaker*
 - *Put the beaker/measuring cylinder on a flat and level surface*
 - *Bring your eyes to the level of the meniscus (surface) and take your reading at bottom of the meniscus.*
12. *Both thermometers will show the same temperature readings*
13. *In a place where there are clouds. During the day clouds absorb and reflect most of the incoming solar radiation. They allow only a small amount of solar radiation to filter through to the ground. This help to reduce temperatures. At night clouds prevent radiation from the ground from escaping into space. This causes the air to be warmer during the night.*
- When there are no clouds. There is too much solar radiation during the day and it becomes very hot. At night radiation from the ground escapes into space and it becomes cold.*
14. (a) *The amount of moisture (water vapour) in the air.*
(b) *Temperature at which water vapour condenses into water droplets*
(c) *When air can no longer absorb water vapour*
15. *Wet and dry bulb thermometers (hygrometer)*
16. *D - Cumulonimbus*
17. *High clouds*
Middle clouds

Low clouds

Clouds of great vertical extent

18. *Overcast*

19. *Anemometer*

20. *Mercury barometer*

Aneroid

Barograph

Altimeter

21. *Millibars (Mb)*

22. *It is a line joining all points with the same pressure readings on the ground.*

23. *When temperature increases it warms the air causing the air molecules to move further apart thus needing to occupy a larger volume. This causes some of the air particles to move away from and occupy another area (volume) away from where they were being heated. When this happens the total weight of air over that area is reduced creating a low-pressure region. When air is cooled it contracts, occupies a smaller volume so more air can come in to fill the space it leaves, for a comparable volume of warm air. This tends to increase the weight of air above the ground surface creating a high-pressure region.*

24. *Movement of air is caused by cold air of high density and pressure over spilling into areas of warmer air which contains less air of a lower density and pressure.*

25. *A high-pressure zone is a region, which has predominantly cool or cold air descending over the area, whilst a low-pressure zone has warm air rising above it.*

26. *This is caused by the bulge of the equator and west to east movement of the earth when it rotates.*

27. *I.T.C.Z stands for the Inter Tropical Convergence Zone. It is where trade winds converge.*

28. *Synoptic chart.*

I hope you were able successfully complete this unit. If you still have areas that you are struggling on, I suggest that you go back to them first and then proceed to the next unit.



Reading

List of References

For further reading you should visit your study centres or your nearby library. These areas are well equipped with Geography books. Some of the books you may want to read include:

1. R.B Bunnett, *General Geography in Diagrams for Africa*,
2. Collin Buckle, *Weather and climate*, Longman
3. Namcol, *Geography Unit 1 Grade 11-12*, Cambridge University Press
4. Pallister et al, *Longman Geography for GCSE*, Longman
5. Adam Arnell, *Geography Dictionary 11-14*, Letts Publishers
6. Collins, *Geography Basic Facts*, Harper Collins Publishers

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Unit 4

Climate

Introduction

In the previous Unit, we discussed the difference between weather and climate. The world is divided into different climatic regions, each having its own climatic and natural vegetation characteristics. In this unit, we will focus on the climatic regions of Africa. The audio cassette or clip will familiarise you with these climatic regions. We will discuss the relationship between each type of climate and its natural vegetation. The major African climatic regions to be addressed in this unit are Equatorial, Savanna, Semi-desert and Desert, Warm Temperate Continental and the Mediterranean climates. We will also discuss human activities and their impact on each environment. Our first lesson will, however, focus on the climate types of Botswana which you are familiar with. This will, hopefully, help you to understand what we mean when we are talking about climate types of other parts of Africa. You will find these lessons interesting and easy to understand as you already have the background knowledge on this unit from your Junior Secondary Course. In this unit we will be looking at the following topics:

Topic 1: Botswana's climate

In this topic we are going to discuss Botswana's climatic characteristics. We will discuss the rainfall and temperature patterns, the natural vegetation, human activities and their impact on the environment.

Topic 2: The equatorial climate

In this topic we will be looking at the climatic characteristics of the equatorial region in Africa largely in terms of temperature and rainfall. We will also look into how these climatic conditions influence the natural vegetation of the region and the human activities taking place in the region.

Topic 3: Tropical savannah climate

This topic is about the tropical savannah climate. In this topic we will be discussing the climatic characteristics of the region where we will look at the temperature and rainfall patterns. We will also look at the natural vegetation of the region, the human activities associated with the climate of the region and their impact on the environment.

Topic 4: Tropical desert climate

In this unit we are going to look at the climatic characteristics of both the true desert and the semi deserts. The two are similar in temperature and rainfall characteristics but there are also some variations. The natural vegetation, human activities and their impact on man are also discussed.

Topic 5: Mediterranean climate

In this topic we are going to look at the climatic characteristics of the Mediterranean climate and then move on to those of the warm temperate continental climate. In both cases we will also discuss the natural vegetation, the human activities and their impact on the environment.

Upon completion of this unit you will be able to:



Outcomes

- *identify and locate* different climatic regions on a map of Africa.
- *discuss* the location, climate, vegetation and human activities in different climatic regions of Africa.
- *explain* the distribution of climatic regions in Africa
- *identify and locate* climate types of Botswana on a map.
- *describe* the climate of Botswana.



Time

Time

You may spend 2 hours on each lesson. It is very important to understand each lesson before you move on to the next one. Two hours is only a guide. You may spend as much time as you need to understand the lesson. The 2 hours is inclusive of the topic self-assessment exercise found at the end of the unit. On completion of the unit, you are advised to go straight to the tutor-marked assessment that should take you 45 minutes to complete.

Teaching and Learning Approach

In order to promote active learning, we engage you in several activities. We keep asking you questions that draw from your previous experience as the basis upon which you can learn new information. There are also activities and assignments with their respective feedback. These are as much a part of the learning process as they are part of assessment. You may also visit your local library. It may have books that will help you understand the unit. If you have access to the internet you may also find in it important information. You should not worry however, if you are unable to find such materials because the unit has most of the information that you need. If you are registered with any distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counselling support. Study centres are resourceful in that you may have access to additional resources like books, maps and videos. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any difficulties you may be having in this unit.

An audio lesson has been prepared for you on climate. Make sure you listen to it when you get to that section.

Assessment

Each lesson has activities that you must do which will help you to understand the lesson. Feedback is given immediately after the lesson. There are assignments for every topic and assessment exercises at the end of the unit that will help you check how well you have understood the unit. Answers to these exercises are provided so that you can correct your own work. It is advisable to go through the whole unit or lesson again if you do not do well on these.

Glossary

Words that are difficult are explained in the glossary. You may also use a dictionary if you come across other difficult words that do not appear in the glossary.



Terminology

Deforestation:	Removal, destruction or clearing of vegetation or woodland
Deciduous trees:	Trees that shed their leaves during the dry season
Endangered species:	Species or wildlife threatened by extinction
Extinction:	Complete disappearance of a species
Gully erosion:	Removal of soil that produces steep sided valleys called gullies and dongas
Habitat:	A specific environment in which an animal lives
Land degradation:	Destruction of the productive value of land
Wilderness:	Undisturbed natural environments

Topic 1: Botswana's Climate

Introduction

Before we begin our lesson on Botswana's climate, you first need to listen to the **audio** clip on climate. This audio clip will give you a good background to the different types of climate. Play it and after listening you can continue with this topic. **This audio has been supplied to you as part of the package.** If you are reading this from a computer, double click on the **01 Track 1.wma** icon below.



01 Track 1.wma



In this topic we will be

studying the climate types of Botswana. We

will identify and locate these regions on maps. This will be followed by a discussion on the climatic and vegetation characteristics of these regions. The last part of this lesson will focus on human activities in Botswana and their impact on the environment.

Topic Objectives

At the end of this topic you should be able to:

- identify and locate on the map, the climate types of Botswana
- discuss the climate types of Botswana under the following: location/distribution, climatic characteristics and natural vegetation of each environment
- discuss human activities and their impact on the environment in Botswana

1.0 Natural Climatic Regions of Botswana

In the introduction to this unit you have learnt that the world is divided into climatic zones or regions. Each region has its own climatic and natural characteristics. In the audio you played, it has been said that Botswana's climate is savannah or tropical continental climate. This is not quite true. Botswana like many other countries in the world has more than one type of climate or natural regions. Study the map on figure 1 showing the major climatic regions of Botswana.

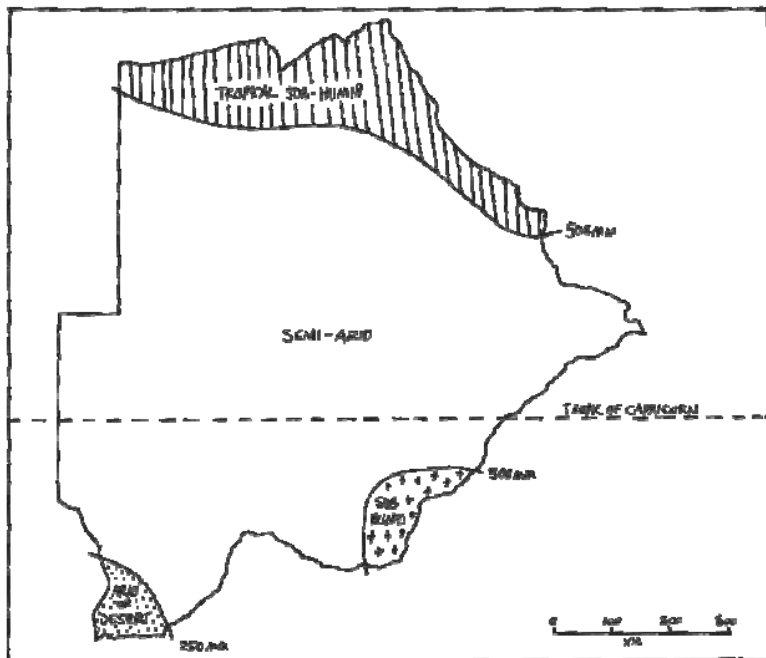


Fig 1: Major climatic regions of Botswana

Before we discuss these climatic regions, their location and distribution, answer the following questions based on the map shown in figure 1.



Activity 1

Study the climatic map (figure 1) carefully and then answer the following questions:

<p>1. Name at least three types of climate of Botswana as shown on the map. [3 marks]</p> <p>----- ----- -----</p> <p>2. Which type of climate covers the largest area of Botswana? [1 mark]</p> <p>----- -----</p> <p>3. Which type of climate covers the smallest area? [1 mark]</p> <p>----- -----</p> <p style="text-align: right;">Total = [5 marks]</p>
--

g responses:

- *tropical sub-humid*
 - *semi-arid or semi-desert*
 - *arid or desert*
2. *The type of climate covering the largest area is semi-arid or semi-desert*
3. *Desert or arid climate covers the smallest area*

In this activity you have learnt that Botswana’s main types of climate are **Tropical sub-humid, semi-desert and desert climates**. According to this map, the sub-humid climate covers the northern and south eastern parts of the country. The extreme south western part experiences desert or arid type of climate while the rest of the country has a semi-arid climate. From this activity, you now understand why Botswana is generally described as a semi-arid country. This is because this type of climate covers the largest area of the country. Having learnt about Botswana’s climate types, let us now discuss the climatic and vegetation characteristics.

2.0 Temperature

As can be seen from the map (figure 1), Botswana lies on both sides of the Tropic of Capricorn. The country experiences hot summers with mean monthly temperatures of about 12°C. Temperatures of over 40°C have been recorded on some summer days especially in the west and south western parts of the country. The highest temperatures are usually recorded in December and January. Winter temperatures range between 2°C and 19°C. Lower temperatures below the freezing point are often recorded in June and July. Large diurnal (daily) temperature range is often recorded in winter. This is because of the clear skies and absence of clouds and lack of moisture. During the day, temperatures are high because of direct insolation and during the night the ground loses heat very rapidly. The following activity will enable you to learn more about temperature variations in Botswana during winter and summer.



Activity 2

Study the maps in figure 2 (a) and (b) showing temperature variation in Botswana and answer the following questions:

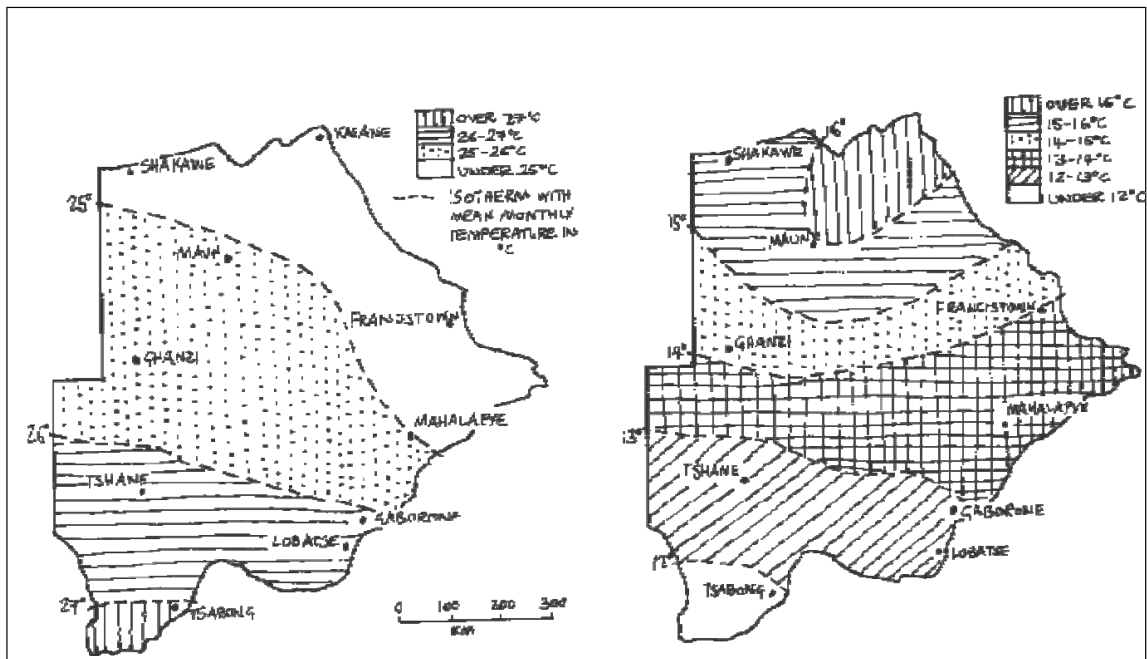


Fig 2 (a) and (b) Temperature variations in Botswana

1. State the January temperature at;

(a) Mahalapye

.....

(b) Ghanzi

.....

[2 marks]

2. State the July mean temperatures for :

(a) Tsabong

.....

(b) Maun

.....

[2 marks]

3. Which part of the country has the highest mean temperature in January?

[1 mark]

.....

4. Which part of the country has the lowest mean temperatures in July?

[1 mark]

.....

Total = [6 marks]

Feedback

Before you look at the answers, let me remind you that if a place lies between 2 isotherms, you give the answer as a decimal. For example, a place lying between isotherms 25°C and 26°C is at 25.5°C. The answers are then as follows.

1. (a) *Mahalpye = 25.1°C*
(b) *Ghanzi = 25.6°C*
2. (a) *Tsabong = 11.9°C*
(b) *Maun = 16°C*
3. (a) *the south western part of the country has the highest temperatures in January*
(b) *the south western part of the country has the lowest temperatures in July*

Having done this activity, the first thing you probably noted is that temperatures are generally high in January (summer) and low in July (winter). There is also a temperature variation in the same season, as you have noted the difference between Tsabong and Maun temperatures in July.

Now that we have discussed the temperatures experienced in the country, let us now focus our attention on rainfall patterns in Botswana.

3.0 Rainfall

In order for you to know more about rainfall in Botswana, Let us look closely at the map in figure 3 which shows the distribution of annual rainfall in Botswana. Notice isohyets which are lines showing places of the same rainfall in the country. They range from 250mm in the south western part of the country to 650mm in areas around Kasane.

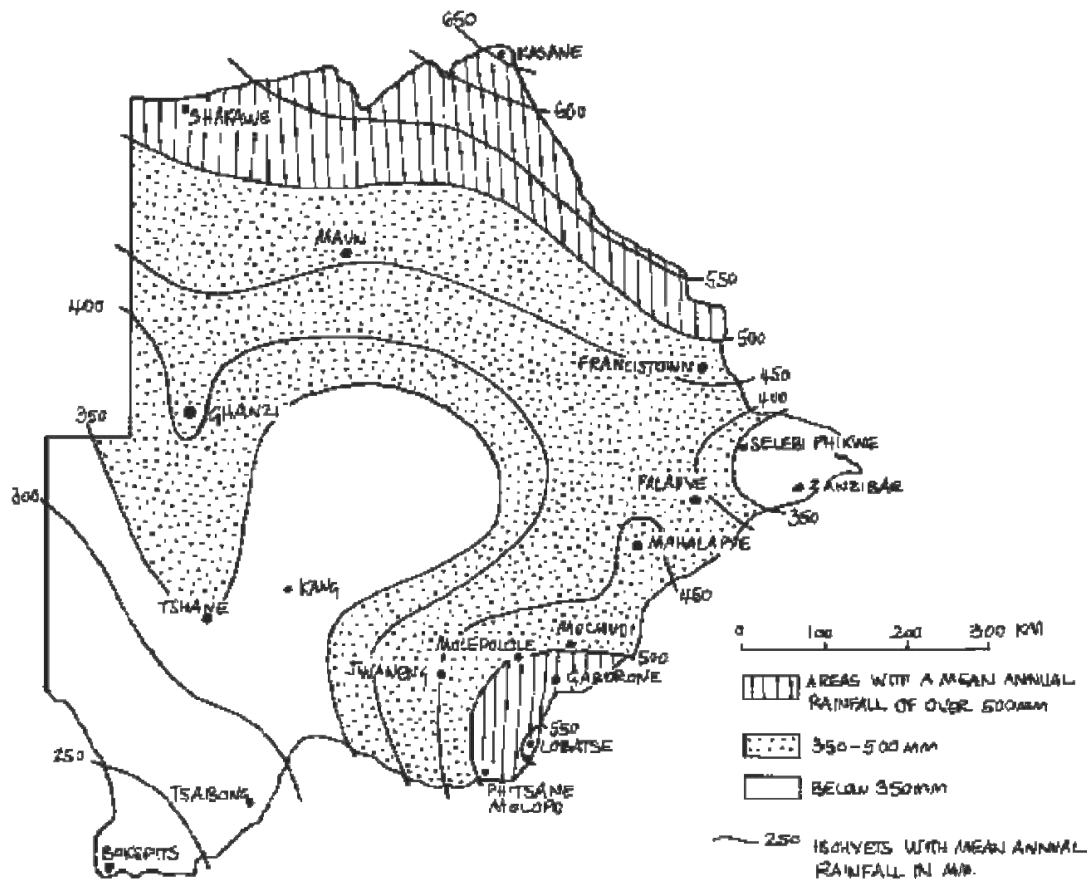


Fig 3: Rainfall distribution in Botswana (Source: Silitshena and Mc Cleod, 2003, page 38)

In order to describe Botswana’s rainfall, first attempt activity 3. As you do this activity, note how rainfall is distributed in Botswana.



Activity 3

Study the maps on figure 1 showing Botswana’s climatic zones and rainfall distribution (figure 3) and answer the following questions:

1. (a) Which area in Botswana receives the highest amount of rainfall? [1 mark]

 (b) How much rainfall does it receive? [1 mark]

 (c) What type of climate does this area have? [1 mark]

2. (a) Name two settlements in Botswana which have a semi-arid climate. [2 marks]

3. (a) Which region receives the least amount of rainfall? [1 mark]

 (b) What type of climate is found there? [1 mark]

 (c) Name one settlement in this climatic region. [1 mark]

Total = [9 marks]

Feedback

If you have read the two maps well, you should have something similar to the following as your response:

1. (a) *The Chobe district or Kasane area receives the highest amount of rainfall.*
 (b) *It gets more than 600 mm of rainfall*
 (c) *The Chobe district has a tropical sub-humid type of climate*
2. (a) *Settlement with a semi arid climate are Ghanzi, Kang and Francistown.*

- (b) This region receives rainfall of amount of 250-500 mm per annum.
3. (a) The south-western part of the country receives the least amount of rainfall.
 (b) It has a desert or arid type of climate.
 (c) Examples of settlements in this environment are Tsabong and Bokspits.

3.1 Rainfall Distribution in Botswana

From the map, we can see that Botswana is generally a low rainfall (semi-arid) country. The northern parts of the country, especially the Chobe district gets the highest amount of rainfall. This area receives more than 600 mm. The south-eastern part or area around Gaborone and Lobatse get more than 500 mm. Rainfall gradually decreases from these areas to the west and south-western parts of the country. Now that we know how rainfall is distributed in the country, we can conclude that Botswana's rainfall is low and unevenly distributed. The next two sections will introduce us to the seasonality, reliability and variation of rainfall in the country.

3.2 Seasonal Rainfall

When do we get rainfall in Botswana? In order to answer this question, study figure 4 below, showing the mean monthly rainfall for five places in Botswana

Place	Month												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
Kasane	163	135	98	24	4	2	-	-	2	21	71	149	669
Francistown	103	82	61	24	7	3	1	1	6	27	59	90	464
Ghanzi	98	82	71	35	8	1	-	1	3	21	47	66	433
Gaborone	99	83	69	44	13	5	3	4	15	44	67	88	534
Tsabong	51	53	53	33	13	7	2	2	7	15	27	35	298

Fig 4: Variations in recorded annual rainfall in selected areas in Botswana (Adapted from Silitshena and McCleod, 2003, page 37)

From the table in figure 4, you will notice that rain mainly falls between November and April. From our discussions on Botswana's temperature, we know that these are summer months and therefore, we can say that Botswana has summer rainfall. The table also shows that there is very little or no rainfall in winter, that is May, June and July.

3.3 Reliability and Variation of Rainfall

We just mentioned that rainfall occurs in summer. Can we tell in advance when it starts and finishes? In order to answer this question, study the table in figure 5 showing monthly variations in rainfall at Francistown.

Year	Months												Annual
	J	F	M	A	M	J	J	A	S	O	N	D	Total
1981	181	146	59	29	6	0	0	1	0	58	118	47	465
1982	14	3	8	34	16	0	0	4	0	125	29	38	271
1983	60	42	42	84	6	0	0	2	0	9	112	55	423
1984	5	20	146	17	0	7	4	0	32	29	59	37	356
1985	127	70	16	13	3	0	0	0	1	35	24	22	311
1986	7	24	66	94	0	0	0	0	15	47	97	101	451
1987	63	43	12	0	0	0	0	0	9	13	90	293	523
1988	60	348	125	8	3	0	0	0	0	46	11	42	643
1989	60	163	1	45	0	5	0	0	0	31	76	47	428
1990	76	46	36	14	12	0	0	0	0	0	14	130	328
1991	111	80	93	0	0	0	0	0	0	11	53	47	395

Fig 5: Monthly variations in rainfall for Francistown (Data from Botswana Meteorological Department)

If you study the table carefully, you will observe that rainfall does not always start or finish as expected. There are times when it comes as early as September and finishes as late as April.

The table in figure 6 shows the total annual rainfall of different places in Botswana. Do you think those places always get the stated amount every year? Before answering this question, study the table carefully.

Recorded Annual Rainfall (mm)			
Year	Gaborone	Maun	Tsabong
72/3	293	244	291
73/4	700	1 188	617
74/5	837	633	287

76/7	752	512	437
77/8	842	733	376
78/9	362	291	297
79/80	645	510	288
80/1	711	494	258
81/2	406	210	229

Fig 6: Recorded annual rainfall (in millimeters) (Data from Botswana Meteorological Department)

The table in figure 6 clearly shows that there is a significant variation from one year to another. The annual amount changes from year to year and therefore we cannot be sure of how much rain will fall in a year. Because of this, we can conclude that Botswana's annual rainfall varies a lot. Because of these variations in rainfall, we sometimes have periods of droughts which are common in this country. We sometimes have long periods of drought. Droughts sometimes alternate with periods of heavy rainfall. Remember that drought is caused by lack of rainfall, rapid percolation of water into the ground and a high rate of evaporation.

In the next section we are going to have a closer look at the types of rainfall in Botswana. Do you still remember the different types of rainfall that we discussed in Unit 4? Which of these types do you think are found in Botswana? Read on to find out.

4.0 Types of Rainfall

Did you know that Botswana experiences all the three types of rainfall that we discussed in the previous unit? Botswana experiences conventional, relief and frontal rainfall.

4.1 Convective Rainfall

This rain falls as heavy showers, often accompanied by lightning and thunder. Convective type of rainfall affects the whole country since it is caused by the heating of land or intense solar radiation. Botswana is a very hot country with a high rate of evaporation. The hot air is forced to rise by convective currents. This air then cools and the water vapour condenses into water droplets to form clouds and eventually rain falls.

I hope you can still recall that this type of rainfall usually comes in the afternoon and is associated with thunderstorms and lightning. The other type of rainfall is relief rainfall. Do you still remember how it is formed? Read about it in the next section.

4.2 Relief Rainfall

Botswana also receives relief rainfall. The moisture laden South East Trade Winds that blow in summer from the Indian Ocean are forced to rise when they reach the Drakensberg Mountains. As this warm and moist air rises, it cools and condenses into tiny droplets of water thus forming clouds. Some of these clouds eventually reach Botswana bringing rainfall. The rain that reaches Botswana however is smaller than the one that falls on the windward side of the Drakensberg Mountains. If you have forgotten, go back to the previous unit where we discussed relief rainfall.

Another type of rainfall received in Botswana is frontal rainfall. Do you recall how this rain is formed? Let's read about it more in the next section.

4.3 Frontal Rainfall

Frontal rainfall comes in summer when the Inter Tropical Convergence Zone (ITCZ) moves southwards into northern parts of Botswana and brings heavy rains. During this time moist air from the south east and very warm moist air from the north west meet. The meeting of the two air masses is called convergence and this rain is therefore called convergence or frontal rainfall.

Let us turn our attention to the conditions of the relative humidity, evaporation and winds in the country. I am sure you are familiar with these concepts from Unit 4 on weather.

5.0 Relative Humidity, Evaporation and Winds

In our previous unit we learnt that relative humidity and winds influence weather and climate. Evaporation is a product of high temperatures.

5.1 Relative Humidity

From your previous unit, you learnt that relative humidity refers to the amount of moisture or water vapour in the air at a certain period of time compared to the amount there would be if the air was saturated. In Botswana relative humidity is low most of the time, though it is high during the rainy season.

5.2 Evaporation

Botswana is a hot country therefore evaporation rates are high, at a rate of 2000mm per year. This exceeds (is more than) the average annual rainfall which is about 450 mm.

5.3 Winds

The prevailing winds affecting climate are both the north east trade winds and the south east trade winds. As mentioned earlier, the convergence of the trade winds results in convergence rainfall in the northern parts of the country.

By now you should be having a clearer picture of the type of climate that we have in Botswana. In the next section we will be looking at the natural vegetation. This section is linked to what you have discussed because the type of vegetation you have will depend on temperature and rainfall.

6.0 Natural Vegetation

If you were to travel around Botswana, you would come across a wide variety of plant species. Vegetation is a very important natural resource. There are many areas in Botswana with the same type of vegetation cover. The map on figure 7 shows Botswana's natural vegetation types. Notice the various types of vegetation shown in the key.

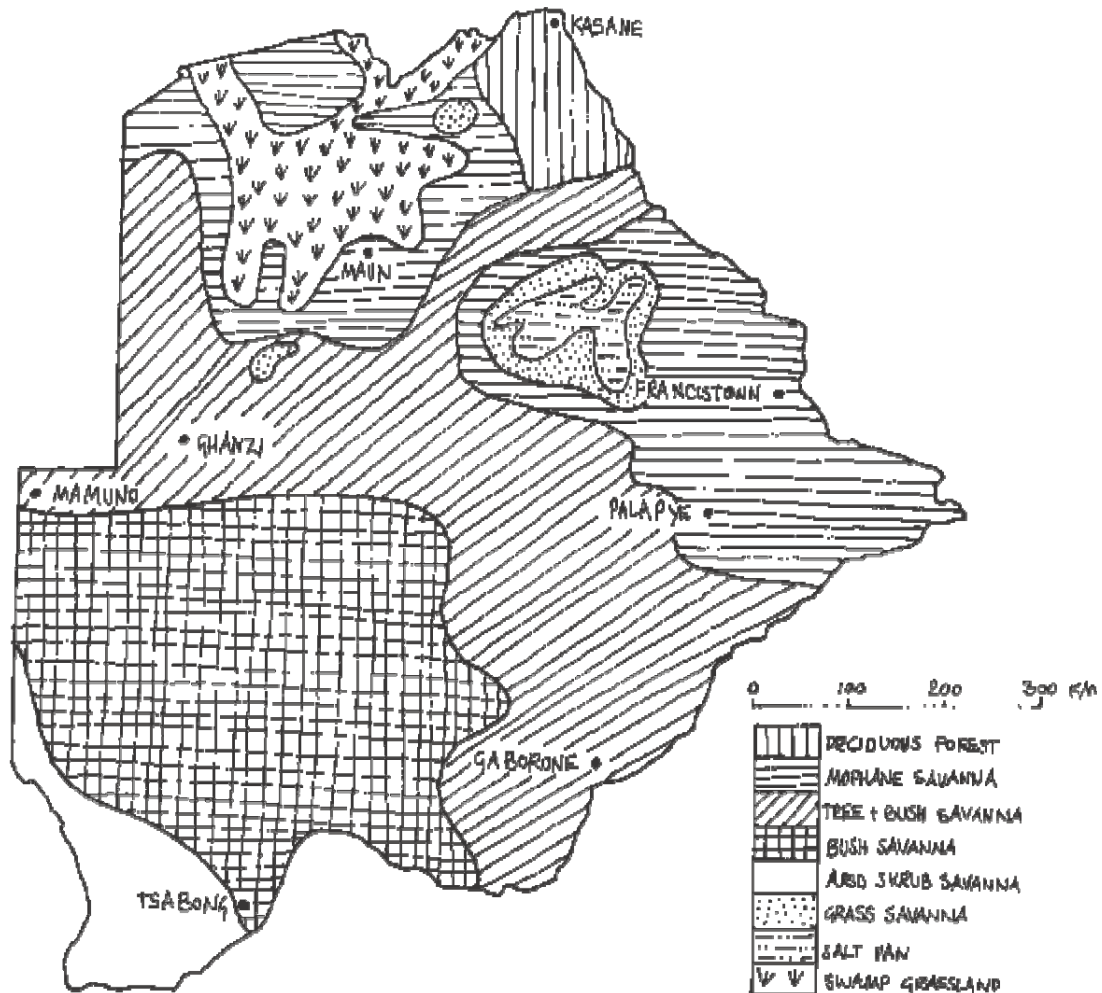


Fig 7: Botswana's natural vegetation types (Adapted from Silitshena and Mc Cleod, 2003, page 60)

Vegetation in any place is controlled by the climatic and soil conditions. These vegetation found in Botswana can be grouped into the following categories:

- Deciduous forests
- Savannah vegetation
- Aquatic vegetation

6.1 Deciduous Forest

As you can see in the map (figure 7) this vegetation is found in the extreme north eastern part of the country, that is, the Chobe District. This area receives the highest amount of rainfall. Deciduous trees shed their leaves during the dry season to reduce transpiration. Examples of such trees are *mukwa* and *mukusi*. In between these grows bushes and scattered grasses. The picture in figure 8 shows what deciduous forest vegetation looks like.



Fig 8: A deciduous forest

<http://en.wikipedia.org/wiki/Deciduous> - retrieved 26/05/11

6.2 Savanna Vegetation

Botswana has different types of savanna vegetation as shown in figure 9. This is due to difference in the climatic and soil characteristics. Savanna types of vegetation in Botswana are as follows:

a) Mophane Vegetation

This occurs mainly in the east and north east parts of the country that are free of frost. Short coarse grasses and bushes grow in between these trees. Mophane trees also occur with other types of trees like *mokoba*, *morula* and *mowana*.

b) Tree and Bush Savanna

From the vegetation map on figure 7 you can see that this vegetation occurs in semi-arid regions with a rainfall amount of 400 – 600 mm. This vegetation consists of acacia thorn trees and trees like *mokoba*, *moloto* and small bushes.

c) Bush Savanna

This is also found in the semi-arid environments but with lower rainfall of about 300 – 400 mm. Bush savanna is characterized by scattered shorter trees, bushes and grasses.

d) Shrub Savanna

This occurs in the driest parts of the country where rainfall is below 300 mm. The vegetation is characterized by thorn bushes, cacti and scattered grasses.

e) Grass Savanna

This is found at Mababe depression, Lake Ngami and Makgadikgadi salt pans. Grass savanna consists mainly of short coarse or wiry grasses. During the rainy season, the soils here become waterlogged. There are a few trees and bushes in this area.

Now that you know the type of savanna vegetation that we have in Botswana, let us now focus our attention on aquatic vegetation.

6.3 Aquatic Vegetation

As the name suggest, these consists of water loving plants like reeds, water lilies and palms. Aquatic vegetation occurs in the swampy areas of Okavango Delta and also on the banks of the Chobe River.


Having completed the discussion on vegetation, now it is time to do an exercise on what you have covered. To see how much you have learnt, attempt activity 4 that follows.





Activity 4


Study figure 9 and write down the type of vegetation represented by each picture


Fig 9: Types of vegetation

A. Vegetation type ----- 

B. Vegetation type ----- 

C. Vegetation type ----- 

D. Vegetation type ----- 

E. Vegetation type ----- 

Total = [5 marks]

Source: Pictures compiled from
<http://www.eoearth.org/files/112201> on 25/5/11

Feedback

You should have been able to match the vegetation description with the picture. The answers are as follows:

Picture A = Tree and bush savanna

Picture B = Aquatic savanna

Picture C = Arid scrub savanna

Picture D = Grass savanna

Picture E = Deciduous savanna

Vegetation, to a large extent determines what people do in their communities. Let's now proceed to the section on human activities.

7.0 Human Activities

Now that you are familiar with the natural regions of Botswana, let us discuss how the people interact with their environment to make a living. Human activities are greatly influenced by the environment. Before we discuss these activities in more detail, let's attempt the exercise that follows.



Activity 5

Complete this table by filling in 3 human activities for each region of Botswana

Chobe District
1. ----- 2. ----- 3. -----
Okavango Delta
1. ----- 2. ----- 3. -----
North East and South East
1. ----- 2. ----- 3. -----
Central and South West Region
1. ----- 2. ----- 3. -----
Total = [12 marks]

Feedback

In Botswana human activities include;

Chobe District: Tourism, crop farming and fishing

Okavango Delta: Tourism, crop farming and fishing

North East and South East Region: Tourism, crop farming and pastoral farming

Central and South West Region: Tourism, pastoral farming, hunting and game farming

From activity 5, you now are familiar with important human activities. Now, let us find out more about them.

7.1 Crop Cultivation

Crop cultivation is confined to the eastern and northern parts of the country. These are the wetter parts of the country with fertile soils. A variety of crops including maize, sorghum, millet, beans, groundnuts, melons and peas are grown. Commercial arable farming also takes place on freehold and leased land. Try to identify these areas on a map below in figure 10. Intensive irrigation is practiced in the Tuli Block and Gaborone Block areas. Crops grown include vegetables and fruits. Extensive dry land farming also takes place at Pandamtenga and Barolong farms. The main crops produced here are sorghum, maize and watermelons.

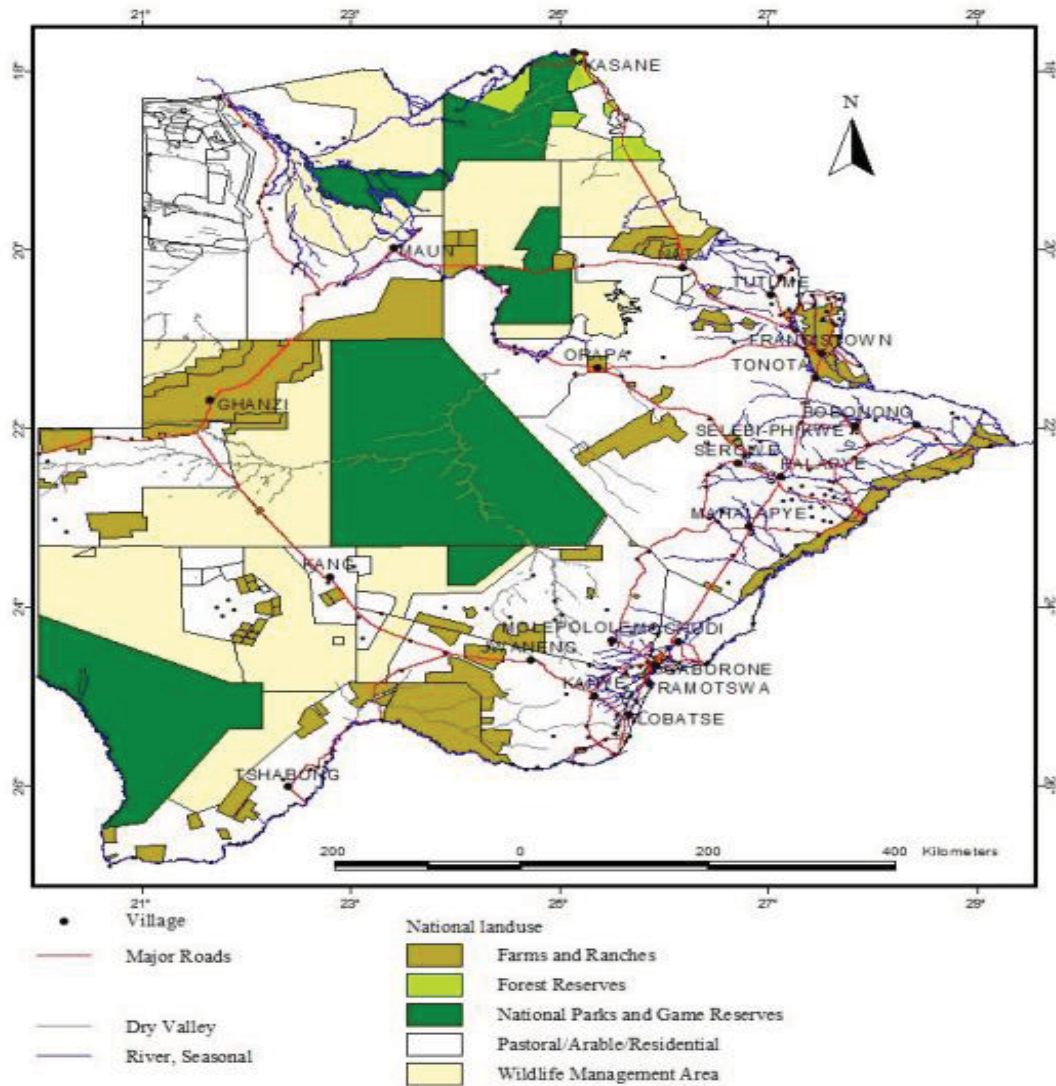


Fig 10: Land use map of Botswana (Down loaded from <http://www1.eis.gov.bw/EIS/SOER/Maps/w/landuse.jpg> on 25/5/11)

Earlier on we discussed the climatic conditions of Botswana. What types of animals do you think are suitable for the country's climatic conditions?

7.2 Pastoral Farming

This is an important economic activity particularly for rural households. Climatic conditions and the vegetation have made most parts of Botswana ideal for livestock farming. Pastoral farming is practiced in most parts of the country. The extreme northern part of the country has fewer livestock because of pests and diseases such as Foot and Mouth. Livestock kept in Botswana include cattle, sheep, goats, poultry and in small numbers donkeys, horses and pigs. Cattle farming is very important and has led to the establishment of a beef industry in Botswana.

7.3 Tourism

Vegetation in many parts of the country provides a good habitation for wildlife. Wildlife and wilderness are the main tourist attractions in the country. There are game parks and reserves with a considerable variety of wildlife. These together with wilderness areas such as Okavango Delta and Makgadikgadi Pans are frequented by tourists. Tourism brings money to the country through recreational hunting (hunting for sport or pleasure) and hotel accommodation.

In this section we listed the human activities as crop production, animal husbandry and tourism. These activities are influenced by climate. Now that we have discussed these we need to look at how they affect the environment.

8.0 Impact on Human Activities on the Environment

All human activities we have discussed in this topic have an impact on the environment and resources. Let us now look at some of the consequences of human activities on the environment in Botswana.

8.1 Deforestation

In Botswana, deforestation occurs all over the country. You may be aware of what causes this problem in your local environment. In many areas it is caused by uncontrolled cutting of trees, especially fuel wood. In some cases, vegetation has been removed or cleared for crop cultivation, to provide fencing material for the fields, used as building materials and timber. You will learn more about deforestation in Unit 7.

8.2 Soil Erosion and Land Degradation

Study the diagram on figure 11 showing causes of these environmental problems.

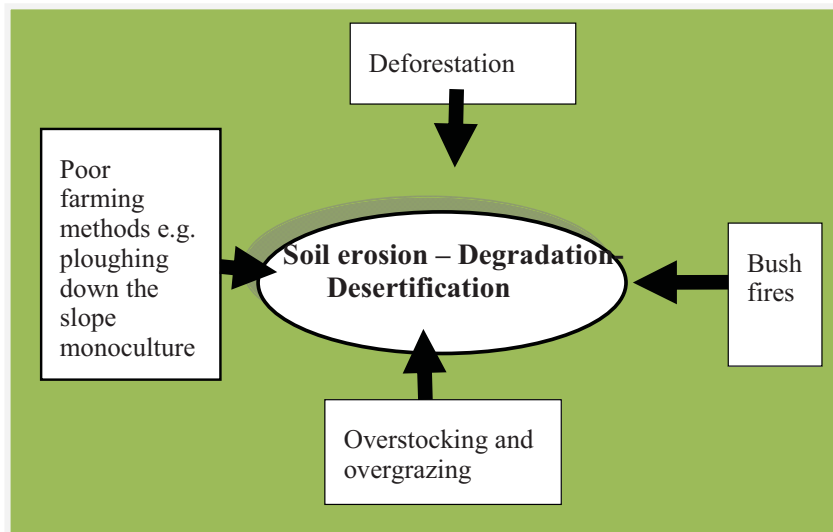


Fig 11: Causes of soil erosion

Figure 11 shows four human activities that cause environmental problems of soil erosion, land degradation and desertification. The problem of soil erosion is due to poor methods of farming such as ploughing up and down the slope and intensive cultivation of land. Overgrazing occurs in most parts of the country and is increasing in intensity every year. This problem has led to many other problems as shown in figure 11. Burning of bushes has also contributed to problems of soil erosion and desertification especially in semi arid regions.

8.3. Poaching

The wildlife population has been reduced due to overhunting. To save the animals from extinction and to protect the tourist industry wild animals are now protected by law and permit have to be obtained before any killing is to be done. However, animals continue to be illegally killed for subsistence use (for food), for their skins and other trophies.

8.4. Pollution

The tourism industry contributes to pollution. In some of the tourist areas there is indiscriminate littering by tourists. Poor management of wastes by hotels and tourist resorts may cause water pollution in rivers. These will be discussed in more detail in the unit on tourism.



9.0 Summary

In this topic you have learnt that Botswana has 3 types of climate, namely tropical sub-humid, semi desert and desert climate. Botswana is generally described as a semi-arid

country because this is a dominant climate. The country experiences hot summers with mean monthly temperatures of about 26°C and cool winters at an average of 12°C. Extreme diurnal temperature range is experienced in deserts and semi arid environments. This is due to clear and cloudless skies. High temperatures are usually recorded before the rainy season. Extreme temperatures have resulted in evaporation rates of about 2000 mm annually. Atmospheric moisture content is usually low because of dry air. The country is characterised by uneven distribution and unreliable rainfall, with great variations. Annual rainfall varies from less than 250 mm in desert region to 600 mm in sub-humid region. The average rainfall is 475 mm.

Vegetation cover is influenced by soil and rainfall patterns. The dominant type of vegetation is savanna which consists of deciduous trees mainly acacia, bushes and grasses. Forests occur in the northern part of the country where the amount of rainfall is the highest. Swamp and aquatic vegetation is found in the Okavango and along the Chobe River.

From the topic you have also learnt that various human activities in different environments of the country are crop cultivation, livestock farming, fishing, hunting and tourism. All these activities involve the use of natural resources. However, rapid population increase has exerted pressure on these resources. The result is problems of deforestation, soil erosion, pollution, land degradation and desertification.

You will need to use the information you have learnt in this topic to do the assignment at the end of the unit. Feedback is also provided to correct you. In the next topic we will now move from Botswana to look at the climatic regions of Africa starting with the equatorial region.

Topic 2: The Equatorial Climate

Introduction

We shall start this lesson by a brief introduction to the climatic regions of Africa. The rest of the lesson will then focus on the equatorial type of climate. Here, we will look at both the climatic and vegetation characteristics. Then we shall find out how human activities in this region are influenced by climate and their impact on the environment. You were first introduced to the different climatic environments of Africa at junior secondary level. With your background knowledge you will certainly enjoy this lesson.

Topic Objectives

At the end of this lesson you should be able to:

- identify and locate in a map of Africa the equatorial natural region
- discuss the equatorial region under the following: location and distribution, climatic characteristics and the natural vegetation
- discuss human activities in the equatorial region

- discuss the impact of human activities on the equatorial environment

1.0 Africa's Climatic Regions

Africa has the largest tropical area of all continents. The seasons for areas south of the equator are the opposite of areas north of the equator. Most of Africa has a warm or hot climate. The highest temperatures have been recorded in the Sahara Desert and the lowest in high mountains where snow or frost occurs. Rainfall varies significantly from one area to another. Areas like the Congo Basin receive high rainfall of up to 2 500 mm whilst others like deserts get little or no rain at all.

Africa can be divided into six climatic regions. These are the Equatorial Climate, the Humid Tropical Climate, Semi Desert, Desert Climate, Warm Temperate Continental and the Mediterranean Climate. The map below shows the geographical distribution of these climatic regions.

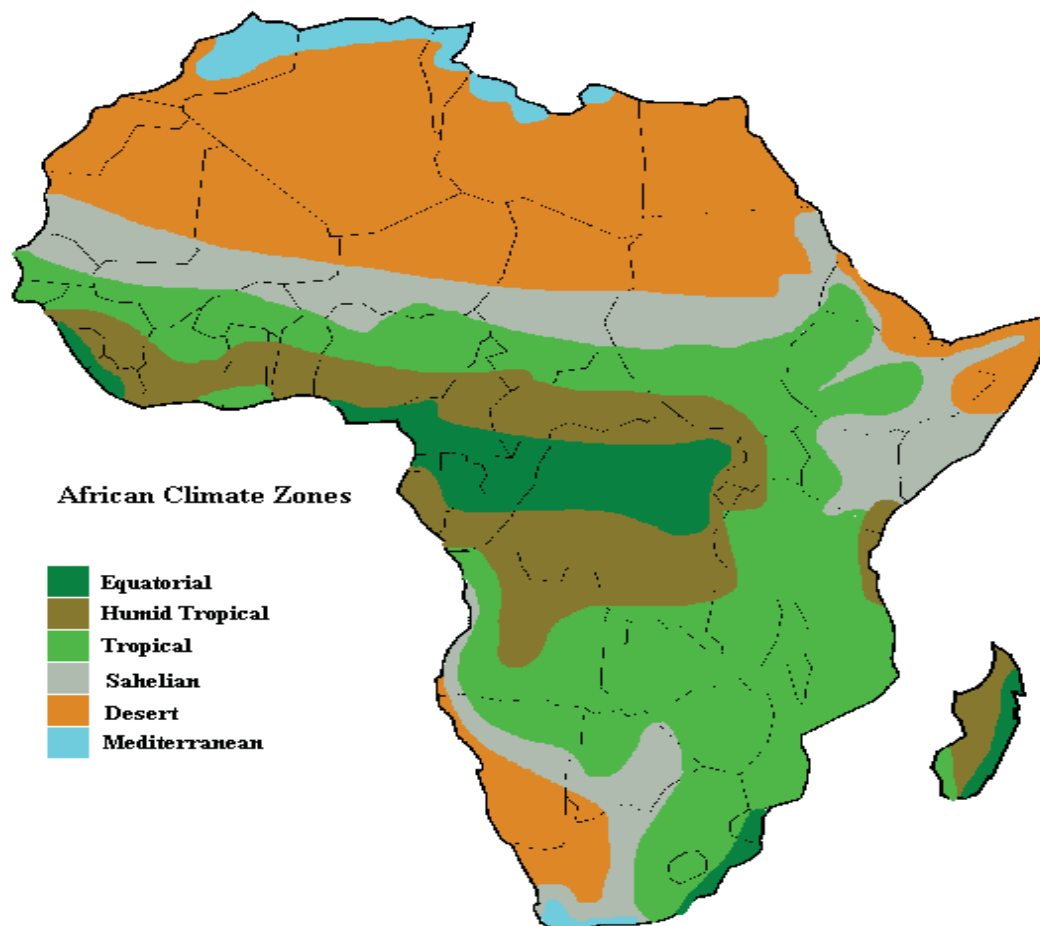


Fig 12: Climatic map of Africa (Downloaded from <http://www.empathosnationenterprises.com/> on 25/5/11)

Now that you have an idea of the different climatic regions of Africa, let us look in more detail at the climatic characteristics of the equatorial region.

2.0 The Equatorial Climate

The Equatorial Climate as its name suggest occurs along the equator between latitude 5° south and 5° north of the equator. In Africa this climate occurs in the Congo basin and the lowlands of West Africa. It does not extend to East Africa because the highlands there reduce temperature by about 15°c. East Africa therefore experience a modified equatorial climate which is more like the tropical savanna climate. Study the map in Fig 12, the shaded area gives the location in Africa of the equatorial climate. Notice that it lies along the equator but does not extend all the way to east Africa.

2.1 Climatic Characteristics of the Equatorial Region

The region lies in a low pressure belt called the doldrums. Conditions are the same throughout the year hence there is only one season. It receives high rainfall of between 1250 and 3000 mm per year. The region is hot and wet all year round. Temperatures are high because the sun is always overhead at the equator. Daily temperatures range between 26°C and 32°C. Annual temperature range hardly exceeds 3°C. Abundant cloud cover prevents temperature from rising above 32°C during the day and from dropping below 22°C at night. The air is always moist. Heavy convectional rain falls almost every day. It mostly comes in the afternoons and is accompanied by lightning and thunder. There is very little difference between the wettest and the driest months.

The diagram in figure 13 is a good example of a climate graph for an equatorial region. Notice that the temperature curve is almost a straight line. This indicates that temperatures are almost the same all year round. There are no seasons like summer and winter. The temperature ranges from 27°c to 28°c. The bar graph in figure 13 shows that there is no month without rainfall. Total rainfall stands at a high of 2354 mm per year.

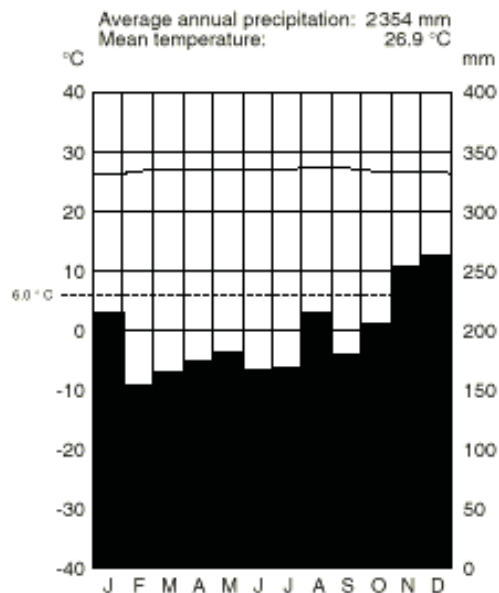


Fig 13: Climatic chart of an equatorial area (Adapted from <http://intranet.st-peters.york.sch.uk/fileadmin/subjects/geography> on 25/5/11)

Now that you have learnt about the climatic descriptions of the equatorial climate, attempt activity 1 that follows before you proceed with this topic:



Activity 1

Study the climatic chart of Kisangani in DRC in figure 14 and answer the questions that follow

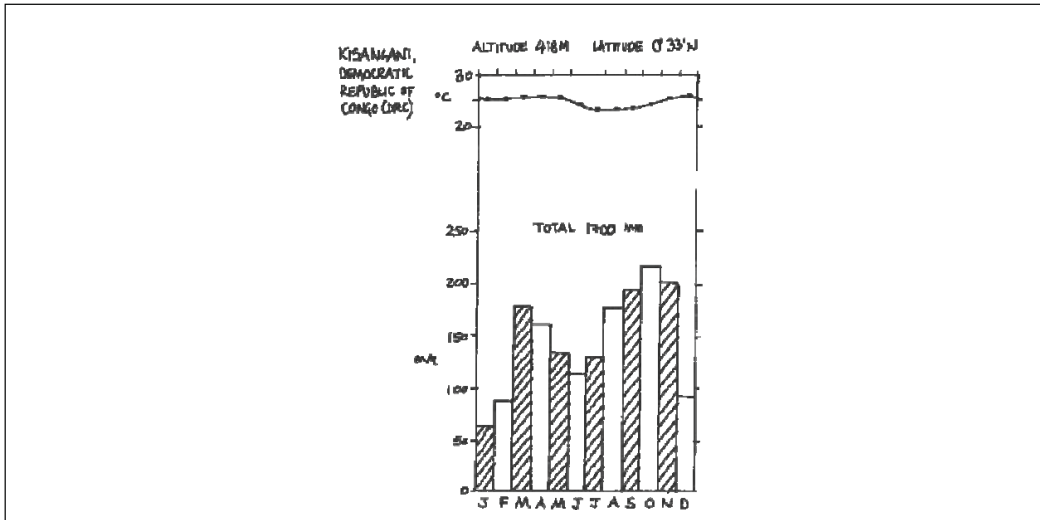


Figure 14: Climatic figures for Kisangani (Adapted from <http://www.tour.tk/pics/weather/kisangani-climate-chart>. On 25/5/11)

1. What features of this graph shows that it is an equatorial type of climate?

[2 Marks]

2. Why is there high temperatures and low daily temperature range in the equatorial climate?

[2 Marks]

3. Which month receives the highest rainfall?

[1 Mark]

4. What is the rough annual temperature range of the area shown?

[1 Mark]

1. *High temperatures and rainfall throughout the year*
2. *The heat of the sun's rays is concentrated because the sun is always overhead the equator. Extensive cloud cover, high humidity and heavy rains prevent temperature from rising highly during the day and from dropping too much at night*
3. *September*
4. *About 1°c or 2°c*

Remember that we said the climate of this region is hot and wet throughout the year. Now that you have covered the climatic characteristics of the equatorial region, what type of natural vegetation do you think is found in this region? Read on to get the answer.

2.2 Natural Vegetation

This area receives a lot of sunshine, high temperatures and large amount of rainfall. These are very good conditions for the growth of plants. The natural vegetation of the area has tall, broad leaved and evergreen trees called the tropical rainforest. The rainforest is covered with dense trees of many kinds. There are about 500 different species of plants growing in this region. These trees are found in three layers:

- **Upper layer:** these are very tall trees that go up to 50 m high. These giant trees are supported by their buttress roots that may go up to 3 m high. They form a continuous canopy above the forest. The canopy provides shade for plants and animals from the scorching sunlight. Many tropical birds, monkeys, apes, reptiles and snakes live in the canopy.
- **Middle layer:** these are trees that grow up to 30 m high. They include creepers or climbing plants that use tree trunks for support.
- **Lower layer:** a layer of dense trees that grow up to 10 m in height. They are under constant shade. Many smaller animals like anteaters and tree kangaroos live here.

The forest floor is always under the shade. Very little sunlight reaches the forest floor and very few herbs and bushes grow there. The forest floor has poor soil. Insects and large mammals like gorillas live on this layer. There are also many rivers due to the heavy rains. Study figure 15, notice the three different layers of trees. There are also climbing plants that go up the tall trees for sunlight.

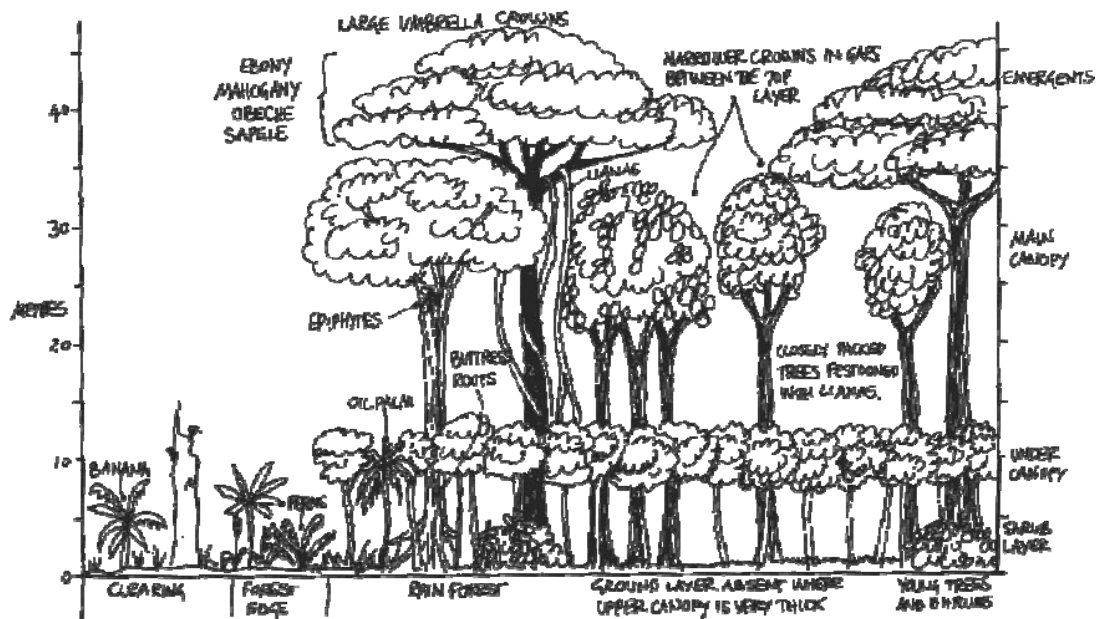


Fig 15: Characteristics of the tropical rainforest

The vegetation has adapted to the wet and hot environment in the following ways:

- Trees grow very tall in an effort to reach for sunlight. Very tall trees have buttress roots for support. Creepers climb large trees to reach the top for sunlight.
- Plants are ever green because of availability of water all year round. They have broad leaves for transpiration.
- The vegetation is dense because the conditions are suitable for the growth of plants
- Trees have shallow roots as the water is easily available at the surface.
- There is continuous growth of vegetation due to constant heat and rain throughout the year.
- Plants flower and produce fruits throughout the year
- Trees have thin trunks and smooth barks as there is neither the need to store moisture in their trunks and to protect themselves from cold weather.
- There is little growth at the forest floor because of lack of sunlight.

When the forest for some reason has been cleared of its original vegetation, the secondary forest develops. Secondary forest is not as luxuriant as the original vegetation. It is characterised by shorter trees with dense undergrowth.

Now that you have completed the section on natural vegetation, attempt activity 2. Use the information given in figure 15 to answer the questions. When you are finished, compare your work with the feedback given.



Activity 2

Using the picture in figure 15, identify characteristic features which enable the equatorial vegetation to adapt to its environment.

Total = [3 marks]

Feedback

From figure 15 we can see the following features

- *Trees that are growing very tall as they are always competing for sunlight*
- *Trees with straight trunks and branches lower parts enables them to grow straight*
- *Trees with large crowns to protect the roots from the sun sun's heat*
- *Tall trees with buttress roots to support their great height*
- *Lianas climbing large trees to reach the crowns for sunlight*

Now that we have discussed the climatic characteristics of the equatorial region it is now time to discuss the human activities. After discussing the climatic characteristics, what do you think are the most suitable human activities for this region?

3.0 Human Activities

Given the kind of climate of this area, you can probably guess the kind of human activities that could be found here. Tropical rainforests have few people due to thick forests and unfavourable climatic

conditions. The climate influences the way in which people live. Major activities of the equatorial region include:

- Fishing, hunting and gathering
- Shifting cultivation
- Plantation agriculture
- Lumbering

3.1 Fishing, Hunting and Gathering

The pygmies of the Congo basin are traditional inhabitants of this region. They live by hunting, fishing and gathering as there are plenty of foods like leaves, nuts, fruits, birds, animals and fish.

3.2 Shifting Cultivation

Some communities of subsistence farmers in the rainforest practise shifting cultivation which is also called the slash and burn technique. These people clear the surrounding vegetation. The vegetation is left to dry and then burned. The land is planted with crops like bananas, pineapples, yam, cassava, cocoyam and coconuts until it loses its fertility. Once the fertility of the soil is exhausted they shift to another fresh area.

3.3 Plantation Agriculture

Large scale farming of cash crop is done in plantations. Plantations are large farms covering several thousands of kilometres usually specialising in the production of one cash crop. The equatorial climate is good for growing a variety of crops including those that are grown for commercial purposes such as rubber, cocoa, palm oil, coffee, tea, tobacco and bananas. Some of the plantations are owned by international companies. After harvesting crops are sent to processing industries or for export.

3.4 Lumbering

Lumbering which is sometimes called logging, is the commercial cutting of trees for purposes of making timber. There are many valuable trees that grow in the rainforest that are used to make good timber such as sapele, iroko, mahogany and ebony. This has given rise to important timber industries that produce timber used in making building materials and furniture.

Agriculture and lumbering contribute to the establishment of processing industries in the region. Timber is used to manufacture wood products such as plywood, paper and boats. It is used in housing

construction and for making railway sleepers. There are a number of industries that process agricultural products. Some plantations have their own processing plants.

In this section we have discussed the human activities in the equatorial region. These are hunting and gathering, shifting cultivation, logging and plantation agriculture. These activities have had a negative impact on the environment.

4.0 Environmental Impact

Both the rainforest and man affect each other. The rainforest makes it difficult for people to carry out some of the human activities in the region. Factors that impact on human activities include:

- The hot and wet conditions of the rainforest are good for the spread of diseases and insects that affect man, his crops and animals. Dangerous pests such as tsetse fly and deadly diseases such as malaria and yellow fever are common in this region.
- The region has high temperature. Hot and humid condition causes sweating and sometimes even sunstroke.
- The dense forest makes it difficult and expensive to clear the land for developments. For instance forest has led to the development of timber industries. However, it is difficult to construct roads and the task of transporting logs from the forests is also difficult.
- The thin soil of the equatorial region loses its fertility very quickly once the forest is removed. If the soil is exposed heavy rains make it lose its nutrients through leaching and soil erosion.

Human activities on the other hand have left a lasting impact on the equatorial environment. Some of the negative human impact on the rainforest include:

- Deforestation is one of the major environmental problems in the region. Deforestation is the cutting down of trees without replacement. The felling or clearing of land is done for the purpose of cultivating crops, for extracting timber, for expanding settlements as the population increases or to create space to build infrastructure. The tropical rain forest is fragile. Once destroyed it is not easy to replace the original vegetation.
- Loss of wildlife as a result of overhunting and destruction of the ecosystem. Some of the animal species in the region are threatened by extinction due to overhunting. Vegetation is part of the ecosystem and if removed the ecosystem is disrupted and the habitat and food for wildlife is destroyed. This has negative effects on wildlife.
- Soil erosion and land degradation occurs as a result of deforestation.
- Pollution arising from the use of fertilisers and pesticides as well as from processing industries. These activities cause pollution of surface water, underground water and air pollution with negative effects on people, plants and animals.

Now that you have covered the section on human activities and the environment, attempt the activity that follows:



Activity 3

What are the effects of deforestation on the environment? Pause for a minute and list at least **three** of them.

Total = [3 marks]

Feedback

This includes:

(a) Soil erosion

Cleared land is exposed to heavy rains and winds which cause soil erosion.

(b) Declining fertility of the soil

The removal of vegetation affects the nutrients cycle because there will be no trees to replace humus in the soil. Some of the nutrients will be washed away or removed through leaching

(c) Contributes to climate change

Deforestation contributes to changes in climate because of carbon dioxide and oxygen imbalance in the atmosphere. Deforestation means less vegetation for taking in carbon dioxide and giving out oxygen.

Now consolidate your knowledge by reading the summary given below.



5.0 Summary

In this topic you have learnt that the equatorial region is mainly found between latitudes 5° north and south of the equator. In Africa this climate is best developed along the west coast, from Guinea to Democratic Republic of Congo. The equatorial region experiences heavy rainfall throughout the year, with a total amount of about 2 000 mm. Even though each month is wet, there are two wettest times in the year which occur just after the equinoxes. Rainfall is mainly of convectional type, accompanied by lightning and thunder, and this occurs mostly in the afternoons. Temperatures are high and almost uniform throughout the year. The daily average temperatures are about 26°C and the annual temperature range is 3°C. Humidity is high throughout the year (about 80%) due to heavy rains and high temperatures. The equatorial region is a low pressure belt and this is known as the doldrums. Generally we can describe the equatorial region as hot and wet throughout the year.

You have also learnt that this region supports luxuriant vegetation known as the tropical rainforest. This consists of thousands of plant species that are well adapted to the environment. The vegetation is evergreen and always growing. It is divided into three layers. The top layer of very tall trees (30-45 m) forms a continuous canopy. The middle layer consists of tree ferns, lianas and epiphytes. Herbaceous plants, ferns and saprophytes make up the bottom layer. Forest clearing has led to the development of less luxuriant trees called secondary forest.

The equatorial region is sparsely populated. The early people lived as hunters and gatherers and the more advanced tribes practised shifting cultivation. Plantation agriculture takes place producing crops such as bananas, palm oil, rubber, cocoa, tea and coffee. The forest contains valuable timber such as mahogany, *makore* and *sapele* resulting in the development of timber industries. The region however may hinder development because the jungle is dense and inaccessible making land clearance and developments costly. There are many diseases (like malaria) and pests. Soil fertility is declining due to deforestation. The disappearing rain forest caused by humans is a major and global environmental problem.

At the end of the unit, there is an assignment. You will need to use the information you have learnt here to do that assignment. Feedback is also provided to guide you. In the next topic we are going to look at another climatic region of Africa which is the savanna climate also known as the tropical continental climate.

Topic 3: The Tropical Savanna Climate

Introduction

In the previous topic you learnt about the equatorial region. We said this region can generally be described as hot and wet throughout the year. In this topic we shall look at another climatic region of Africa called the savanna or tropical continental region. We will discuss and describe the climatic characteristics and the natural vegetation of this environment. This will be followed by a discussion about human activities on the savanna and their impact on the environment. During our discussion, note the difference between the equatorial and savanna environment.

Topic Objectives

At the end of this topic you should be able to:

- identify and locate in a map of Africa the savanna climatic region
- discuss the climatic and natural vegetation characteristics of the savanna environment
- discuss human activities in the savanna region
- discuss the impact of human activities on the environment

1.0 Location and Distribution

The tropical Savanna climate is also known as the tropical continental or Sudan climate. It is called tropical continental because it is found within the tropics, between the tropic of Cancer and the tropic of Capricorn inside continents. It is also called Sudan type because it is best developed in Sudan. It is found on both sides of the rainforest between 5° and 15° north and south of the equator. It stretches from the equatorial zone to the desert and covers about one-fifth of the area of Africa. Study the map on figure 16 which shows the distribution of this climate in Africa.

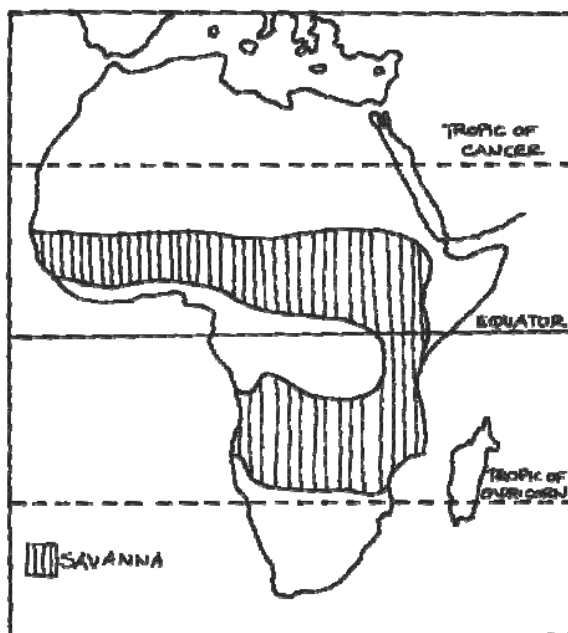


Fig 16: Location and distribution of the savanna region in Africa

Notice that the shaded area on the map is on both sides of the equator. It also lies between the tropic of Cancer and Capricorn. You can also see that this region surrounds the area in the centre which is the

Equatorial climate. The savanna climate stretches to East Africa along the equator because the highlands there have modified the Equatorial climate to Savanna like climate.

2.0 Climatic Characteristics

The Savanna climate is characterized by a hot and wet season during the summer months and a dry and cold season during the winter months. Study the climatic graph of a town in this region. Figure 2a shows the climate of Kayes, Mali in the northern hemisphere. Notice that rain falls mainly from June to September, these are summer months in the northern hemisphere. The same graph for the southern hemisphere will show rainfall and high temperatures between the months of October and February.

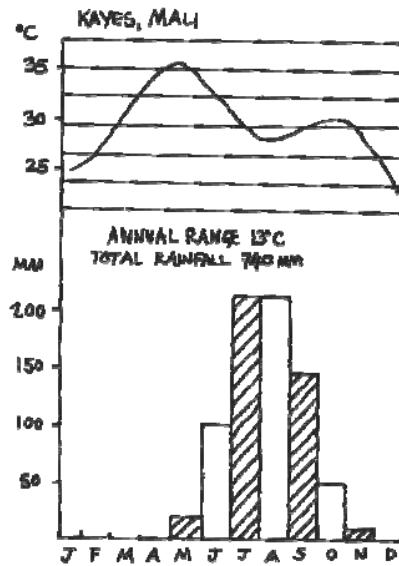


Fig 17: Climatic graphs of a town in the Savanna (Adapted from

www.eldoradocountyweather.com/.../Kayes.html on 25/5/11)

Notice that in figure 17 the months of rainfall are also the months when temperatures are high. Read the sections below for details on the temperature and rainfall of the region.

2.1 Temperature

Monthly temperatures ranges between 21°C and 32°C, making the annual range of about 11°C. Summers are best described as hot and winters as cold. The maximum daily temperatures are recorded just before sunset in summer. Although temperatures are high in summer, when rain falls, temperatures may drop due to the overcast sky and cooler atmosphere. The dry winter season is associated with low period of sunshine.

2.2 Rainfall

In the northern hemisphere the hot rainy season begins in May and lasts until September. The rest of the year is cool and dry (winter). The situation is just opposite in the southern hemisphere. The rainy season starts from October and lasts until April. From May to September the southern hemisphere Savanna experiences winter. Study the climate graph in figure 17. You will note that rain falls when temperatures are high (summer) and there is no rain in winter. This is because of the prevailing winds that blow onshore in summer but are off shore in winter. In West Africa the north east trade winds blow off shore from the Sahara desert. This dust laden wind is locally called the Harmattan. In southern Africa the north east trade winds blow onshore in summer and bring rainfall.

In the savanna, rainfall differs from place to place. Around the borders of the equatorial region, rainfall is quite high and decreases gradually towards the desert borders. The annual rainfall is about 762 mm and is mainly convectional. Humidity is high in summer due to high temperatures and rainfall. In general the savanna region experiences hot wet summers and cool dry winters.

Now that you have covered the climatic characteristic of the savanna region, this is the right time to complete the activity that follows.



Activity 1

Study the savanna climate graph in Figure 17 and answer the following questions

1. (a) In which hemisphere is this station? [1 mark]

(b) When does most rainfall occur? [1 mark]

(c) What is the annual temperature range for this region? [1 mark]

(d) Briefly describe temperatures just before period of maximum rainfall [1 mark]

Total = [4 marks]

Feedback

From this graph we can see that:

- (a) Northern hemisphere, because rain falls when temperatures are high (in summer) May, June and July are summer months in the northern hemisphere*
- (b) In June, July, August and September, which are summer months*
- (c) About 13°C*
- (d) The highest temperatures are recorded just before the period of maximum rainfall.*

The natural vegetation is influenced greatly by rainfall and temperature. We said the climate of this region is hot and wet in summer and cold and dry in winter. What kind of vegetation do you think will be most suitable for these conditions? Read the section that follows to get the answer.

2.2 Natural Vegetation

Savannas are characterized by tall grass and scattered trees. Grass may grow up to a height of 2 meters. This vegetation is sometimes referred to as parkland vegetation. Savannah vegetation varies with the amount of rainfall in a given area. In areas bordering the rain forest, trees dominate. There are broadleaved trees some of which are evergreen and others deciduous. This type of vegetation is sometimes called savannah woodland. As one moves further away from the equatorial rain forest the dry season becomes longer and these areas bordering the desert is called savannah scrub. It consists mainly of drought-resistant and fire-resistant open deciduous trees, thorn bushes or scrub. Figure 18 shows typical vegetation of the savanna region.



Fig 18: Typical savanna vegetation (Downloaded from <http://www.savannas.net/luimages/w.gif> on 25/5/11)

In summer due to high rainfall and high temperatures, the veld is green with luxuriant trees and grasses. The opposite occurs in winter. Some areas of the savannah region have low rainfall and a long dry season. The vegetation have adapted to the long dry season in the following ways:

- Some trees have small leaves, others lose their leaves in winter. This prevents loss of moisture through transpiration. Trees that lose their leaves in winter are called deciduous trees.
- Some trees such as the acacia tree have long roots to reach for water deep underground. Acacia trees also have an umbrella shaped canopy to provide shade for the roots and trunk thus conserving moisture.
- Some trees like the baobab tree store water in their trunks, others like cacti have thick succulent stems for storing water.
- Grasses wither during the dry season. Their roots remain dormant and when the rains come they spring back to life.
- Trees grow separate from each other thus avoiding competition for water.

There are fewer types of trees in the savannah than there are in the rainforests. However, the seasonal fall of leaves produces abundant nutrients and more fertile soils than found under tropical rainforests. Fires are common because of the dry grasses and leaves which create fuel for fires. Termites, which are many in this region contribute to soil formation and also build big mounds.

To test your understanding of the natural vegetation of the savanna that you have covered, try this activity



Activity 2

Study figure 19 showing savanna vegetation during a dry season and a rainy season

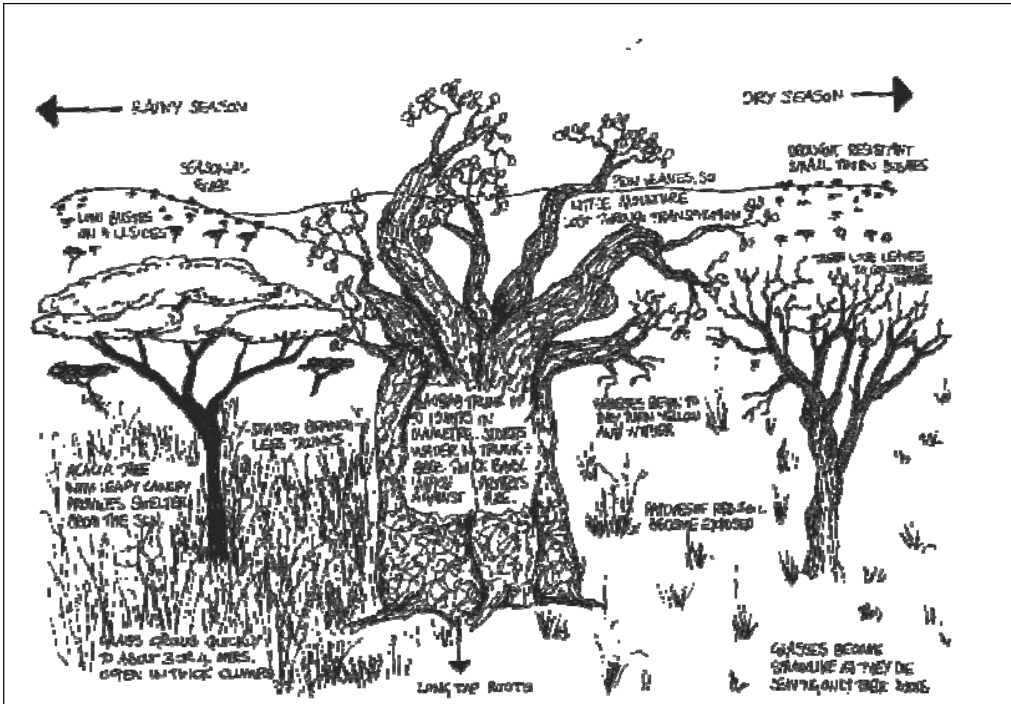


Fig 19: Savanna vegetation during a dry season and a rainy season

Briefly explain why this vegetation has the following features as labelled in figure 19. [1 mark each]

- a) Trees lose leaves during the dry season

- b) The baobab tree has a thick trunk with a diameter of about 10m

- c) Trees have Y shaped branches

- d) Trees have long tap roots

- e) Some trees have few leaves

- f) Grass becomes straw like and die leaving only the roots during the dry season

Total = [6 marks]

Feedback

- a) *Trees lose leaves during the dry season to reduce transpiration*
- b) *The baobab has thick succulent trunks to store water*
- c) *Trees have Y shaped branches to conserve moisture around the roots*
- d) *Trees have long tap roots to reach water and nutrients deep underground*
- e) *Some trees have few leaves to reduce transpiration*
- f) *Grasses die and leave roots to lie dormant while awaiting the rainy season and grow again*

In short, the savanna vegetation can be described as having tall grasses and scattered trees while its climate is hot and wet in summer and cold and dry in winter. These conditions affect the way in which people live as discussed below.

3.0 Human Activities

What kind of human activities do you think exists in this region given the nature of its climate? The climate has an influence in the way in which people live. Farming both arable and pastoral as well as tourism are important activities in this region.

3.1 Pastoral Farming

As grassland, the savannah is ideal for pastoral (livestock) farming. There are a number of subsistence pastoralists in this region who keep enough livestock to meet their family needs. For instance, the Masai of East Africa and the Fulani of West Africa keep large herds of cattle, goats and sheep that graze on the savanna grasslands. Both groups are nomadic pastoralists, in that they move from place to place in search of water and pastures for their livestock. Commercial cattle ranching also take place in this region.

3.2 Arable farming

Many people in the savannah have practiced crop cultivation for a long time. Crops grown include sorghum, maize, millet, cotton, and tobacco. The Hausa people of Nigeria are an example of settled cultivators of the savanna. Commercial plantation farming has become established in the savanna. Crops grown include sugarcane, tobacco, maize, cotton, and sisal. Most of these plantations and large commercial farms are found in Kenya, Tanzania, Nigeria, Malawi, Uganda and Zimbabwe. The first white settlers introduced Plantation Agriculture in this climatic region during the colonial era. Crops from plantations are mainly grown for export.

Agriculture has led to the establishment of agro-based industries that process agricultural products. There are industries in countries such as Kenya and Tanzania that process and package sugar, coffee, tea, chocolate and milk products.

3.3 Tourism

Tourism is an important source of income for a number of countries in this region. Savannah has a wild variety of wildlife that includes herbivores (grazing animals) like buffaloes, wildebeests, warthogs, zebras, rhinos, giraffes and elephants. Large variety of herbivore supports carnivores (predators) like lions, leopards, cheetahs, wild dogs and hyenas. For this reason national parks and game reserves have been set up in many countries in the region and facilities like lodges and camp sites have been developed to attract tourists. Masaimara and Serengeti plains are famous for tourism.

3.4 Fishing

In parts of the savannah climate where there is high rainfall, there are perennial rivers. In some countries such as Malawi, Tanzania and Uganda there are perennial lakes. Fishing is an important activity in these areas.

In this section you have learnt about the human activities of the savanna region. We said these are tourism, fishing and arable and pastoral agriculture. In the next section we will look into the factors that affect development in the region.

4.0 Factors Affecting Development in the Region

There are a number of challenges that affect agricultural developments in the savanna region. These include droughts, pests and diseases and poor soils.

4.1 Drought

Farming in the Savanna is often affected by long drought periods. Rainfall in this region is unreliable. Drought affects both crop and livestock farming. It also increases the problem of desertification.

4.2 Pests and Diseases

In some parts of the savanna, farming is limited by pests and diseases. Tsetse fly brings sleeping sickness to man and trypanosomiasis (nagana) to cattle. Large areas have been neglected or abandoned due to the presence of pests like tsetse fly and mosquitoes. Locusts also have a devastating effect on both vegetation and crops.

4.3 Poor Infertile Soils

Heavy rains cause both soil erosion and leaching which removes silica from the upper soil layers, leaving behind the red coloured oxides of aluminium and iron. These red soils are compacted or cemented forming a hard layer known as **laterite**. The laterites are poorly drained and plant roots cannot penetrate them easily. Such areas are better suited to animals than crop farming.

As we have seen the savanna like all the other climates has an impact on the way in which people live. The people also have had a negative impact on the environment of this region as will be shown in the next section.

5.0 Impact of Human Activities on the Savannah

You have learnt how human activities have caused numerous changes to the equatorial environment. The savannah environment has also been subjected to many changes due to human activities. The most significant ones are:

5.1 Overgrazing

We have already mentioned that the savannah grassland is ideal for pastoral farming. Pastures for livestock have been greatly affected by overstocking and overgrazing. This poor management of rangelands, which is worsened by drought, has led to soil erosion and invasion of thorny grazing lands and drought resistant bushes.

5.2 Deforestation

In the savanna both trees and grasses are being exploited for various purposes. Savanna vegetation is being destroyed at an alarming rate. This includes cutting trees for fuel wood, clearing land for farming and veld fires.

Both overgrazing and deforestation exposes the soil to weather elements like wind and rain. Bare soil is easily eroded and huge dongas and gullies as shown in figure 20 may develop, resulting in land degradation.



Fig 20: Gullies and dongas (Downloaded from <http://thedunfords.org/blog/wpcontent/uploads/2009/10/donga.jpg> on 25/5/11)

Notice the bare ground and the trenches of dongas caused by erosion in the diagram in figure 20.

5.3 Desertification

The savanna regions bordering the desert are slowly turning into deserts. Desertification usually occurs when dry land is used intensively. Human activities like over cultivation, over-grazing of livestock and deforestation all degrade the soil. Drought can also accelerate this problem of desertification. Desertification does not only affect people and animals. It also has a significant effect on climate and vegetation. To appreciate the seriousness of this problem, read through the case study on desertification that follows.

Case Study: The Sahel

The Sahel is a region in West Africa that stretches from Senegal through Mauritania, Mali, Burkina Faso and Niger to Chad. It is part of the Savanna belt that lies on the fringes of the Sahara Desert. It occurs in areas with an average rainfall of about 250-550 mm. The Sahel vegetation consists mainly of thorn bushes, short coarse grasses and several species of acacia.



Fig 21: Location of the Sahel region in Africa

Notice that the Sahel is widely spaced and is in the margin of the Sahara Desert. The area has suffered from severe droughts in recent years. This area is increasing in size and expanding southwards. The reason for this is desertification due to drought and human activities. Marginal areas such as these are sensitive and need to be used with care. Overstocking, deforestation coupled with drought has led to the expansion of the Sahara into the Sahel Region.

5.4 Loss of Wildlife

Some of the human activities in the savanna have negative impact on wildlife. The use of pesticides for instance, kills many other living organisms some of which are essential for soil formation. Indiscriminate dumping of toxic wastes kills both plants and animals. Overhunting threatens many animals with extinction. Animals such as the rhino have become endangered species because of overhunting. The destruction of vegetation also affects animals because it destroys their natural habitats.

5.5 Impact of Tourism

The tourist industry which is rapidly growing in the savanna has led to the preservation of natural resources such as wildlife, forests and scenic landscapes. A good example is the Serengeti National Park in Tanzania, which covers an area of about 15 000km² and protects thousands of wild animals. In most countries scenic landscapes are preserved to keep them attractive to tourists.

On the other hand, tourism has caused great damage to the environment. In game reserves and parks vegetation and animals may be affected as the quality of their wilderness is reduced. The growing demand of wildlife souvenirs such as livery ornaments has led to indiscriminate killing of animals and poaching (illegal hunting of animals). Littering and burning of the veld through the careless use of fires are some of the common problems associated with tourists in game parks and game reserves.

Now read the summary and consolidate your understating of this topic.



6.0 Summary

In this topic you have learnt that the savannah is a widespread type of climate lying between the equatorial and the desert climatic regions. This climate is characterised by hot and wet summers and cool dry winters. Average summer temperatures are about 32°C and winter temperatures are around 21°C. The annual temperature range is around 11°C. Heavy rains, mainly convectional occur in summer. The total annual rainfall is around 750mm. Generally, the rain is higher near the equatorial margins (about 1500mm) but decreases towards the desert margins. The vegetation is grassland with scattered trees. Savanna woodland occurs in areas with the highest amount of rainfall and savanna scrub occurs in regions with the least amount of rainfall. Tall grasses often reaching two meters, dominate this vegetation, especially near the equatorial regions. The savanna is a well-known home for wild animals like lions, giraffes, rhinos, and cheetahs. Here we find various species of wildlife. This has led to the establishment of game reserves and parks.

Population distribution in the savannah is influenced by a number of environmental factors. One of the major factors is the availability of natural resources, which in turn influence human activities. You have learnt that human activities in this environment include pastoral and arable farming practised at both subsistence and commercial level. Abundant wildlife also attracts tourists from all over the world. All these activities have a great impact on the environment as they cause deforestation, soil erosion, pollution, ecological disturbances and other negative results.

Now that you have completed this topic you will need to do the assignment at the end of this unit. What you have learnt in this topic will help you to do that assignment. Feedback is also provided to guide you. In the next topic we are going to look at another climatic region found in Africa, which is the tropical desert climate.

Topic 4: Tropical Desert Climate

Introduction

In the previous topic you learnt about the tropical continental or savannah type of climate. This is a transitional type of climate occurring between the equatorial region and the deserts. The savanna is sometimes called the tropical grassland. In this topic we shall study another climatic region in Africa. Here, we will discuss the climatic and vegetation characteristics of the desert and semi-desert

environment. We shall also find out how people make a living in this environment. As we proceed through the topic, note the differences between this climatic region and other types of climate covered in the previous topic.

Topic Objectives

At the end of this topic, you should be able to:

- identify and locate on a map of Africa the semi – desert and desert environment
- discuss the climatic and natural vegetation characteristics of the desert and semi-desert regions
- discuss human activities in the semi desert and desert region
- discuss and describe the impact of human activities on the environment.

1.0 Location and Distribution

The tropical desert is a climatic region characterized by extreme conditions. It is the driest and the hottest region. Very little rainfall is received and in some years no rain falls at all. The dry conditions of the deserts are due to the year-round influence of cold currents, subtropical high pressure and distance from the sea. You learned about this in the previous unit.

In Africa, the tropical deserts occur approximately between latitude 15°N and 30°N of the Equator and also between 15°S and 30°S of the Equator. Study the map in figure 22. The shaded area shows the distribution of the deserts in Africa.

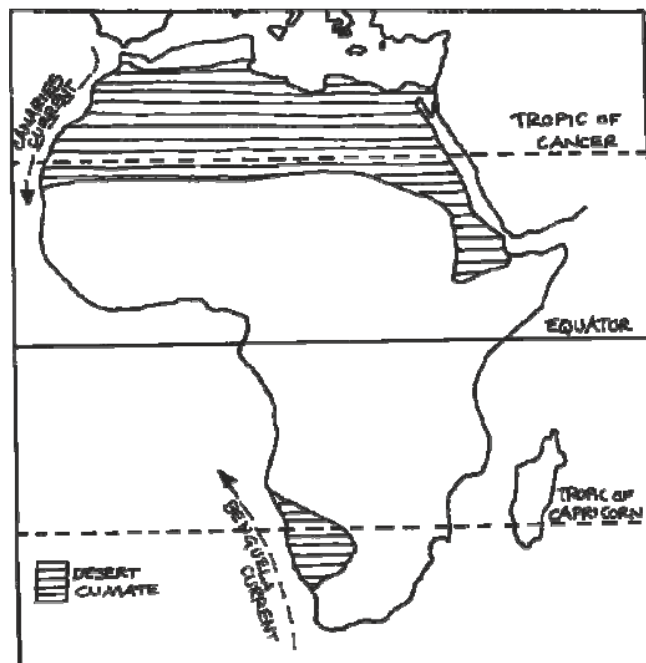


Fig 22: Location and distribution of deserts in Africa

You should have covered some of the climatic regions at your junior school. Before you proceed further with this topic let us see how much you remember by completing activity 1 that follows.



Activity 1

1.	Using the map on figure 1, name the 2 deserts of Africa. [2 marks]
	----- -----
2.	Name the latitudes that pass through these deserts. [2 marks]
	----- -----
3.	Which desert covers most parts of Namibia? [1 mark]

4.	Which desert is the largest in Africa? [1 mark]

	Total = [6 Marks]

Feedback

1. The 2 deserts are: Sahara desert and Namib Desert.
2. The latitudes that pass through these deserts are:
Tropic of Cancer which pass through the Sahara Desert.
Tropic of Capricorn running through the Namib Desert.
3. The Namib Desert covers most of Namibia.

4. *The largest desert in Africa is the Sahara.*

From the map in figure 22 you can see that most of the deserts are located in the western side of continents. These deserts are called tropical deserts because they are confined to the Tropic of Cancer and Capricorn. The Sahara desert, which is the largest, stretches from the west coast, across the continent to the east coast in North Africa. Generally, the deserts lie within the offshore trade wind belt. In the previous unit, you learnt about trade winds blowing across Africa. Trade winds blowing across the deserts are dry and dusty. For example, the Harmattan winds, mentioned in the previous topic blow across the Sahara Desert. In Southern Africa, the South East trade winds are usually dry by the time they reach the Kalahari Desert. Another factor influencing the desert climate is the cold current. On – shore winds blowing across these cold currents quickly get heated up on land and absorb moisture. Rainfall can only be formed when the rising air releases moisture.

The map in figure 22 shows the two cold currents: Benguela and Canaries currents. The Namib coast and the Sahara west coast are affected by these cold currents. These cold currents reduce evaporation on-shore. The winds blowing across the cold current carry little moisture with them. On land they absorb moisture instead of releasing it. Study the diagram in figure 23 that shows the climatic characteristics of a town in a desert region. Notice that the area does not receive any rain at all.

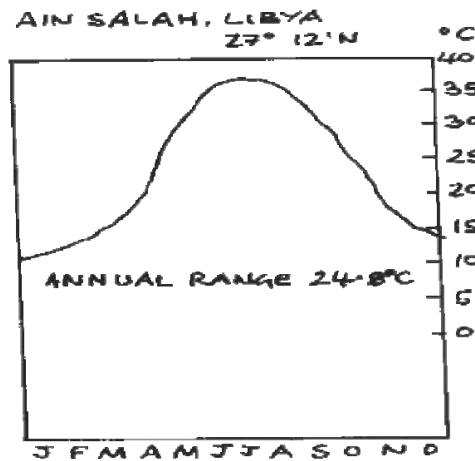


Fig 23: Climate characteristics of a desert region (Adapted from www.eldoradocountyweather.com/climate/africa/ On 25/5/11)

2.0 Climatic Characteristics

The information on temperature and rainfall that follows will give you a more detailed coverage of the climatic characteristics of the desert region.

2.1. Temperature

The tropical desert experiences cool winters and extremely hot summers. The mean monthly temperatures are about 29°C in summer and 10°C in winter. In summer, maximum day temperatures of over 40°C have been recorded. Deserts have very high day temperatures and very low night temperatures. The daily temperatures vary from freezing point to over 50°C. These daily temperature extremes are caused by clear or cloudless skies and dry air. The sky in the tropical desert remains cloud-free due to the subsiding air of high pressure. This results in large amounts of heat reaching the ground during the day hence the high temperatures. The absence of clouds also lets much heat out at night hence low temperatures. Such extreme temperature ranges are common in the interior of deserts. In winter frost may occur at night. The greatest temperature extremes are mostly experienced in the interior of the Sahara Desert where temperatures of over 50°C are often recorded. Figure 24 gives you an example of a desert environment. Notice the sand dunes that are as big as hills.



Fig 24: A typical desert environment with sand dunes (Downloaded from <http://davidwallphoto.co.nz/images> on 25/5/11)

Look at the picture of a desert environment in figure 24. Does it give you any idea of the amount of rainfall that the area receives? To find more about rainfall in desert regions proceed to the next section.

2.2 Rainfall

Desert areas get very little or no rainfall. Rainfall hardly exceeds 250 mm in a year. For this reason some parts of the deserts are characterized by barren sand dunes as in figure 24. Low rainfall in deserts is caused by the following factors:

- a) Deserts lie in high pressure belts called the Horse latitudes. The descending air of the subtropical high warms causing the air to dry out and prevent condensation. Humidity is very low in desert regions.

- b) The continental location of many tropical deserts places them far from a source of moisture, which is the sea or ocean. This situation is called continentality. Warm and moist air travelling long distances from the sea loses much of its moisture by the time it reaches the desert region.
- c) The coasts of some desert areas are washed by cold currents. The Sahara is washed by the cold Canary Currents whilst the Namib is washed by cold Benguela Currents. The cold waters of these currents do not readily evaporate, thus depriving these coasts almost completely of rain. The little moisture that occurs is from the fogs that form when the cold current chills the warm air above and causes its moisture to condense.
- d) In the Sahara, the small amount of rainfall is also due to the effects of offshore winds, called the Sirocco, which blows to the Mediterranean Sea and the Hamattan which blows towards the Equator. All these winds are hot, dry and dusty.

The small amount of rain that occurs is usually of convectional type. It occurs as violent thunderstorms sometimes causing flash floods. There is little or no permanent surface water because of high evaporation rates. Other than rivers that pass through deserts the only other permanent source of water in deserts are oases which are found where the groundwater table is near the surface. Study figure 25 which shows an oasis. Notice that the whole area is dry and barren but the green plants and trees are concentrated in one place where the oasis is.



Fig 25: A typical oasis in a desert (Downloaded from <http://1.bp.blogspot.com/> on 25/5/11)

To test your understanding of the content covered thus far on the characteristics of desert regions, attempt activity 2 that follows.



Activity 2

1. Briefly explain why desert regions have the highest daily temperature ranges. [2 marks]

2. What influence do cold currents have on the desert climate? [3 marks]

Total = [5 marks]

Feedback

If you have read through this lesson well, you should have something similar to the following:

- Deserts have the highest temperature ranges because of the clear skies which allow intense heating of the land during the day and great loss of heat from the land at night.*
- Cold currents have an influence on desert climate because winds blowing across these currents are cold. These onshore winds are quickly heated up on land, and absorb moisture as they rise.*

We have discussed the climatic characteristics of the desert climate which we said are characterised by hot summers and cold winters with a high daily temperature range. Deserts also have very low rainfall. Given these conditions what kind of vegetation do you expect to see in desert regions? The next section deals with the type of vegetation found in desert regions.

2.3 Natural Vegetation

Very few plants grow in deserts. In some of the desert regions there is no vegetation cover at all. The limited amount of rainfall, high temperatures, high evaporation rates and infertile sandy soils have combined to produce an environment characterised by poor vegetation cover. The vegetation is generally described as **scrub**. Plants growing in this region have adapted to the harsh conditions. Plants found here are shrubs, coarse grasses, cactus like plants and thorn bushes.

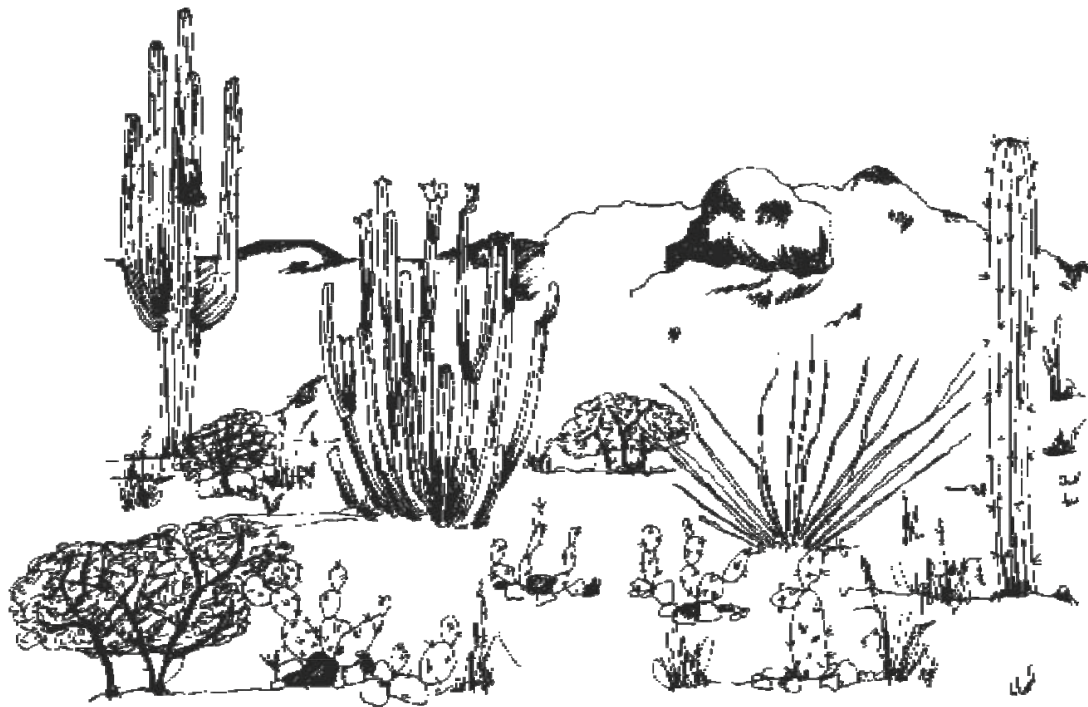


Fig 26: Plants Found in Desert Regions

A closer look at figure 26 gives us an idea of the characteristics of the vegetation of this region that makes it survive in these dry and hot conditions. These characteristics include:

- Long roots which reach for water and plant nutrients deep underground
- Few or no leaves with a thick skin and waxy surface to reflect heat and reduce transpiration.
- Storage of water by succulent plants like cacti and aloes in their thick stems or roots.
- Green stems that can photosynthesize even when in leafless
- Small hard leaves that close their pores during the dry season
- The shedding of leaves to reduce transpiration.
- Seeds with tough skins and hard shells to protect them while lying dormant for years before germination
- Thorns for protection against herbivores.

These characteristics of desert plants allow them to survive in this climate. For this reason desert plants are also known as **Xerophytes**. Intense evaporation in the desert increases salinity of the soils. Salts accumulate on the surface forming hard salt pans. Plants, which grow in these pans, are called **halophytes** (salt lovers). These plants are well adapted to such saline conditions. In some salt pans, there are no plants at all.

Now that you have covered this section of the natural vegetation of desert plants, try this activity to see how much you have learnt.



Activity 3

Answer the following questions in the spaces provided.

1. Briefly explain how the following characteristic features of desert plants enable them to adapt to their environment. [3 marks]

(a) long roots -----

(b) thick succulent stems -----

(c) few or no leaves -----

2. What are halophytes? [1 mark]

3. Why is there little or no vegetation cover in desert regions? [2 marks]

Total = [6 marks]

Feedback

The correct answers to this activity are as follows

1. (a) *long roots enable plants to search for water and plant nutrients deep underground.*
(b) *thick succulent stems store water.*
(c) *there are few or no leaves to reduce transpiration*
2. *Halophytes are plants, which grow in saline soils conditions.*
3. *Because of little or no rainfall, high temperatures that kill plants, sandy soils are poor in plant nutrients.*

Given the climatic characteristics of desert regions that we have discussed, what kind of human activities do you think takes place in this region? Read the next section to appreciate how human beings have adapted to this environment.

3.0 Human Activities

From what we have learnt so far about deserts, we can describe them as harsh or inhospitable environments. The desert regions are sparsely populated due to these harsh physical conditions. However, people still struggle against this environment to make a living. Human activities in this environment include:

- Nomadic herding, pastoralism
- Cultivation
- Caravan trading

3.1 Nomadic Herding / Nomadic Pastoralism

Some desert dwellers keep livestock and move from place to place in search of water and pastures. For example, the Tuaregs of the Sahara traditionally kept sheep, goats and camels. Camels provided transport across the desert. The camels are well adapted to this environment and provided them with some of their basic needs like meat, milk and skins. The skins were used for making tents, clothes, bags and carpets. They traded these animals and their products for necessities like grain, firearms and ammunition.

3.2 Settled Cultivators

Crop cultivation takes place around oasis and river valleys. Here crops are grown under irrigation, for example, more than 40 million people are concentrated along the Nile River where crops are grown under irrigation. Crops grown extensively include wheat, barley, cotton, rice and maize. The Nile floods do not only provide water for irrigation, but also deposit fertile soils on the flood plains

3.3 Caravan Trading

This was common in the Sahara Desert. The desert merchants travelled in caravans using camels and horses. They carried a wide range of goods like clothes, firearms, ammunition, beverages, household utensils, grains and tobacco. They bartered these for goods produced by nomadic pastoralists like carpets and rugs.

The most common types of human activities in deserts are nomadic pastoralism and cultivation under irrigation. The region as we have said have harsh conditions for human development. In the next section we will look at these factors that affect development.

4.0 Factors Affecting Development

From our discussion, you already know some of the factors affecting development in the desert environment. These factors include:

- Lack of water

- Poor or infertile soils
- Little or no vegetation cover

4.1 Lack of water

Some desert areas are not habitable because of lack of water. Water is essential for people, plants and animals. There are a few water sources in the desert such as oasis and this is where the population is concentrated.

4.2 Poor or Infertile Soils

Deserts have sandy soils, which lack plant nutrients and have a poor water holding capacity. The soils are not ideal for crop cultivation.

4.3 Little or no Vegetation Cover

This affects pastoral farming. Lack of vegetation means lack of pastures for livestock

It is ironic that the few that live in the inhospitable conditions of the desert may have a negative impact on the desert environment. This is further explained in the next section.

5.0 Impact of Human Activities on Desert Climates

In the desert, human activities have had both positive and negative impact on the environment.

5.1 Positive Impact

Some places, which are dry, are transformed into agricultural lands. This is made possible by perennial rivers running through the desert and the presence of oasis. For example, the Nile River supports a population of over 40 million. Irrigation has made it possible for people to produce crops in desert areas. Both river valleys and oasis support many settlements and their domestic animals.

5.2 Negative Impact

We have already mentioned that there is pastoral farming in the arid and semi-arid regions, particularly where there is some form of vegetation cover. Little vegetation cover has resulted in overgrazing in this area. This activity has accelerated the problem of soil erosion.

Another activity, which has had a great impact on the environment, is irrigation. Not all irrigation water is absorbed into the soil. Some of it evaporates leaving behind dissolved salt (e.g. sodium chloride) in the topsoil. The accumulation of salts in the soil is known as **salinization**. This ruins the land and often results in crop failure.

To test your understanding of the content you have covered in this section, attempt activity 4 that follows.



Activity 4

Answer the following questions in the spaces provided.

1. Briefly explain how irrigation has had a positive impact on the desert environment. [1 mark]

2. State one human activity which causes the following environmental problems.

- (a) desertification [1 mark]

- (b) salinization [1 mark]

- (c) soil erosion [1 mark]

Total = [4 Marks]

Feedback

If you have read well and understood the lesson, then I expect something similar to the following:

1. *Irrigation has made crop cultivation possible on the land otherwise regarded as useless.*
2.
 - (a) *Desertification is caused by overgrazing and deforestation which cause soil erosion.*
 - (b) *Salinization is caused by irrigation.*
 - (c) *Soil erosion is caused by overgrazing, overstocking deforestation and poor methods of farming.*

Very similar to the climatic characteristics of desert environments, are the climatic characteristics of semi-arid regions. In what way do you think semi deserts are similar to desert regions and in what way do you think they are different? To find out more, read the next section.

6.0 Semi-Deserts

Semi deserts lie on the edge or border of true deserts. As their name suggests, semi-deserts are not as dry as true deserts. They form a transitional zone between the desert and wetter climates like savanna and temperate grassland. Like deserts, semi deserts are areas of high pressure which has hot and dry air. Few people live here because the region receives low and unreliable rainfall and has infertile soils. Areas that experience this type of climate are the Kgalagadi Desert on the edge of the true Namib Desert. On the edge of the Sahara is the Sahel, a region transitional between semi-desert and savannah. Study the map in figure 27 that shows the distribution and location of semi deserts in North Africa. Notice the Sahel region.

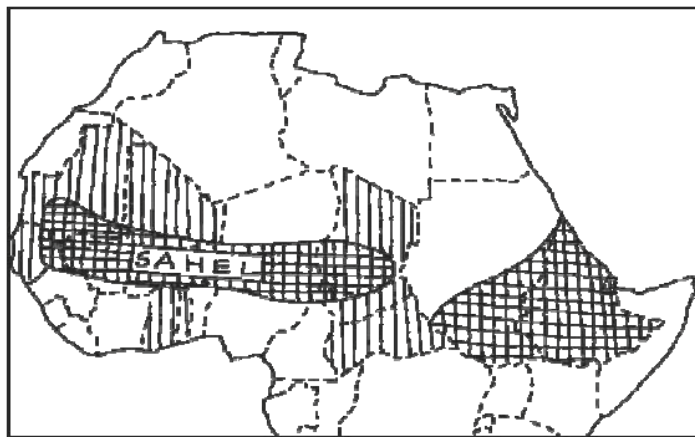


Fig 27: Distribution and location of semi deserts in Africa

We have earlier said that the main determinants of climate are temperature and rainfall. In the next two sections we will be looking at the characteristics of temperature and rainfall in semi desert regions.

6.1 Temperature

The semi desert region generally has warm summers and cold winters. Although the conditions are not as harsh as those of desert, day temperatures may be very high in summer. There is a large difference between day and night temperatures (high diurnal temperature range). This is because of the cloudless skies.

6.2 Rainfall

Semi-deserts are regions of low rainfall and high evaporation rates. The average rainfall is between 250-500 mm per year. Rainfall is mainly of convectional. The region experiences long droughts and dry winds.

Given these conditions, what type of vegetation is likely to be found in semi desert region? To find out read the section that follows.

6.3 Natural Vegetation

Short acacia, scrubs and short grass are common plants in the area. During the rainy season grasses and flowering plants may cover a wide area. These plants however last only for a short time during the rainy season. Grass withers and flowers soon fade away as the long dry season arrives. Plants here have to cope with high heat, intense sunlight, and prolonged drought in much the same way as those in desert regions. The vegetation cover in semi desert however is much better than those of the barren deserts. Study figure 28 and compare it with figure 24. Can you identify the difference and similarities between these two pictures? Notice that figure 28 has more vegetation cover than figure 24.



Fig 28: A semi desert environment (Downloaded from <http://www.pawsforwildlife.co.uk/> on 25/5/11)

Like in all other regions, there are people living in semi deserts. How do you think people living in these areas survive? You can use your notebook to briefly state how you think people live in these regions. The next section explains how people make a living in the semi desert environments.

6.4 Human Activities

Semi-deserts get comparatively higher rainfall than true deserts. For this reason semi deserts support a variety of plants and animals. They may have good grazing areas after the rains that allows for livestock and large game. The traditional inhabitants of this region were largely hunter-gatherers and nomadic pastoralists.

a. Hunting and Gathering

In Southern Africa, Basarwa are traditional inhabitants of this region. They lived by hunting wild animals with bows and arrows and gathering wild fruits, berries, melons and nuts, as well as insects. They obtained water from dew, sip wells, plant roots and desert melons. They used tortoise and ostrich shells for storing water. Their clothes were made from animal skins. Fire was used for roasting meat and for keeping them warm in winter.

b. Normadic Pastoralism

Livestock are raised in semi-arid regions. Farmers rear cattle, goats, sheep, camels and donkeys. The Tuaregs of Sahel are shepherds who move from place to place looking for water and pastures. They ride camels and keep sheep and goats.

c. Tourism

The presence of wild animals has led to the establishment of game parks such the Kgalagadi Trans-frontier Park and Central Kgalagadi Game Reserve. There are game ranches in the region, as wild animals can adapt to the dry desert conditions better than domestic animals

d. Crop Production

Cultivation of drought resistant crops like sorghum, beans, millet and watermelons is done. Crops that need more water like vegetables, fruits and cotton can only be grown under irrigation.

The human activities in desert regions therefore can be listed as crop cultivation, irrigation, animal rearing, tourism and hunting and gathering. These human activities have had a negative impact on the environment. One of the major environmental problems in semi deserts is desertification, whereby these regions are slowly being turned into true deserts. The Sahel and the Kgalagadi Desert are becoming true deserts due to land degradation caused by a combination of drought, overgrazing by livestock and firewood collection. To learn more about semi desert regions read the case study on the Kgalagadi Desert that follows.

Case Study: The Kgalagadi Desert

The Kalahari Desert is a large arid to semi-arid sandy area in Southern Africa covering much of Botswana parts of Namibia and South Africa. The Kalahari supports some animals and plants because it is not a true desert, as some parts of the Kalahari receive over 250 mm. When it rains, water collects in ancient river beds and pans including large salt pans like Makgadikgadi Pans and Etosha Pan. Temperatures are high in summer.

The Kalahari has a number of game reserves such as Khutse Game Reserve. Animals that live in the region include wild dogs and cats, herbivores, antelopes, birds and reptiles. The vegetation is largely grasses and acacia but over 400 different plants have been identified.

Basarwa are the traditional inhabitants of the Kgalagadi who survive by hunting and gathering. There are also some Batswana, Baherero, Bakgalagadi and Europeans living there. They have built settlements such as Ghantsi in Botswana, Gobabis in Namibia and Rietfontein in South Africa in these semi desert regions.

Now that you have learnt more about semi desert regions, attempt Activity 5 that follows to see how much you have understood.



Activity 5

1. The Kgalagadi Desert spreads into 3 countries. Which countries are these? [3 marks]

i. -----

ii. -----

iii. -----

2. List at list two differences and two similarities between desert and semi-desert climates [2 marks]

a. Differences

i.-----

ii.-----

b. Similarities

i. -----

ii. -----

3. What is desertification? [1 mark]

Total = [6 marks]

Feedback

1. *Botswana, Namibia and South Africa*
2. *a. semi-deserts get higher rainfall, and have more vegetation cover*
b. large daily temperature range, and xerophytes
3. *Encroachment of desert like conditions into neighbouring areas*



Summary

7.0 Summary

The desert environments cover a large area. The Sahara in Africa is the world's largest desert. In Southern Africa we have the Kalahari and Namib deserts. We have learnt that semi-desert or semi-arid regions lie on the fringes of the desert. The deserts are characterised by low or no rainfall, which hardly exceeds 250 mm. In the semi-arid regions annual rainfall ranges between 250 mm and 500mm. Daytime temperatures are extremely high due to intense insolation (heating up), while night temperatures are much lower because of rapid loss of heat by radiation. Winter nights are extremely cold with temperatures often falling below 0°C. In Africa, the greatest temperature extremes are experienced in the Sahara areas due to clear skies.

Vegetation in semi deserts and desert regions is very sparse or scanty. The major type of vegetation is scrub, thorny acacias and bushes, short coarse grasses and cactus. These plants have characteristic features which enable them to stand the harsh environmental conditions. Human activities include crop cultivation under irrigation in oases. The Nile valley is a good example where crops like cotton; sugarcane, rice, maize, wheat and tobacco are grown. There are nomadic herdsmen like the Tuaregs of the Sahara who keep sheep, goats, camels and horses. Human activities have both a positive and negative impact on the environment. Desert areas which were otherwise regarded as useless have been transformed into agricultural and settlement areas with the use of irrigation. On the other hand, overgrazing of livestock is increasing the problem of desertification particularly in the semi-deserts.

There is an assignment for this topic at the end of the unit. Please make sure you attempt that assignment to reinforce what you have learnt. After completing the assignment look at the feedback provided to see how well you have done. In the next topic we are going to look at yet another climatic region that is found in Africa, which is the Mediterranean climate.

Topic 5: Mediterranean Climate

Introduction

In the previous topics you have covered four climatic regions so far. In all these climatic regions, we discussed the climatic and vegetation characteristics. We also looked at human activities and their impact on each environment. In this topic, we are going to look at the two climate regions: Mediterranean and warm temperate continental climates. Our first part of the topic will cover the Mediterranean climate. At the end of this topic you should be able to give a comparison of all these climatic regions.

Topic Objectives

At the end of this topic you should be able to:

- identify and locate on a map the Mediterranean and warm temperate continental climatic regions
- discuss the climatic and vegetation characteristics of each climatic region
- discuss human activities in each climatic region
- discuss and describe the impact of human activities on the environment

1.0 Location and Distribution

The Mediterranean climate is so named because most of the areas with this type of climate are found along the Mediterranean Sea. This climate type is also known as the warm temperate eastern margin. Study the map in figure 29 which shows the location and distribution of the Mediterranean climate in Africa.

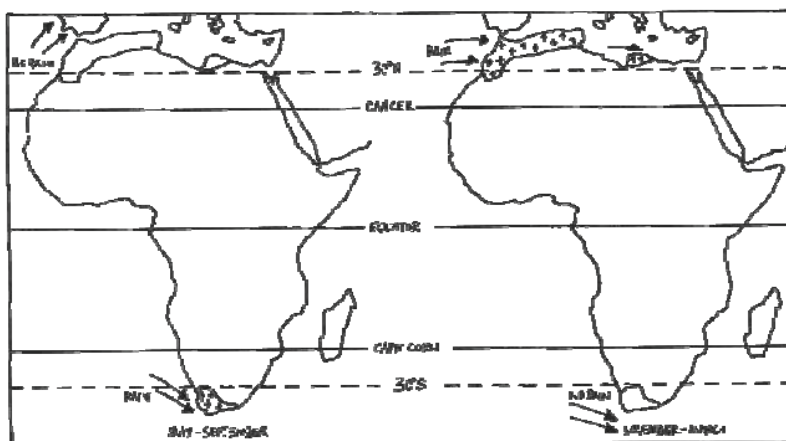


Fig 29: Location and distribution of Mediterranean climate in Africa

From this map, you can see that the Mediterranean climate is found in relatively few areas. It occurs between latitudes 30°N and 45°N and 30°S and 45°S on the western sides of the continents, especially lands bordering the Mediterranean Sea. In Africa, it is best developed in the coastal northern parts of Algeria, Morocco, Tunisia and Egypt in the northern hemisphere and also in South Western Cape (South Africa), in the southern hemisphere.

2.0 Climatic Characteristics

The Mediterranean type of climate is characterised by sunny, warm to hot, dry summers and cool to warm, wet winters. The graphs in figure 30 (a) and (b) show climatic characteristics of two areas in the Mediterranean region. Figure 30(a) shows an area in the northern hemisphere while figure 30(b) shows an area in the southern hemisphere.

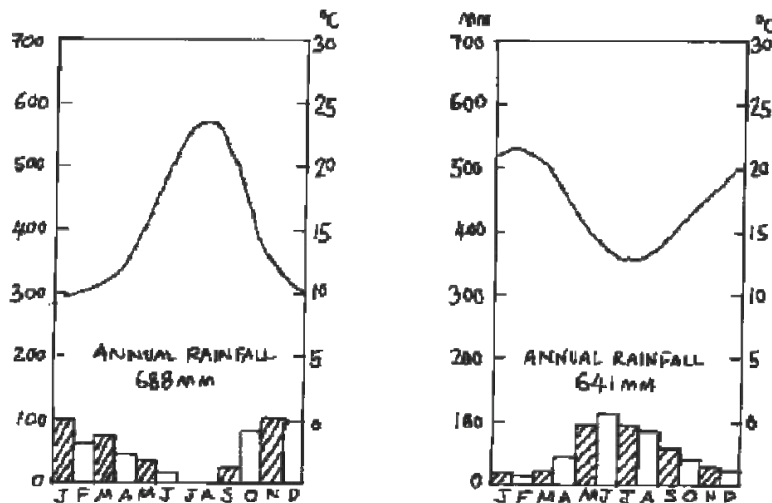


Fig 30 (a) and (b): Typical Climatic Conditions in Mediterranean Regions (Adapted from <http://www.scalloway.org.uk> on 25/5/11)

Notice that in both graphs rain falls when temperatures are low. These are winter months in the two hemispheres. What more can you say about the temperature and rainfall in this regions? To find out read the next two sections that follows.

2.1 Temperature

Mediterranean regions are located near large bodies of water. For this reason there is a relatively small difference between summer and winter temperatures. These regions have mild winters and summer temperatures range from mild to very warm. The average temperatures range from 21°C in summer to 10°C in winter. Temperature increases from warm to hot as one moves further away from the coast towards desert regions. Hot winds from the desert increase temperatures of this region and increase the risk of veld fires. Generally the temperatures of this region are warm and mild and therefore good for human settlements and for tourism.

2.2 Rainfall

From the climatic graph in figure 30 (a) and (b), you can see that rainfall occurs when temperatures are low. The most interesting and unique feature of this climatic region is rain that falls in winter. Dry off shore winds from deserts blow in summer. In the northern hemisphere these hot, dry and dusty winds are called Sirrocco winds. Summers are therefore dry with cloudless skies. On shore westerly winds blow in winter bringing cyclonic rainfall. The region receives annual rainfall of about 500 mm to 750 mm. Areas near deserts get less rain while those near the sea get maximum rainfall. Rainfall may come as heavy showers which sometimes cause floods.

Given the type of climatic characteristics that we have discussed, what type of vegetation do you think grows in the Mediterranean region? Find out from the section on natural vegetation that follows.

2.3 Natural Vegetation

The natural vegetation of the Mediterranean region is classified into three groups, the evergreen trees or woodlands, shrubs and grasses. Evergreen trees are found in areas that receive more rainfall. They include cork oak, pine, cypress and eucalyptus. Under the trees are shrubs. Shrubs dominate in drier areas. These shrublands are called marquis in North Africa and fynbos in South Africa. They include sweet smelling herbs such as lavender, rosemary, thyme and oleander. Some of these names must be familiar to you because they are used for making sweet scents used in perfumes, lotions and bath soaps. Tough grasses and flowers also grow in this region. Study figure 3 that shows the vegetation of the Mediterranean region.



Fig 31: Typical Mediterranean Vegetation (Downloaded from <http://www.dubrovnik-online.com> on 25/5/11)

The natural vegetation of Mediterranean lands has adapted to survive long, hot and dry summers. They have many of the characteristics of desert plants hence they are also called xerophytes. The following characteristics enable them to survive:

- Plants tend to be less than a meter tall and relatively shrubby in appearance.
- They grow briefly after winter rains, then survive the dry summer in the form of seeds.
- The woodland has evergreen leaves, but the leaves are often small, curled, with the stomata hidden among numerous hairs on the bottom side of the leaf.
- Many of the plants contain numerous volatile chemicals such as turpentine that prevent herbivores that retard their growth.
- Many species are fire resistant. Some like cork trees have thick heavy bark others have underground roots and seeds that survive fires.

To test your understanding of the content that you have covered on the climatic characteristics of the Mediterranean region, attempt activity 1 that follows.



Activity 1

Study the climatic graphs in figure 32 and answer the following questions.

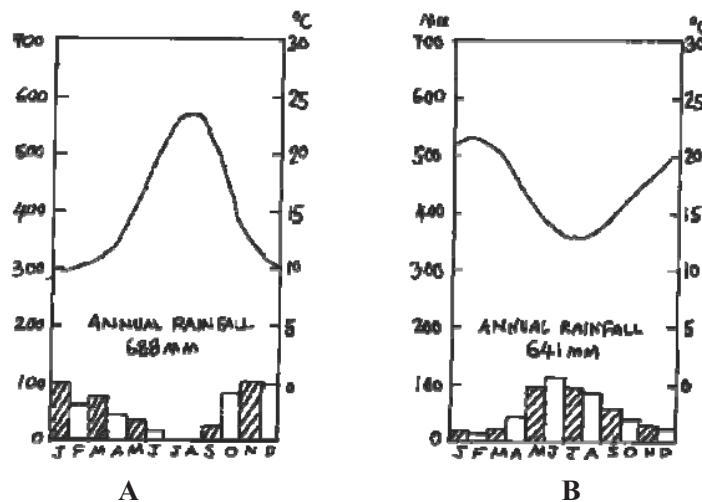


Fig 32. Typical climate graphs of the Mediterranean region (Adapted from <http://www.scalloway.org.uk> on 25/5/11)

- In which hemisphere is the climatic station? [2 marks]
A -----
B-----
 - What is the annual temperature range of climatic station?[2 marks]
A -----
B-----
 - What are the main characteristics of the Mediterranean climate?
[2 marks]

(d) What type of rainfall is mostly experienced by the Mediterranean region?
[1 mark]

(e) What is the most unique climatic characteristic feature of the Mediterranean region?
[1 mark]

2. State 2 types of vegetation found in the Mediterranean region.

[2 marks]

Total = [10 marks]

Feedback

1. (a) A Northern hemisphere

B Southern hemisphere

(b) A 14°C to 14.12°C

B 8.5°C to 9°C

(c) warm to hot dry summer and cool to mild wet winters

(d) cyclonic

(e) winter rainfall

2. Mediterranean woodland

Mediterranean scrub

Pine, cypress, cork oak, grass & herbs

Having discussed the temperature and rainfall characteristics as well as the natural vegetation of this region, let's now move onto the human activities topic.

3.0 Human Activities

Agriculture is an important activity in the Mediterranean region as the climate permits a variety of crops to be grown. Below are some of the activities in the region.

3.1 Orchard Farming

The Mediterranean is well known for orchard farming and as a result it is often referred to as the world's orchards land. A wide range of fruits, especially citrus fruits such as oranges, lemons, limes, citrons and grape fruits are grown. Olive trees are also grown extensively to produce olives that are processed into olive oil.

3.2 Crop Production

Cereals are grown extensively, especially wheat and barley. A wide variety of nuts like chestnut, walnut, hazelnuts and almonds are grown. Other crops include tobacco, cotton and figs.

3.3 Viticulture

The Mediterranean specialises in viticulture, which is the cultivation of grapes. Most grapes are used for making wine, while some are dried into raisins, currants and sultanas.

3.4 Livestock Rearing

Livestock such as sheep, goats and cattle are also kept in the Mediterranean region.

3.5 Tourism

As mentioned earlier, the bright sunny weather attracts tourists, particularly from cold countries. The Mediterranean coastal areas are therefore densely populated and more developed than the interiors.

3.6 Agro-industries

Agriculture has given rise to specialised industries such as wine making, flour milling, fruit canning and food processing.

You must have realised that the Mediterranean region is well suited for a variety of human activities. Like all other regions these human activities have had an impact on the environment. Although there are positive effects of human activities on the environment, you will realise that in most cases humans have had a negative impact on the environment.

4.0 Impact of Human Activities on the Environment

Most natural vegetation in the Mediterranean areas has long since been cleared. Some trees in the region have been cut down because they are valued for their softwoods. Vegetation has been cleared to give way to farms and for human settlement. The warm climate that is near the coast is desirable for settlement hence some of the major cities are found in this region. Overgrazing by goats and sheep has led to the dominance of scrub vegetation and also soil erosion. For this reason the natural evergreen open woodland has been reduced to scattered woodland and shrubs.

People have also had a positive impact in preserving some of the natural vegetation. For instance cork oak trees are valued for their cork products. Cork plantations have been established to grow cork oak trees so as to harvest cork for commercial purposes. This helps maintain the land in cork oak and thus protect the other plants growing in the shade of the oaks.

Now that you have completed the sections that were dealing with vegetation and human activities of this region, this is the right time for you to do the next activity.



Activity 2

Answer the following questions in the spaces provided.

- Which human activities have degraded the Mediterranean forests into scrub vegetation? [2 marks]

- How has the scrub vegetation adapted to its environment? [4 marks]

- Briefly discuss the relationship between:
(a) Tourism and climate [2 marks]

(b) Vegetation and climate distribution [2 marks]

Total = [10 marks]

Feedback

1. (a) *lumbering , overgrazing, clearing land for cultivation.*
2. *Long roots to reach water deep underground,*
Bulbous roots to store up water,
Small leaves with waxy surfaces / few stomata to reduce transpiration,
and thick back to reduce transpiration.
Some plants roll their leaves to reduce transpiration.
3. (a) *The bright sunny weather of the Mediterranean attracts many tourists, especially from cold countries.*

(b) *The wetter parts of the Mediterranean have forest vegetation while the drier parts have scrub vegetation.*

Let us now look at the last of the climatic regions of Africa, which is the warm temperate continental climate. What kind of climate do you think this is and where is it found in Africa?

5.0 Warm Temperate Continental Climate

The Warm Temperate Continental Climates which are sometimes called Temperate Grasslands or **Steppe** are found inside the continents between latitudes 20°N and 35°N and 20°S and 35°S. In Africa it is best developed in South Africa between the Drakensberg Mountains and the Kgalagadi Desert in an area that includes Gauteng Province, North West, Free State, Lesotho, Mpumalanga, Swaziland and Limpopo Province. It covers 30% of South Africa's land area and is popularly known as the High Veldt. Study the map on figure 33 showing the location and distribution of this type of climate in Africa.

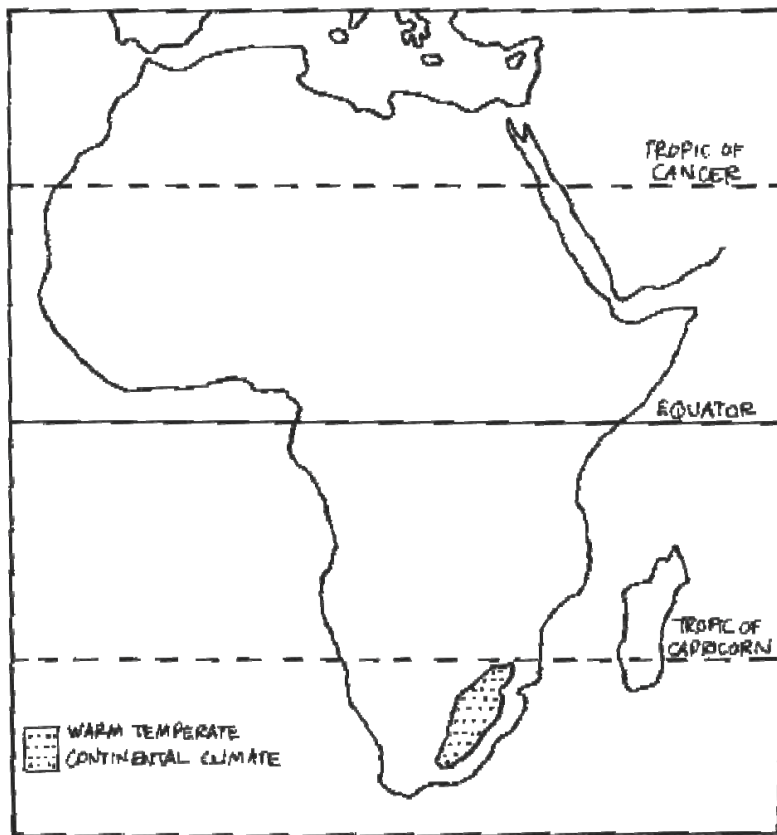


Fig 33: Location and distribution of the warm temperate continental climate

5.1 Climatic Characteristics

The graph in figure 34 is an example of a station experiencing **the warm temperate continental climate**. Study the climatic graph of Pretoria carefully in order for you to fully understand the area's climatic characteristics.

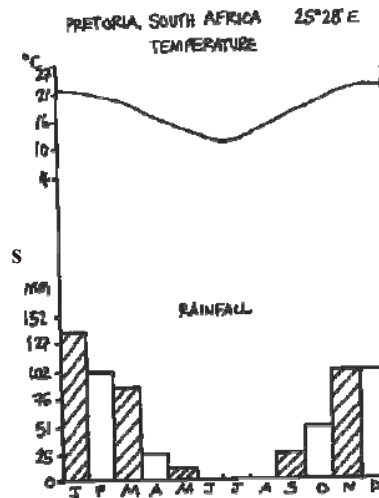


Fig 34: Climatic conditions in a typical temperate continental climate (Data compiled from table in [http://www.findtripinfo.com/assets/Africa/south_africa/gauteng-climate.](http://www.findtripinfo.com/assets/Africa/south_africa/gauteng-climate/)) on 25/5/11

Temperate grasslands have cold winters and warm summers with rain. As you can see in figure 34, the annual temperature range from 10°C in winter to 26°C in summer. The annual temperature range is high. The South East Trade Winds blow in the region bringing cyclonic rainfall of between 400 mm and 780 mm. Rainfall is higher in eastern areas close to the sea but decreases westwards towards the desert. Convectional rainfall also falls due to the hot summer conditions. The wettest months are from November to January while from June to August are the driest.

5.2 Natural Vegetation

The natural vegetation is mainly grass, sometimes called temperate grassland or steppe. In Southern Africa it is called the veldt or veld, pronounced as “felt”, which is a Dutch word meaning “field”.

The veldt has a few scattered trees. Grasses are much shorter, tough and less nutritious, especially in the drier areas. The grasses, along with other plants, such as herbs, form a continuous cover, except in areas where there is sufficient ground water to support clumps of trees. Grass wither and die in the dry season. The roots do not die but produce new stems during the rainy season. In the wetter regions and along rivers and streams the grasses are tall and nutritious.

Now let’s look at the human activities given its climate and natural vegetation.

5.3 Human Activities

The grassland is a good grassing land. Agriculture in this region is dominated by extensive grain production and pastoral farming.

a. Crop Production

The temperate grassland is a good area for wheat production. The flatland is good for ploughing and harvesting using machines. Most of the world wheat is produced in these regions. Crops grown in the Highveld include wheat, maize, sorghum, citrus fruits, groundnuts and sunflower. Vegetables are grown in irrigated areas and farmland closer to urban areas.

b. Pastoral Farming

The grassland is ideal for pastoral farming. Animals such as beef cattle, sheep, goats, pigs and horse are kept in ranches. Dairy cattle are kept for the production of milk, butter, cheese, cream and skimmed milk. Fodder crops like Lucerne and Alfalfa grow well in this region and are grown to feed livestock.

These activities have had an impact on the environment. To find out how they have affected the environment read the next section.

5.4 Human Impact on the Environment

All activities we have discussed have a great impact on the environment. In the drier parts of the veldt, there is a problem of overgrazing which is caused by overstocking. The resulting environmental problem is soil erosion. Intense use of land for crop cultivation and the use of heavy machinery have led to soil erosion too. Droughts and veldt fires have worsened this problem.



Summary

6.0 Summary

So far you have learnt that the Mediterranean climate is characterised by warm to hot, dry summers and cool to mild, wet winters. The most unique feature of this climate is winter rainfall which is brought about by the effect of the westerlies. These winds blow onshore in winter bringing cyclonic rainfall varying from 250mm to 800mm.

Summers are dry because of the hot dry wind from the desert regions. Summer temperatures are around 21°C while winter temperatures are about 10°C. The natural vegetation consists of forests in wetter areas and scrub in the drier areas. Human activities such as lumbering and overgrazing have greatly reduced the density of forests. Important human activities include orchard farming, viticulture, cereal and nuts cultivation, agro-based industries and tourism.

The warm temperate continental climate is also known as steppe. Temperatures in this region range from 10°C in winter to 26°C in summer. The annual rainfall varies from 380mm to 700mm. Rainfall is brought by the southeast trade winds which blow onshore in summer. These winds lose moisture as they blow westwards. Consequently, rainfall decreases from east to west. The convectional type of rainfall, which occurs, is due to the low-pressure system in this region. The vegetation here is mainly grass. In South Africa, this grassland is known as the “veldt”. This environment is ideal for pastoral

farming. Crops like maize are grown extensively. Other crops grown include wheat, sorghum and sunflower. Lucerne (alfalfa) is grown to feed livestock. Soil erosion is the main environmental problem caused by overgrazing, intensive use of land through crop cultivation and veldt fires.

Now that you have completed this topic you need to do the assignment at the end of this unit. Your knowledge of this topic will help you to do that assignment. Feedback is also provided to guide you. Once you are finished with the topic assignment proceed to the unit summary to consolidate your knowledge of this unit.

Unit Summary



Summary

In this unit you learnt about climate. We began the unit by looking at the climate types of Botswana. We said that Botswana is divided into three climatic regions of tropical sub-humid, semi-arid and arid. The dominant type is the semi-arid climate. Hence, the country is often said to be semi-arid. From Botswana we went on to look at other climatic regions of Africa. We began by discussing the equatorial climate which is characterised by uniformly high temperatures and rainfall throughout the year. This climate has led to the luxuriant vegetation called the rainforest. We then discussed the tropical continental climate which is commonly known as the savanna because tall grasses are the dominant feature of its vegetation. In general, the tropical continental climate has hot and wet summers but cold and dry winters. The desert and semi desert climates are dry climate characterised by low rainfall. These regions experience cool winters and very hot summers. Because of lack of cloud cover, the differences between day and night temperatures are very high. We also looked at the Mediterranean climate which receives its rainfall in winter. Generally its summers are hot and dry while winters are cold and wet. We finally discussed the warm temperate continental climate which occurs in the high veldt area of South Africa and is characterised by fairly treeless grassland.

Now that you have completed this unit you need to do the assessment that follows. This assessment is meant to help test how much of this unit you have understood. After completing the assessment send it to your learner support centre where your tutor will mark it and give you feedback. If you do not do well in the assessment, do not worry. Review the unit again and have another go at the assessment until you are comfortable with your performance.

Before you move on however, having learned about different climates, let's take a moment to imagine your ideal climate. Which climate did you think of? Discuss your choice with your peers and teacher or tutor.

Assignment



Assignment

You will find the relevant topic assignments here. Make sure to complete these after completing the topic. Feedback is provided at the end. If you find that you have not done well in any of the topic assignments, go over the topic till you master it. Don't worry too much about time you spend on these. What is important is for you to master each topic.

Topic 1: Botswana's climate

1. What type of climate exists in Botswana? Describe the climatic characteristics of Botswana's climate.

Topic 2: The equatorial climate

1. (a) How does the climate, character of vegetation and condition of the land surface make the extraction of trees difficult in equatorial forests? [3 marks]
- (b) State **four** ways, other than lumbering, in which interference by people has affected the distribution of the equatorial forest. [4 marks]

Topic 3: Tropical savanna climate

1. Briefly describe and explain how vegetation is distributed in the savanna region. [4 marks]

Topic 4: Tropical desert climate

1. What type of vegetation is in a desert region? Describe the characteristic features which enable it to adapt to this environment. [5 marks]
2. How have desert plants adapted to their climate? [4 marks]

Topic 5; Mediterranean climate

3. Describe the four main human activities of the Mediterranean region. [8 marks]

Feedback

Topic 1

Botswana's climate is the semi-arid type. Its characteristics include:

-
- Low rainfall of between 250 – 600mm per year
- Rain comes in summer
- Rainfall is unreliable and is unevenly distributed
- Temperatures are high in summer and low in winter
- May be as high as 40°C in summer and as low as 0°C in winter
- High daily temperature range in extreme south western Botswana

Topic 2

1 (a)

- Difficult to work under hot and wet conditions.
- Thick forest making the felling and transportation of trees difficult.
- Wet / muddy surface.

(b)

- Shifting cultivation
- Mining
- Settlement
- Plantation agriculture

Topic 3

1. Savanna woodland and tall grasses (2-3m) occur near the equatorial region because of higher rainfall. Near the desert, where rainfall is lower, there's coarse grass, which is shorter with scattered trees.

Topic 4

1. Desert plants have:

- long tap roots to absorb water deep underground.
- few or no leaves to reduce transpiration.
- store water in roots, stems, leaves e.g. succulent plants.
- leaves with thick skins and waxy surfaces to reduce transpiration.

2. Scrub vegetation.

- Long tap roots to reach water deep underground.
- Thick succulent stems to store water.
- Few or no leaves to reduce transpiration.
- Leaves with waxy and thick surface to reduce transpiration.

Topic 5

1. Human activities in the Mediterranean region include:

- Crop cultivation
- Viticulture
- Orchard farming
- Lumbering
- Agro-Industries

Assessment

Answer all the questions in this Assessment Exercise. The time allocated is 45 minutes. When you are finished please send your answers to your tutor to have marked.

1. Study the climate map of Botswana in **figure 1** and answer the following questions.

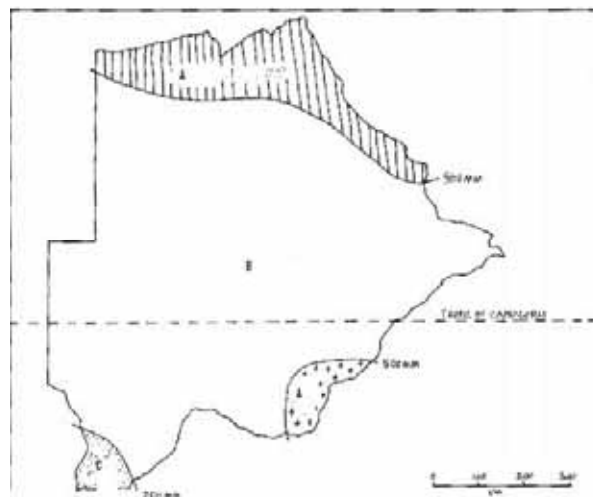


Fig 1: Climate map of Botswana

- (a) Name the climate environments of Botswana marked A, B and C. [3 marks]
 - (b) Which climatic region receives the lowest amount of rainfall? [1 mark]
 - (c) Describe the annual temperature range of the region that receives the lowest rain. [2 marks]
2. Study the climatic chart for Gaborone in **figure 2** and answer the following questions.

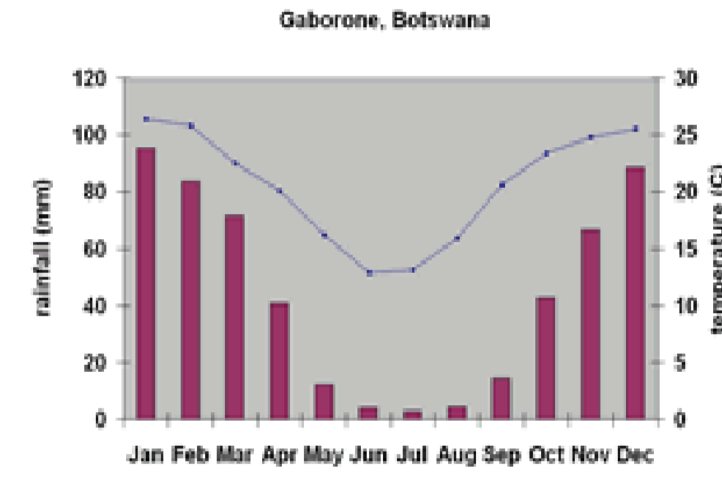


Fig 2: Climatic chart for Gaborone

- (a) State the months in which evaporation is at its highest and lowest. Give reasons for your answers. [4 marks]
3. (a) What negative impact does tourism have on the environment? [2 marks]
4. Study the climatic graph in **figure 3** and answer the following questions

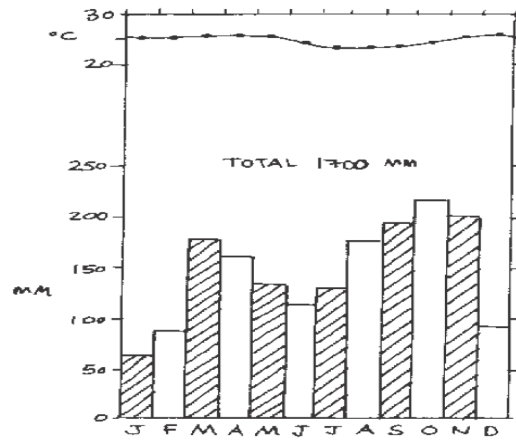


Fig 3: Climatic chart of an equatorial area (Adapted from <http://intranet.st-peters.york.sch.uk/fileadmin/subjects/geography> on 25/5/11)

- (a) Describe the main features of rainfall and temperature. [6 marks]
 - (b) State and explain the annual temperature range for such regions. [2 marks]
 - (c) Name the type of rainfall often experienced in such regions and explain why it occurs. [2 marks]
 - (d) Name **two** areas in Africa where this type of climate is experienced. [2 marks]
 - (e) What impact does deforestation have on the equatorial environment? [4 marks]
5. Study the climatic graph in **figure 4** and answer the following questions.

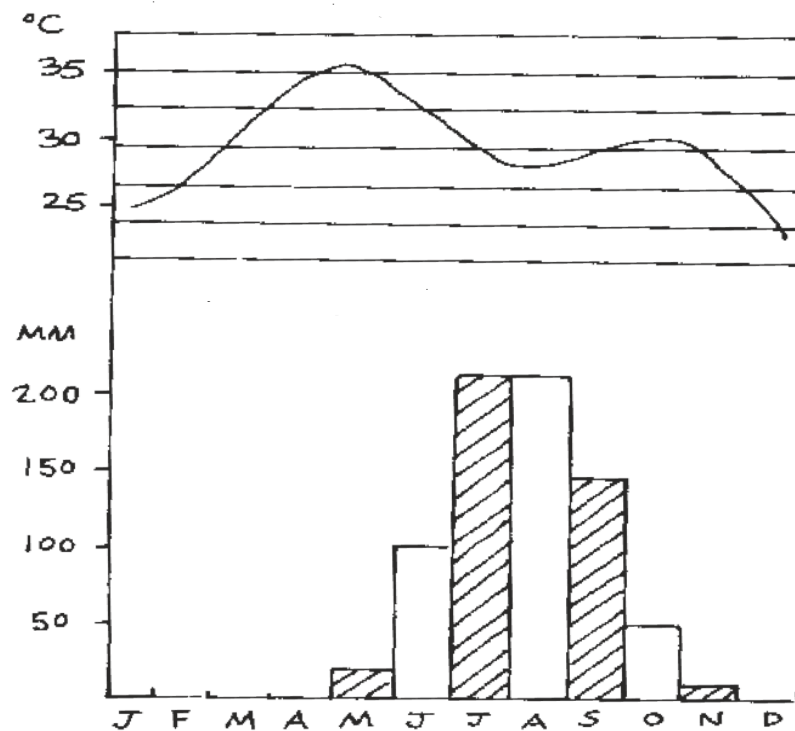


Fig 4: Climatic graphs of a town in the Savanna (*Adapted* on 25/5/11 from www.eldoradocountyweather.com/.../Kayes.html)

- (a) In which hemisphere is this station? [1 mark]
 - (b) Describe the rainfall distribution throughout the year as shown in this graph. [3 marks]
 - (c) What is the annual temperature range shown by this graph? [1 mark]
 - (d) Name **one** town in Africa, experiencing this type of climate [1 mark]
6. (a) Explain why livestock rearing is the main activity in the savanna. [2 marks]
- (b) What is the main tourist attraction in the savanna? [1 mark]
- (c) State one impact of cattle farming and tourism on the savanna environment. [3 marks]

7. (a) What is the Sahel? [1 mark]
8. (a) Why do hot desert areas experience a large range of diurnal range of temperature? [2 marks]
- (b) Which human activities have transformed desert areas into habitable areas? [2 marks]
- (c) Which human activity increases the problem of desertification in semi-deserts? [1 mark]
- (d) Desert plants can be described as xerophytes because of their characteristic features which enable them to adapt to their environment. What are xerophytes? (1mark)
9. (a) Name the type of vegetation found in the wetter parts of the Mediterranean regions. [1 mark]
- (b) Briefly describe how human activities have affected this vegetation. [2 marks]
10. (a) Briefly describe the climatic characteristics of the warm Temperate Continental region. [2 marks]
- (b) What name is given to the temperate grassland of South Africa. [1 mark]
- (c) Explain how climate influences the distribution of this vegetation [2 marks]
- (d) Briefly explain the impact of pastoral farming on the veldt. [2 marks]

Total = [56 Marks]

ANSWERS TO THE ASSESSMENT EXERCISE

1. (a) A Tropical sub-humid climate.
B Semi-arid or semi-desert climate.
C Arid or desert climate.
(b) The desert or arid or south western part receives the lowest amount of rainfall.
(c) The annual temperature range for this region is very high.

2. (a) Evaporation is highest in December/January and lowest in June /July. Evaporation rate is highest when temperatures are high and lowest when temperatures are low.

3. (a) Negative impact of tourism
 - Littering or land pollution
 - Poaching and threatening some animals with extinction

4. (a) **Rainfall features**
 - Heavy rainfall throughout the year.
 - Two wetter periods occurring before the equinoxes.
 - Convectional type of rainfall, accompanied by thunder and lightning.
 - Annual rainfall amount of about 2 000 mm.**Temperature**
 - High temperatures
 - Uniform temperatures
 - Mean daily temperatures of about 26°C.
 - Low / small temperature range of about 3°C.

(b) The temperature range is about 2.5°C or 3°C. The temperature range is small because temperatures are uniformly high.

(c) Convectional type of rainfall because of high temperatures which cause intense heating of the ground and evaporation.

5. (a) It is the Northern hemisphere
(b) The rainfall is mainly in summer in the months of July and August.
(c) The annual temperature range is about 12^o
(d) Any town in the northern hemisphere which is in the Savanna region.

6. (a) Livestock rearing is the main activity because the savanna grasses provide good grazing lands.
(b) Wildlife is the main tourist attraction.
(c) Impact on the environment:
 - (i) Cattle farming overgrazing of livestock leads to soil erosion.

- (ii) Tourism and poaching threatens the existence of some wildlife leading to endangered species

7. The Sahel is the Savanna semi-arid area bordering the Sahara Desert.

8. (a) Deserts experience a large variation of diurnal temperatures because day – time temperatures are extremely high due to intense insolation, while night temperatures are extremely low due to rapid loss of heat by radiation. All this is caused by lack of cloud cover (clear skies).

(b) Mining and Agriculture / crop cultivation under irrigation.

(c) Nomadic pastoralism or nomadic herding

(d) Drought resistant plants

9. (a) Mediterranean forest / woodland or coniferous forest.

(b) Deforestation through lumbering and crop cultivation has greatly reduced the forest into scrub vegetation.

10.(a) Hot summers and cool winters.

Temperatures ranges from 10°C in winter to 26°C in summer and convectional rainfall. The total rainfall amount varies from 380mm to 700mm

(b) Veldt

(c) Drier areas of this region have short course grasses and the wetter parts have tall, nutritious grass.

(d) Pastoral farming has led to overgrazing, which in turn causes soil erosion.



Reading

List of References

For further reading you should visit your study centres or your nearby library. These areas are well equipped with Geography books. Some of the books you may want to read include:

1. Silitshena & McLeod, 2003, *Botswana: a physical, social and economic geography*, Longman
2. May D, 1998, *Geography of Botswana*, Macmillan

3. R.B Bunnett, *General Geography in Diagrams for Africa*,
4. Collin Buckle, *Weather and climate*, Longman
5. Namcol, *Geography Unit 1 Grade 11-12*, Cambridge University Press
6. Pallister et al, *Longman Geography for GCSE*, Longman
7. Adam Arnell, *Geography Dictionary 11-14*, Letts Publishers
8. Collins, *Geography Basic Facts*, Harper Collins Publishers

Unit 5

Utilisation and Management of Water Resources

Introduction

Welcome to Unit 5 on the utilisation and management of water resources. The unit is meant to develop an appreciation for sustainable utilisation and management of water resources in the country. You have learnt about water since your primary schooling. You have also covered water as a topic in your junior secondary education. You may also have noted that water is a common topic to almost all subjects, particularly science, agriculture, social studies, development studies. The study of water does not end here, It goes on even at the university level. Water is also an important political, economic and social subject. You may have heard about agreements signed by countries on the use of shared water resources. All this shows that water is essential for life.

The unit is made up of three topics. In Topic 1, you will learn about the water cycle, its structure and processes involved. Topic 2 covers sources of water in Botswana and the importance of water to human activities. We will also look at factors that make water a highly demanded resource and why it is a scarce resource in Botswana. Furthermore, it will discuss water as an internationally shared resource especially between Botswana and her neighbours Namibia, South Africa, Zimbabwe and Zambia. In the last topic we will discuss and assess water management strategies adopted in the country.



Outcomes

Upon completion of this unit you will be able to:

- describe the process of the hydrological cycle or water cycle.
- identify the sources of water in Botswana.
- explain the significance of water resources to human activities
- discuss the factors that make water a scarce resource while the demand is high in Botswana
- assess the negative impact of human beings on water resources
- discuss water management strategies adopted in Botswana and at a regional level to ensure water conservation in the region
- discuss the role of Environmental Impact Assessment in environmental conservation especially in relation to water conservation

Time

You will need two (2) hours to study each topic. Note that this unit has 3 topics and that means you will need a total of 6 hours to study the whole unit. The time for the self-assessment exercise for a topic is inclusive in the 2 hours. You might finish studying the topic in less than two (2) hours or exceed your study time as this is determined by your reading pace and understanding of the lesson. On completion of the unit, you are required to do an assignment. The assignment is divided into 3 self-assessment exercises. Each exercise is for a particular topic. It should take you 30 minutes to do each assignment. You therefore need a total of 1 hour 30 minutes to do this assignment. To further test your understanding of the unit, you must do a tutor marked assessment exercise. The assessment should take you about 1 hour to complete.

Teaching and Learning Approach

In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experience or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. There is a variety of information that you can use to learn more about important concepts in tourism. Most libraries in your country do have some information on water resources. There are some magazines, pamphlets, books, etc which contain important information on tourism. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near any water offices like water affairs or utilities you are advised to collect any relevant information from such offices. If you have access to the Internet, you may look for relevant information. Remember to refer to topic objectives when searching for relevant information. Do not worry yourself if you have no access to the internet, content provided in each topic is adequate. If you are registered with any distance education provider, you are advised to make use of

their learner support components such as study centres, tutorials, radio programmes and counselling support.

Study centres are resourceful because you may have access to additional resources maps and relevant videos. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any difficulties you are experiencing in this unit. Remember that amount of time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or before you attend tutorials. This will help you raise questions on difficult areas of your study materials.

I would like to once again emphasise that, active learning or participating effectively throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions will you be in a better position to realise that this unit forms the basis of other units on utilisation and management of other resources which are covered in units 7 to 10.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the information relevant to different sections of the topic and form part of your learning. They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately below the activity. If you cannot do well in the activities do not be discouraged, you may revise the section related to the activity and later carry on with the more concentration. You are advised to revise the sections you did not do well before continuing with the topic.

On completion of each topic, you are advised to go to the assignment section found at the end the unit. You will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score lower marks you must not be discouraged, appreciate the marks and try again by going over the topic and the exercise.

The assignment self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the assignment. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, you can then go on to the next unit.

Glossary

At the beginning of this unit there is also a glossary of words that have been used in the unit. These are words which might be difficult for you to understand. The words are explained in simple ways or terms in this

unit. You are also encouraged to refer to dictionaries available in the local libraries and study centres.



Terminology

Conservation:	the wise use of natural resources by the present generations. This is meant to leave natural resources in stock for next generations.
Condensation :	This is the process whereby water vapour changes back into liquid water (water droplets)
Ecosystem:	a give community of animals, plants,bacteria and its interrelated physical and chemical environment.
Evaporation:	This is the process whereby water changes from liquid into a gas called water vapour.
Hydrological Cycle:	The hydrological cycle is the movement of water and water vapour through the sea, air and land that results in the availability of water on earth. The Hydrological Cycle can also be said to be the interaction of water vapour, precipitation, infiltration, run-off, evaporation and condensation.
Precipitation :	The process whereby water droplets or liquid water becomes saturated in the atmosphere hence it is forced to fall down as rainfall, hail or ice.
Protocol:	an agreement between countries. Countries can agree to share information or water resources.
Transpiration :	This is the loss of water from green plants into the atmosphere.
Wetlands (Ramsar definition):	Areas of marsh, fern, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing. Fresh, blackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Topic 1: The Hydrological Cycle

Introduction

Water is an important natural resource needed by human beings for survival and their socio-economic development. Without water, it is impossible for life to survive on earth. In this topic, you will learn about the hydrological cycle or water cycle as it is sometimes called. You will know about the movement of water and the processes involved. This, therefore, explains why the planet earth continues to have water.

Topic Objectives

At the end of the topic you should be able to:

- explain the processes involved in the hydrological cycle
- draw and explain the structure of the hydrological cycle.

1.0 The Water Cycle

Did you know that water is the most widespread substance on earth? It is important because it is the source of all life on earth. In science you have learnt that it exists in the form of liquid, solid and gas. You also learnt that it occurs as surface water, underground water, water vapour or as ice or snow. It is also found in green leaves of plants. The hydrological cycle which is also called the water cycle, is the constant movement of water and water vapour through the sea, air and land. The cycle involves a number of processes such as evaporation, transpiration, condensation, precipitation, infiltration, surface runoff and underground water flows. These processes ensure that water not only circulates between the land and sea but also that it is made available to people, plants and animals. Before discussing the water cycle,

attempt activity 1 to see how much you remember about processes involved.



Activity 1

From your previous Units 4 and 5, do you still remember how clouds are formed? See if how well you can answer the questions below.

(a) What makes the rain clouds to form in the sky?

(b) Where does the rain water that flow in the rivers and streams finally go?

Feedback

For Question (a), if you said rain clouds are formed as a result of water vapour from the leaves of green plants, sea/oceans, lakes and pans, then you are correct. Rain clouds form from water vapour.

For Question (b), if you said rain water from rivers and streams flow towards the sea, then you are also correct.

From Question (a) and (b), you can realise that water evaporates from the sea, lakes, pans and leaves of green plants to form rain clouds. After the rain clouds have been formed, then rain water falls and collects in the rivers and streams and flows towards the sea. It is at the sea where water

will again evaporate to form clouds. This partly explains the hydrological cycle or water movement. However, you will need to study the structure of the hydrological cycle to explain each step of the water movement. The next section will help us understand the structure or nature of the hydrological cycle.

2.0 The Nature of the Hydrological Cycle

To fully understand the movement of water that make up the water cycle, study Fig 1 that shows the nature of the hydrological cycle.

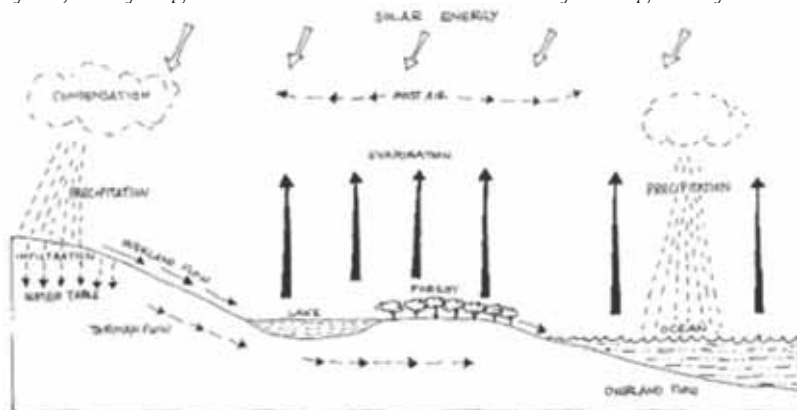


Fig 1: The hydrological cycle

As you have already noted, there are processes or stages in the hydrological cycle. These are shown by the use of arrows. The processes include Evapo-transpiration, Condensation, Precipitation, Groundwater Run-off, Infiltration and Through Flow. All these processes are not yet labelled but we shall do so as we go through each process in the following sub-sections. Let us first start with evapo-transpiration because you have learnt about it before in your junior secondary science. We will thereafter discuss the other stages.

2.1 Evapo-transpiration

Study the hydrological cycle in Fig 1 and attempt the next activity.



Activity 2

Use the diagram in Fig. 1 to help you answer the question.

Which letter represents arrows showing evapo-transpiration

.....

Feedback

If you said arrows at D show evapo-transpiration, then you are correct.

Surface water from the land, lakes and sea is exposed to the heat from the sun (incoming solar radiation). The sun's heat provides energy that evaporates water. When water evaporates, it changes from liquid to a gas called water vapour. This process is called **evaporation**. Plants also lose water to the air. This process is called **transpiration**. Both evaporation and transpiration (**evapo-transpiration**) send continuous supplies of water vapour which transfer water from the surface to the atmosphere.

2.2 Condensation

In order for you to have a clearer understanding of condensation, first try activity 3 that follows.



Activity 3

Imagine that you are taking a hot bath on a cold winter morning. The steam from the hot water rises and then strikes the cold window pane. What do you think happens to the steam? Write down your explanation below.

I am sure you got Activity 3 correct. When steam from a boiling pot strikes a window pane in a cold winter morning, some water droplets can be seen on the window pane.

The steam was cooled by the cold window pane and converted into water droplets. This process is called **condensation**. The water vapour that evaporates from the land, sea, lakes and plants at the earth surface moves up into the atmosphere. As it moves up it cools and eventually condenses, forming tiny droplets of water. Condensation is a process by which water changes from gas to liquid. These tiny droplets of water or ice appear as clouds in the sky.

2.3 Precipitation

Precipitation is the water that falls from the atmosphere to the ground surface. This water falls in a form of rain, snow or hail. As water vapour continues to condense in the atmosphere, the tiny droplets of water accumulate into thick rain clouds. As the process continues, the water droplets will eventually become too big to remain suspended in the air. They then fall down to the ground as rain. Precipitation in Fig 1 is represented by rain that is falling from the clouds. Precipitation recycles water back to the ground.

2.4 Surface Run-off, Infiltration and Through Flow

Study Fig 1 once more, notice the labels run off, infiltration and through flow. Attempt activity 4 that follows as it will help you appreciate the concept of overland flow or run off.



Activity 4

If you were to pour a lot of water on the ground, the water would probably flow in a single direction forming a small channel. Now think of rain water! We have rain year after year falling on the same place, what do you think would happen to the ground on which the water falls every year? Write down your answer below.

Feedback

I hope you got this one correct. Rain water will finally form a big channel which we call a river.

Most of the water which returns to land wets the vegetation and soaks the ground. When the soil is saturated or the surface is made of impermeable rocks, water collects at the surface and soon flows down the slope as **run-off or overland flow**. Run off or overland flow is a process whereby rain water collects in rivers and streams and flows into lakes or returns to oceans.

The process where water penetrates the soil is called **infiltration or percolation**. What do you think happens to water that penetrates the ground through soil pores? Some of the rain water that sinks into the soil will move further downward until it reaches an impermeable rock deep underground. This rock forms the water table. Water collects on it to form underground water systems called **aquifers**. As water accumulates underground, it flows along the water table and may appear at the surface in lakes, springs or empties into the sea. The process by which underground water flows and eventually discharges its water into the sea is called **through flow**.

Water in the rivers which flows through the surface of the earth or overland flow or run-off and that which flows underground through the process of through flow will finally reach the seas or oceans. Most people used to think that it is the other way round that is, that water from rivers comes from the sea. This is totally wrong because the sea is lower than the ground on which we find rivers.

All water bodies and other sources of water get heated by solar energy from the sun and once more evaporate into the atmosphere to form clouds and then fall down as rain. This, therefore, starts the process of water movement or hydrological cycle once more. The process will repeat itself over and over again as the years go by. This is why we continue having water in planet earth.



3.0 Summary

You have learnt that the sun is the source of heat and light energy that makes the hydrological cycle possible. That is, the hydrological cycle is made effective by energy from the sun which is called **solar energy**. The sun heats the water in the sea / oceans, lakes, ponds and plants or vegetation resulting in evaporation and transpiration. This process is known as **evaporation**. The evaporation of water from green plants is called **transpiration**. The

processes of evaporation and transpiration are called **evapo-transpiration**. The water that evaporates from the lakes, ponds seas / oceans and from the green leaves of plants results in cloud formation in the atmosphere. The process which changes water vapour into water droplets to produce clouds is called **condensation**.

As the water droplets keep on increasing and the cloud becomes too big, saturation point is reached hence the water droplets fall down as rain. This process is called **precipitation**. Precipitation can therefore be in the form of rain, snow or hail. Rain water on the ground can either flow over the land surface in streams and rivers and collect in dams, pans and lakes or flow towards the sea. The process involved is called **overland flow** or **run-off**. Some of the water sinks or infiltrates into the ground, when the water table is saturated, water will flow towards the sea in a process called through flow.

The water that flows into the rivers or underground results in water getting back to the oceans, seas and the lakes. It is in the seas, oceans and lakes where the process of heating and evaporation once more take place causing water to evaporate to form clouds. Water from the green plants also evaporates into the atmosphere. The process of water movement then starts all over again. This explains why some of the world's water is continually in motion and the process is called the **Hydrological Cycle** or **Water Cycle**.

Before moving on to the next topic, you should complete the end of topic exercise which can be found at the end of the unit in the Assignment section. Once you have completed the exercise, check your answers against those provided. If you are happy with your progress move on to the next topic. If some of your answers were incorrect, revise the relevant sections.

Topic 2: Water Resources in Botswana

Introduction

In Topic 1, we looked at the hydrological cycle between the earth and the atmosphere as it changes into different states. The hydrological cycle explains why we have water on earth. You must know that this water is not equally distributed on earth. In Topic 2, you shall look at sources of water in Botswana. You will also look at the significance of water to human activities and why water is a scarce resource in the country but yet, high on demand. Botswana

is one of the few developing countries which are faced with a serious shortage of water resources. As a result, the demand for water is high in the country.

Topic Objectives

At the end of this topic, you are expected to be able to:

- identify sources of water in Botswana
- explain the significance of water resources to human activities
- explain why water is a scarce resource but highly demanded

1.0 Water Sources in Botswana

Water sources refer to areas where water is obtained or suppliers of water. There are several areas in Botswana where most of our villages, towns and cities obtain water. However, before we look at these sources closely, let us first brainstorm by doing Activity 1 that follows.



Activity 1

You probably used water today for bathing, drinking or cooking. This water was obtained from somewhere. Where is the water you use in your house obtained from?

(a)

(b)

Feedback

You probably said it is obtained from a borehole, well, river, pan, lake or a dam. I hope you did not say a water tap. A tap is a water pipe or tap is a means of transporting water.

let us look at the surface water sources in Botswana.

2.0 Surface Water

Surface water mainly refers to water that is found in rivers, ponds, lakes, dams and swamps. This is water which collects on the surface of the earth. We will now move on to discuss each source of surface water, starting with

2.1 Rivers

Rivers are important water resources. Botswana, as we pointed out earlier however, has few perennial rivers



Activity 2

Study the map in Figure 1 showing water sources in Botswana. From the map identify and list any five areas in Botswana where surface water is mostly found. [5 marks]

- (a)
- (b)
- (c)
- (d)
- (e)

Feedback

You probably gave names of such rivers as the Okavango, Chobe, Zambezi, Shashe or dams such as the Gaborone, Shashe or Letsibogo. If you did then you are correct.

Botswana's surface water is mainly found in the three perennial rivers that the country has. What is a perennial river? A **perennial river** is a river that has water flowing throughout the year. Do you know any perennial rivers? Perennial rivers in Botswana include the Limpopo River, Zambezi River and the Chobe River which are the border rivers. These are rivers that are found along the boundary of Botswana with neighbouring countries such as South Africa, Zimbabwe, Zambia and Namibia. The largest perennial river in Botswana is the Limpopo River that forms the eastern border between Botswana and South Africa. The fourth perennial river is the Okavango and its delta which contains about 95% of the total surface water in the country.

All these rivers obtain most of their water outside Botswana. For example, the Chobe and Okavango Rivers rise from the highlands in Angola, the Zambezi rises from northern part of Zambia while the Limpopo rises from the High Veldt area of South Africa.

There are also **seasonal rivers** in Botswana which flow only during a certain part of the year especially during the rainy season. Let us see how these rivers are important in the provision of surface water by attempting the activity given below.



Activity 3

With the aid of the map provided in Fig 1, identify and list any six main seasonal rivers in Botswana. [6 marks]

- (a)-----
- (b)-----
- (c)-----
- (d)-----
- (e)-----
- (f)-----

Feedback

You probably named rivers such as the Limpopo, Shashe, Motloutse, Notwane, Tati, Lotsane and Mhalatswe (some of the seasonal rivers might not be shown on the map, just identify and list those shown).

There are many seasonal rivers in Botswana which are a source of surface water supply in the country. Water that collects in these rivers is used to supply water to rural people and their livestock. Some seasonal rivers like Boteti, Metsimotlhabe and Notwane have dams built across them to supply water to the nearby population centres. Some of the seasonal rivers are tributaries of perennial rivers. Rivers such as Notwane, Lotsane, Motloutse and Shashe are tributaries of the Limpopo River. Fig.2 below shows a flowing river during the rainy season.



Fig. 2: Limpopo River

Source:<http://en.wikipedia.org/wiki/File:Limpopo.jpg>

Retrieved 13/04/11

In the next section we shall look at dams as another important source of water in Botswana.

2.2 Dams

Apart from perennial or seasonal rivers, there are big dams in Botswana which are also a source of surface water.



Activity 4

Again refer to the Map on Water Sources in Botswana in Fig 1. Name any five major dams built across seasonal rivers in Botswana. [5 marks]

- (a)-----
- (b)-----
- (c)-----
- (d)-----
- (e)-----

Feedback

*You probably mentioned the **Gaborone, Shashe, Letsibogo, Bokaa, Mopipi and Nnywane Dams***

These are the major dams found in Botswana that are sources of surface water. The Shashe Dam is built across the Shashe River and supplies water to the mining towns of Selibe-Phikwe, Francistown City and to Tonota. Water in these settlements is used for industrial and domestic

purposes. Gardening is practised on a very small scale in schools and institutions or in homes behind houses. Gardening in this case uses a small percentage of water. Letsibogo Dam is built across the Motloutse River and supplies water to Gaborone and other southern towns in the country through the north south water transfer pipeline. In Gaborone the water is used for domestic and industrial purposes. Agricultural activities are very low because they mainly comprise small school or institutional gardens and those in the backyards.

Mopipi Dam was built across the Boteti River to supply water to Orapa and Letlhakane mines. The mines depend largely on water from the boreholes because this dam remains dry most of the time. The mines mostly use water for industrial purposes. They actually consume a lot of water. In mining centers water is also important for domestic use. Bokaa Dam is built across Metsimotlhabe River and supply water to Gaborone, Morwa, Bokaa and Mochudi. Water is again used for domestic and industrial use in these areas. The villages of Morwa, Bokaa and Mochudi use water for domestic purposes.

Gaborone Dam(see Fig 3) is built across the Notwane River and supplies water to Gaborone City and the neighbouring settlements of Tlokweng and Mogoditshane. Water from the Gaborone Dam is very important for the industrial development of Gaborone. However it is also used for domestic purposes in the city and in the two villages of Tlokweng and Mogoditshane. Nnywane Dam is built across one of the streams that flows through the Lobatse area. The dam supplies Lobatse with water especially the Botswana Meat Commission (BMC). The BMC is an important industry in Lobatse hence a lot of water is used in it. Water from the dam is also important for domestic purposes.



Fig 3: Gaborone dam

Source:http://en.wikipedia.org/wiki/File:Gaborone_25.92305E_24.68895S.jpg

Retrieved: 06/08/11

You might have heard that there are new dams built in Botswana. A new dam, Ntimbale has been built across the Tati River to supply water to areas in and around Francistown. An even bigger dam that will store up to 400 million cubic meters of water is currently built on the Lower Shashe River called Dikgatlhong Dam.

Study the table in Fig 4 showing the full storage capacity of the major dams in Botswana including Molatedi Dam, situated in South Africa which supplies water into Gaborone Dam.

Name of Dam	River	Nearest Town	Capacity in million cubic meters
Gaborone	Notwane	Gaborone	141.4
Shashe	Shashe	Francistown	85
Bokaa	Metsimotlhabe	Gaborone	18.5
Nnywane	Nnywane	Lobatse	2.3
Letsibogo	Motloutse	Selibe-Phikwe	100
Molatedi	Marico	South Africa	201
Ntimbale	Tati	Francistown	26.5

Fig 4:Capacity of major dams in Botswana and including Molatedi Dam in South Africa

Source: Botswana NDP 9 – Government Printers

From the table in Fig 4, you can see that Gaborone Dam is the second largest dam after Molatedi Dam. Gaborone Dam however is unable to meet all of the water demands in and around Gaborone. Additional water supplies is obtained from Letsibogo Dam and Molatedi Dam. Letsibogo Dam is connected to the Gaborone area by a 320 km pipeline. Molatedi Dam is important to Botswana because it is connected by a pipeline to Gaborone Dam and has been able to increase the yield of Gaborone dam by over 5 million cubic metres, replacing the 2.1 million cubic metres lost through evaporation. The Republic of South Africa allows Botswana to use a maximum of 7.3 million cubic meters when Molatedi Dam is more than 25% full.

Surface water supplied from dams is used mostly to supply major urban centres such as Lobatse, Gaborone, Francistown and SelebiPhikwe. The country however, has limited supplies of surface water as a result the majority of rural areas and some urban

centres depends largely on underground water sources. In the next section, we shall discuss the underground water resources in Botswana.

3.0 Underground Water

Apart from surface water, underground water sources in Botswana are important. These sources mainly use boreholes to extract water from the ground. You may know some of the areas that depend on underground water. The next activity is meant to tap on this prior knowledge,



Activity 5

Name five areas in Botswana which depend on underground water sources? [5 marks]

- (a)-----
- (b)-----
- (c)-----
- (d)-----
- (e)-----

Feedback

If you gave examples of villages such as Thamaga, Tsabong, Kalkfontein or cattle posts or crop farms (masimo) then you are correct.

At the cattlepost or your village, you probably use water from boreholes. Rural areas including big villages and small settlements use both surface and underground water supplies. Boreholes and wells are the most reliable sources of water in rural areas. However, small settlements in the countryside such as cattleposts and crop fields mostly depend on water from small dams, wells, rivers and pans.

In general, boreholes play an important role in the provision of water in the country. In Botswana, about 75% of the human and livestock populations depend on underground water supplies. It is estimated that underground water resources for the whole country amount to some 1 000 000 (1 million) cubic meters. These are extracted mainly by means of boreholes and wells. Today, there are about 16 000 registered boreholes around the country as well as a smaller number of shallow wells. Together they supply an estimated 75,5 million cubic meters of water per annum.

We have discussed the major water sources in Botswana. Let us now move forward to look at other sources of water in Botswana.

4.0 Other Minor Water Sources in Botswana

Apart from surface and underground water, there are other minor water sources in Botswana that have been used especially in rural areas. These are roof and ground catchment systems. First let us look at the roof catchment system.

4.1 Roof Catchment System

If you visit some of the primary schools and clinics in rural areas, you are likely to find water collection tanks designed to collect rain water from roofs of buildings. These are referred to as roof catchment systems. Roof catchment systems mainly involve harvesting rainwater from roof tops through gutters into water storage tanks. Some homes in rural and urban areas have roof catchment systems. The water storage tank rests on a platform that has been erected at the ground surface. In some cases a water storage reservoir is buried under the soil. The harvested water is used for domestic purposes including washing, gardening and watering livestock. Study Fig 5 that shows a roof catchment system.



Fig 5: Roof catchment system

The roof catchment systems consist of three main components:

- a roof which acts as a catchment area
- a gutter and down pipe that are used to channel the harvested water into the storage tank and
- a tank used for water storage.

The roof catchment system does not store much water. However, the little water that is harvested is used for domestic purpose and home gardening.

4.2 Ground Catchment System

If you have been involved in arable farming in Botswana, you should be aware of the Arable Land Development Programme (ALDEP) and the water catchment systems used in the scheme. The systems have been referred to as Ground Catchment System. Study Fig 6 showing a ground catchment system.

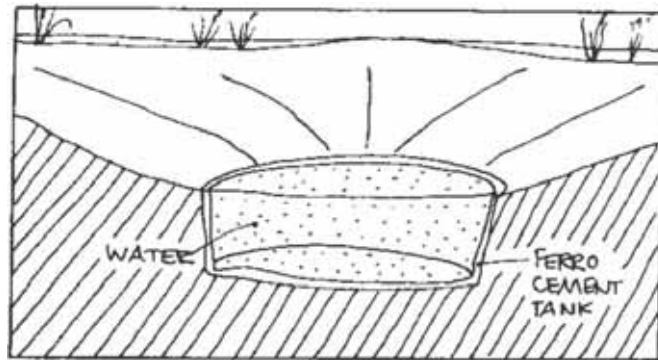


Fig 6: Ground catchment system.

As you can see in Fig.6, ground water catchment system consists of the catchment surface which in most cases was a field used for threshing grain and a water catchment tank below the surface. Rainwater that falls on the catchment area, collects at the edge of the catchment area and flows down into the water tank built of cement below the surface. These ALDEP ground tanks although intended to supply water to livestock were also used for household water supply in rural areas.

You now understand most of the major sources of water in Botswana. Our next discussion is on wetlands which as you will see are closely related to some of the sources of water that we have discussed.

5.0 Botswana's Wetlands

Some of the water sources that you have learnt about are referred to as wetlands (*makgobokgobo*). There are many types of wetlands. Our well known wetlands are the Okavango and Linyati swamps. Wetlands include both perennial and ephemeral rivers such Limpopo, Shashe, Motloutse, Tati, Okavango, Chobe rivers, and also the springs some of which exist during the wet period only. Wetlands also include artificial water storage sites such as dams and sewage ponds. The pools, fossil river valleys of the Kgalagadi and the salt pans of Makgadikgadi are also considered to be wetlands. Study the map on figure 7 that shows the wetlands of Botswana.



Fig 7: The wetlands of Botswana

Adopted from David May: Geography of Botswana

From this map you can see that only a small portion, about 4 % of the country's total area, is covered by wetlands.

6.0 The Significance of Water to Human Activities

Now that we have identified sources of water in Botswana, we are now faced with the question of who uses most water in the country. Water is a significant resource that is used for the socio-economic development of any country. Water is mostly used for domestic purposes, mining and energy, agriculture and wildlife.

- Rural and urban settlements use water for domestic purposes such as drinking, cooking, laundry and bathing.
- Industries use water in their production processes For example, Botswana Meat commission us lots of water for beef processing.
- Mining uses water mainly for industrial purposes like Orapa,

Letlhakane and Jwaneng mines use water in diamond production.

- In energy, water is used for electricity production. The Morupule Power Station for example uses water from the boreholes in the production of electricity.
- Agriculture uses water mainly for livestock watering and irrigation. Irrigation is done in places such as Talana Farms in the Tuli Block and Chobe Farms in the Chobe District.
- The wildlife sector uses water for watering wild animals. A number of boreholes have been dug in almost all of Botswana's national parks and game reserves including Chobe National Park which is close to a lot of surface water.

Study the table in Fig 8 which shows the demand of water by each of the sectors mentioned above.

Sector	Demand ($10^6 \text{ m}^3/\text{a}$)	Percentage
Total Domestic	78	40.4
Urban Centres	45	23.3
Major Villages	21.5	11.1
Rural Centres	9.2	4.8
Other Settlements	2.3	1.2
Mining and Energy	35.7	18.5
Agriculture	73.7	38.1
Livestock	44.8	23.2
Irrigation and Forestry	28.9	14.9
Wildlife	6	3.1
Total	193	100

Fig 8: Water demand by sector in Botswana in the 1990

Source: Botswana Government Statistics Report 2007

From the table you can notice that the leading consumer is the human settlements sector which is closely followed by the livestock sector.

Urban settlements in particular consume a lot of water. This is primarily due to rapid urbanisation and the increase in urban population. Botswana is a beef producing country which has about three million cattle that need water for drinking and uses a lot of water. Do we have enough water to satisfy this demand? The next section will help answer this question.

7.0 Water Scarcity and Demand

Perhaps in your area you probably experience water shortages. This problem is common in most parts of the country as already mentioned. This shows that water is a scarce resource in Botswana and there is a high demand for it. Water scarcity in Botswana is a result of several factors which we shall study later. However, attempt Activity 6 as an introduction to water scarcity in Botswana.



Activity 6

Give reasons why water is a scarce resource in Botswana?

[5 marks]

(a)-----

(b)-----

(c)-----

(d)-----

(e)-----

Feedback

I am sure you gave more than five reasons. Some of the correct ones include the following unreliable rainfall, drought, high rates of evaporation, loss of water through run off, limited water sources and increasing demand for water.

Water is a scarce resource in the country because of the following reasons:

- Botswana is a semi arid country, it receives very little rainfall and droughts are common. Therefore small amount of rain water that flows into dams and rivers. This amount varies

from year to year because rainfall also unreliable and changes from year to year.

- The country is very hot and there are high evaporation rates, which cause further loss of the little water available. A great deal of water is lost through evaporation and seepage.
- Water is lost through run-off. There are limited funds to build dams in Botswana.
- There is limited surface and underground water sources. There is no permanent surface water in much of the country except in the Okavango Delta, the Chobe River and major dams. Most rivers in the country are ephemeral (flow only during the rainy season). The only perennial rivers, the Okavango and the Chobe Rivers are shared with neighbouring countries. Ground water is very limited and recharge is generally low. Some boreholes in western Botswana yield salty water.
- The increasing demand for water contributes to water scarcity. The increasing population and the increase in economic activities require more water supplies. Available water resources are unable to cope with the rising demand for water in many parts of the country especially in south eastern Botswana. For this reason water has to be drawn from outside the area to meet the increasing demand.
- There is spatial mismatch between areas where water is available and areas where it is needed. This has made it necessary for the construction of costly transfer schemes such as the North South Water Carrier project. Suitable dam sites are limited and can no longer be found in the south eastern part of the country where most people live

We have now come to the end of Topic 2. Read the summary and thereafter attempt the end of topic exercise and correct your work as recommended in Topic 1.



Unit Summary

8.0 Summary

In this topic, you have learnt that Botswana depends on two main water sources, surface and ground water sources. Surface water sources are mostly found in the northern part of Botswana where

there is the Okavango Delta and are **perennial rivers** such as the Zambezi, Chobe and the Okavango. There are also **seasonal rivers** such as the Shashe, Motloutse, Notwane, Boteti and Metsimotlhabe. Most of the dams are built across these seasonal rivers, e.g. the Shashe, Letsibogo, Gaborone, Mopipi and the Bokaa dams. However, surface water is very limited hence most of the water used in the country is from ground water sources. Boreholes are mostly used to extract water from underground. There are also minor water sources such as roof and ground water catchment systems in Botswana. You also learnt that water is used in agriculture, mining, wildlife, energy as well as for domestic purposes in settlements. Finally, you learnt that while the water demand is high, it is a scarce resource in Botswana.

Topic 3: Water Management Practises in Botswana

Introduction

Water remains a scarce and yet highly demanded resource in Botswana. There are several factors that contribute to this scarcity and demand. While water remains a scarce resource in Botswana, there are negative human impacts on water resources which worsen the water problems of the country. In Botswana the negative impacts of human beings on water resources though small, are becoming severe. The government has put in place some water management strategies to ensure water conservation and management. An example is the National Water Master Plan of 1990. The use of water in industries, livestock, wildlife or settlements, make water a highly demanded resource in the country.

In the last two topics, you learnt about the hydrological cycle, water sources in Botswana and the significance of water to human activities. In this topic, you are going to learn about the negative impact of human beings on water resources, factors that influence the demand for water and water management strategies that can ensure the conservation of water resources in Botswana.

Topic Objectives

At the end of this lesson, you should be able to:

- explain the factors that influence water demand in the country
- explain water management strategies that can ensure the conservation of water resources in Botswana
- explain the role of international water protocols governing water as an international shared resource
- discuss Botswana's water management policies e.g. Wetland Policy
- discuss how human beings pollute surface and ground water resources
- explain the role of Environmental Impact Assessment in ensuring water conservation.

1.0 Factors That Influence Water Demand in Botswana

In your last topic, you learnt that water is a scarce resource and the demand for it is high in Botswana. We now need to look at factors that influence water demand in Botswana. To do this let's first start by attempting Activity 1 below which will prepare you to fully understand some of the reasons why water is in high demand in Botswana.



Activity 1

Give at least **five** factors that you think influence the demand for water in Botswana. [5 marks]

- (a)-----
- (b)-----
- (c)-----
- (d)-----
- (e)-----

Feedback

If you did not get all of the factors, do not worry. Some of the factors that influence water demand in Botswana include the following: increase in human and livestock (especially cattle) populations, rapid rate of urbanisation, the development of industries and development of the mining sector.

1.1 Increase in population

Botswana's human population has been increasing since independence in 1966. Currently the population stands at about 1.7 million people. This increase in human population increases the demand for water as more and more people need to use water for domestic purposes.

1.2 Increased water demand by livestock and for irrigation

The cattle population in Botswana has also been increasing since independence due to government plans that encourage cattle farming. The cattle population in Botswana at the moment stands at about 2.5 million. It is also believed that the water needed for irrigation will increase. All these contribute to the increases in demand for water.

1.3 Rapid Rate of Urbanisation

Urbanisation is increasing at a fast rate. This is shown by the increase in rural-urban migration and the transformation and expansion of major villages. The expansion of urban settlements increases the demand for water as more and more people need water for domestic use.

1.4 The Development of Industries

Botswana is slowly developing her industries. These industries in turn use a lot of water and contribute to a high demand of water in towns.

1.5 Development of the Mining Sector

Mining is an economic activity that uses a lot of water for processing the crude raw materials from the ground. The diamond industries consume a lot of water used in the mining sector. New mines have recently been opened while others are being built. This will further increase the demand for water by the mining sector.

2.0 Growth in Water Demand

Study Fig 1 showing the growth of water demand in Botswana.

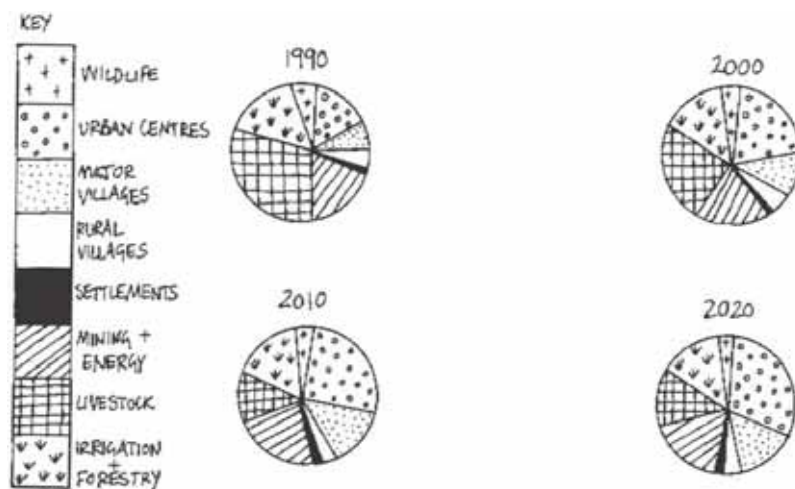


Fig 1: Growth in water demand

Source: Adapted from Botswana National Development Plan 8

From these charts, you can see that the water demand for each sector has been increasing rapidly. For some sectors the demand is expected to double by the year 2020. High growth rate for water demand in both urban and rural settlements is mainly due to rapid population growth. For example, the total demand of water in Gaborone has increased from 4850 thousand cubic metres (1981/82) to 14 252 thousand cubic metres (1995/96).

From the charts in Fig 1 you can see that the demand for water will continue to increase rapidly in the future.

3.0 Water Management Strategies

Since the demand for water in Botswana is high while water is a scarce resource, there is need for proper water management strategies to be put in place. These strategies are meant to lead to the conservation of water resources in the country. Attempt Activity 2 that follows, it will help you

understand some of the strategies that can be used to conserve water in the country.



Activity 2

Give at least **five** measures that you think can be taken in order to ensure water conservation in Botswana. [5 marks]

- (a)-----
- (b)-----
- (c)-----
- (d)-----
- (e)-----

Feedback

I hope you mentioned some of the following measures: Charges for water consumption, Reduction of water pressure in water taps, imposition of water restrictions, Building houses with water conservation measures in their design, fixing leaks in the water system, educating people about the need to conserve water and growing garden plants that do not require a lot of water. These and other measures are further explained below.

3.1 Charges for Water Consumption

Where water is provided free of charge people tend to waste it. Where people pay for water usage, they tend to reduce wastage and use it more efficiently. People who use large amounts of water are penalised through high water bills which will compel them to save water.

3.2 Reducing Water Pressure in Water Taps

Water pressure can be reduced especially during the drought period. When the pressure is reduced, the amount of water that comes out is small. When pressure is high, a lot of water comes out some of which tend to be wasted. Think of a shower or water tap at a nearby school. A shower or a water tap used by school pupils with a high water pressure will use a lot of water.

3.3 Imposition of Water Restrictions

In times when there is limited water supply, the water authorities put in place restrictions on the use of water. For instance people are not allowed to use portable water to water their lawns, fill their swimming pools or use hosepipes to clean their cars as these uses a lot of water. For instance, people use more water when washing their cars using a hose pipe than when using a bucket.

3.4 Building Houses with Water Conservation Measures in their Design

Water conservation measures can be taken into account when designing and constructing houses. For instance water catchment tanks can be erected to harvest rain water. Low volume shower-heads and dual flush toilet cisterns can be installed as these use less water.

3.5 Fixing Leaks in the Water System

Most water systems have leaks which remain unattended for a long time. These are the leaks that result in a lot of water being wasted. In some cases leaking pipes have created wetlands next to the public standpipes. Fixing such leaks will cut on the amount of water being wasted.

3.6 Educating People about the Need to Conserve Water

Public education is one of the most important tools for water conservation. It does not only create an awareness of the need to conserve water but also instils a sense of discipline and restrictions on how one chooses to use water.

3.7 Growing Garden Plants that do not require a lot of Water

There are plants which do not require a lot of water; these are the ones that should be encouraged in Botswana. For instance, exotic trees grown to decorate homes require frequent watering but local trees need not be watered and are therefore most appropriate for Botswana's water situation.

The picture in Figure 2 shows some water conservation measures appropriate or suitable for households in Botswana.

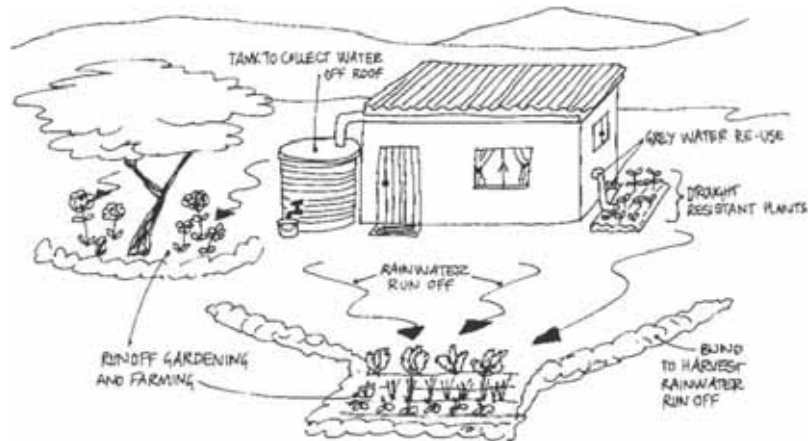


Fig 2: Water Conservation Methods Suitable in Botswana

4.0 Water as an International Shared Resource

In topic 2, you learnt that some of the rivers in Botswana originate in other countries; the Okavango is from Angola, Zambezi from Zambia, Limpopo from South Africa. The Limpopo and Zambezi flows through Zimbabwe and Mozambique into the Atlantic Ocean. This means that the water that these rivers carry must be shared between these countries. If water is a shared resource, it needs joint management by the countries concerned. There are a number of international agreements on the management of shared water resources. These include:

4.1 Helsinki Rules

These are rules or laws that govern the use of international rivers or waters. They provide for the equitable distribution of water resources by member states that happen to share the rivers or water courses.

4.2 SADC Protocol on Shared Watercourses of 1995

This is an agreement between SADC member states on the use of shared water resources in the region. The protocol binds member states to have equal share of water in rivers crossing their countries. Countries agreed to work together in the wise use and conservation of water through a common water management plan of shared water courses and to maintain a balance between using water to benefit the people and conservation and protection of the environment.

4.3 The Permanent Commission on the Okavango Basin (OKACOM)

This is an agreement between Botswana, Namibia and Angola on the use of water in the Okavango River. The three countries have agreed that they should always consult and agree with each other when intending to use water from the Okavango River. They agreed to work together in the management of the Okavango basin and will come up with an Integrated Water management Plan guided by an EIA.

4.5 Ramsar Convention

The Convention on Wetlands of International Importance was signed in 1971 at an Iranian town of Ramsar hence it is popularly known as the Ramsar Convention. Botswana ratified this convention in 1997 hence is committed to its obligations. It was in line with this convention that Botswana listed the Okavango Delta as a wetland of international importance. The convention emphasizes sustainable use of wetlands.

Botswana is part or a signatory of the above bodies hence she is bound to observe the protocols in the use of water resources in the country.

5.0 National Policies on Water Conservation

Apart from the international agreements above, Botswana has her own policies which are meant to protect and direct the use of the country's water resources.



Activity 3

Name two of Botswana's policies that are meant to protect water resources in the country. [2 marks]

(a)-----

(b)-----

Feedback

I am sure you mentioned the Wetland Policy, Water Act and the National Water Master Plan of 1990.

These are some of the measures in place that direct the use of water resources in Botswana. The **wetland policy** stipulates all the conservation measures that Botswana should take in the utilisation of water resources. This also applies to the **Master Plan**.

Let us now discuss these policies in some detail.

5.1 Water Act

This Act defines ownership, rights and use of public water. The act defines public water as comprising all surface and groundwater. This public water could be in the form of rivers, streams, lakes, pans, swamps or all forms of underground and surface water resources. According to the Act, public water cannot be privatised. The use of such waters can only be with the permission granted by the lawful authority. The Act therefore makes water a public resource that should be used for the benefit of all the people in society. It also prohibits the pollution of, interference with or changing the flow of public water.

5.2 Botswana's Wetland Policy

A wetland as discussed earlier in this unit is any landscape in which wetness is a common feature. Different countries have different definitions of wetlands. In Botswana, a wetland (locally called *makgobokgobo*) is an area where water collects above the soils for periods of time thus affecting the ecological characteristics of the area. The next table shows the different types of wetlands in Botswana.

Type of wetland	Characteristics	Examples
Swamps and marshes	Permanent or seasonal freshwater swamps	<ul style="list-style-type: none"> • Okavango Delta • Savuti Swamps
Salt pans	Permanent or seasonal with water by rain or runoff	Makgadikgadi Pans
Rivers	Perennial and seasonal rivers	<ul style="list-style-type: none"> • Okavango • Motloutse
Flood plains	Seasonally flooded by water	<ul style="list-style-type: none"> • Flood plain of the Chobe River • Flood plain of Linyanti River
Lakes, pans, pools and ponds	Seasonally flooded with fresh water	<ul style="list-style-type: none"> • Lake Ngami • Hukuntsi pans • Hippo Pools on Boteti River
Dams	Man made dams	<ul style="list-style-type: none"> • Letsibogo Dam • Bokaa Dam
Flooded arable lands	Low lying areas	<ul style="list-style-type: none"> • Fields along Boteti and Chobe rivers
Salt ponds	Man made evaporation ponds	<ul style="list-style-type: none"> • Sua mines evaporation ponds
Sewage ponds	With waste water	<ul style="list-style-type: none"> • Glen valley sewage treatment plant
Borrow pit	Pits left after digging soil for road construction	<ul style="list-style-type: none"> • Along major roads

Fig3: Wetlands in Botswana

Source: Compiled from Ramsar report - <http://ramsar.wetlands.org/Portals/15/BOTSWANA.pdf>

- 18/08/11

The Botswana Wetlands Policy was developed to ensure appropriate management, conservation and sustainable utilization of the country's wetlands resources. The Wetland Policy aims at

- Promoting coordinated wetland management at national, district and local level through the establishment of appropriate institutions and wetland legislation
- Ensuring that funding and investment activities are in line with the policy and support sustainable conservation and management of wetlands
- Promoting regional co-operation in wetland conservation and management and fulfilling Botswana's obligations in international conventions and agreements on wetlands.
- recognizing wetland problems like pollution and finding means of controlling and preventing these problems
- Promoting active participation of all stakeholders in the conservation and management of wetland systems
- promoting ecologically sustainable wetland conservation measures such as management plans for wetlands of national and international importance



Fig 3: The Okavango Delta

Source: <http://en.wikipedia.org/wiki/File:Okavango11.jpg>

Retrieved: 14/04/11

To ensure the conservation and sustainable use of wetlands of national and international importance like Okavango Delta in Fig3 above, the

government of Botswana has developed the Okavango Delta and Makgadikgadi Pan management plans.

5.3 Botswana's National Water Master Plan

As the name suggests, this is a plan that stipulates how Botswana should meet her water demands for the period 1990 – 2020. This has facilitated the development of water supply schemes such as the construction of Letsibogo Dam in Mmadinare and the North-South Carrier Water pipe to transport water from Letsibogo Dam to Gaborone.

Study Fig 4, showing the North-South Carrier water project in the eastern part of Botswana.



Fig 4: North-South Water Carrier Project

The North-South Carrier project entailed the construction of the Letsibogo Dam on Motloutse River and a 360 km water pipeline to Gaborone during phase 1. Phase 2 of this project entails the construction of the second dam on the lower Shashe River that will feed into the North-South pipeline. Small and medium scale dams will be constructed during the last phase of the project.

The National Master Plan also examines recycling as an additional source of water to complement existing water sources. There is significant amount of wastewater produced in Botswana and the amount is expected to increase over time. Very little of this water is used or recycled. The use of wastewater can relieve the country from the costly transfer schemes, lower water charges and make more water available to the nation. The National Water Master Plan aims at encouraging Botswana to use water on sustainable basis taking into consideration the water problems the country has.

6.0 Human Impact on Water Resources

The human impact on water resources can either be positive or negative. In this lesson, we are more concerned with the negative impact of human activities on water resources. This means we will be more concerned about water pollution. Among the causes of water pollution are:

6.1 Agricultural Waste

Agricultural chemicals, fertilisers and pesticides used mostly in crop fields are usually carried by running water into rivers and streams. They finally end up polluting the downstream water resources. They can also sink into the soil and pollute ground water resources.

6.2 Nitrate Pollution

Ground water resources are mostly polluted by nitrates. This is mostly the case in many big villages such as Mochudi and Ramotswa. The main source of nitrate is faecal matter resulting from improperly constructed pit latrines. Boreholes constructed near pit latrines in big villages record high nitrate content.

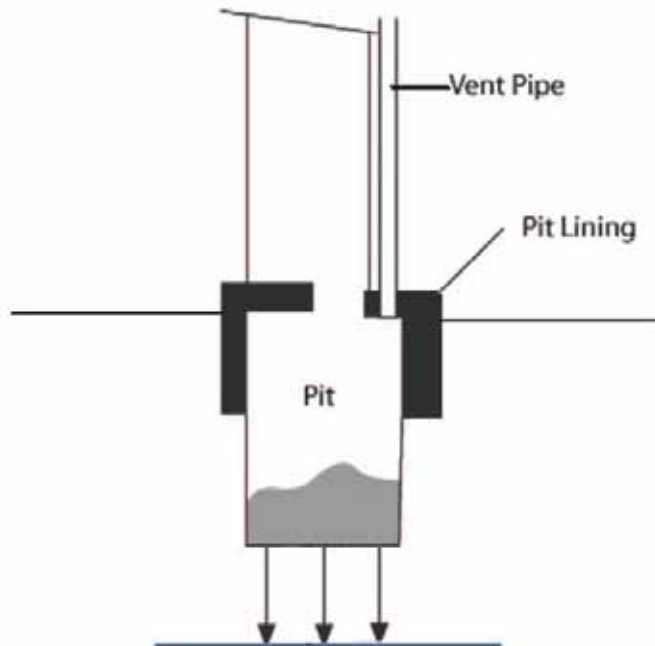


Fig 5: A Pit latrine

Study Fig5, notice how nitrate from a pit latrine shown by arrows percolate into ground water thus causing pollution.

6.3 Domestic Waste

Domestic waste such as refuse and garbage at times are not properly dumped. It is dumped in rivers and streams ending up polluting water resources in those areas.

6.4 Industrial Waste

Some of the industries release waste matter into streams and rivers resulting in the pollution of water in these areas. This means that proper dumping procedures should be followed and waste should be dumped in specific marked areas.

Based on the information above, it can be concluded that both ground and surface water resources in Botswana are threatened with pollution from human activities. Measures are needed to avoid water pollution. This brings us to the idea of Environmental Impact Assessment.

6.5 The Role of Environmental Impact Assessment (EIA) in Environmental Management

Environmental Impact Assessment (EIA) is a study conducted before a development project is allowed to proceed. It is done to provide decision makers with the likely impacts of the proposed project on the environment. It is designed to protect the environment from the negative impacts that the project might bring. Developments that are pursued without any consideration for the environment are not sustainable. When the environmental impact report is submitted for review, the authorities may either reject or approve the project. If the project is approved, an environmental management plan is drawn up to ensure that the least possible negative impacts result. Regular monitoring is required to enforce the environmental plan. After a period of time the developer is expected to produce an environmental audit report the results of which may cause the developer to address some unforeseen circumstances. EIA therefore ensures conservation of natural habitats and restoration of damaged environments.

In relation to water resources, EIAs need to be taken on projects that can impact on both ground and surface water resources. A good example of EIA projects is that which was carried out at Pandamatenga farms to determine the impact of agro-chemicals on water resources in the area.

As a result, specific agro-chemicals were recommended for the area. In case of the North-South Carrier Project, the EIA was completed in 1994. This was conducted by independent consultants, free of any interests in the project. The assessment involved the following:

- soil samples on the pipeline route were collected and analysed
- land uses were determined and some of the information was used to decide on compensation
- rural communities were addressed on the importance of the project
- archaeological excavations were carried out and some historical artefacts were taken to the museums.

Other factors, which were to be considered after the completion of the project, include:

- transplanting some of the tree species, which were removed during the construction
- assisting some animal species to relocate
- maximum care to avoid elimination of species.

All these are examples of roles that EIAs play in maintaining a safe environment.



7.0 Summary

In this topic you learnt about the factors that influence water demand which basically are determined by human activities such as industrial use, domestic use, agricultural use and wildlife use. You also learnt about strategies that can be taken to conserve water resources. These are pricing of water, educating people on water conservation and reducing water pressure in water taps.

In this topic you also learnt that water is an internationally shared resource which is governed by international agreements and protocols such as the SADC Shared Water Protocol and the Ramsar Convention. Botswana has her own national policies to protect water resources. These are the Wetland Policy, Water Act and the National Water Master Plan of 1990.

Finally, you learnt about the impact of human activities on water resources. This mainly refers to water pollution. Water pollution in Botswana is a result of nitrates, agricultural chemicals, fertilisers and pesticides, domestic waste and industrial waste.

Remember to complete the topic exercise before doing the unit assessment. Follow the same processes as in the earlier topics to correct your work and decide on further revision or moving to on to the next task, that is the assessment.

Unit summary



Summary

In this unit you learned about the hydrological cycle. We began in the first lesson by discussing the processes involved in the endless water cycle. We moved on to look at the water resources in the country where we discussed the various sources of water both surface and underground water sources. Lastly we discussed the water management practises in the country where we looked at the factors influencing water demand, the scarcity of water, government policies for protecting water resources and human impact on water resources.

Once you have completed and corrected your Topic 3 assessment, you should do the unit assessment which you will find after the Assignment Section. This assessment should be submitted for marking by your tutor.

Assignment

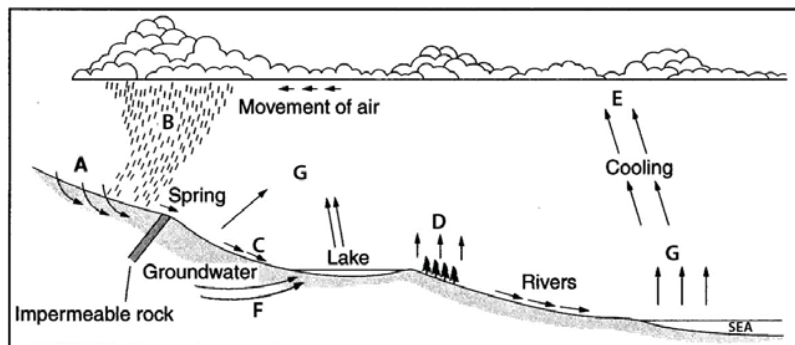


Assignment

The assignment comprises of self-assessment exercises related to each topic in this unit. Remember that these exercises should be done on completion of a related topic. For example, self-assessment exercise 1 should be done after successfully completing topic 1. Check for the correct answers at the end of these exercises. You are advised to take 30 minutes on each exercise.

Self-assessment Exercise 1

1. Study Figure 1 which shows the hydrological cycle. Write down the name of processes as shown by the following letters. Give the main processes involved in the hydrological cycle as marked by the following letters on the map. [6 marks]



- A _____
- B _____
- C _____
- D _____
- E _____
- F _____
- G _____

2. Name **three** sources of water vapour that are important in the water or hydrological cycle. [3 marks]

- (a) _____
- (b) _____
- (c) _____

3. Explain the process of water or hydrological cycle.

[6 marks]

Explanation

Total = [20 Marks]

Self-assessment Exercise 2

Answer the following questions in the given space.

1. Give **two** main types of water sources that Botswana depends on.
[2 marks]

(a) _____

(b) _____

2. Name **five** areas where water is mostly used by human beings for socio-economic purposes. [5 marks]

(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

3. Explain why water is obtained chiefly from underground sources in most parts of Botswana. [5 marks]

4. State **two** advantages and **two** disadvantages of using dams and boreholes as sources of water.

Advantages

[4 marks]

(a)

(b)

Disadvantages

[4 marks]

(a)

(b)

Total = [20 marks]

Self-assessment Exercise 3

1. Name **five** factors that influence water demand in Botswana.

[5 marks]

(a)

(b)

(c)

(d)

(e)

2. Give **five** measures that can be taken to ensure water conservation.

[5 marks]

(a)

(b)

(c)

(d) _____

(e) _____

3. Name any **two** international protocols that govern the use of shared water resources. [2 marks]

(a) _____

(b) _____

4. Describe **four** human activities responsible for water pollution. [8 marks]

(a) _____

(b) _____

(c) _____

(d) _____

Total = [20 marks]

Assignment Answers

Exercise 1

1. A - Infiltration
B - Precipitation
C - Overland flow or run-offEvaporation
D - Evapo-transpiration
E - Condensation
F - Through-flow

G - Evaporation

2. (a) Sea/ocean
(b) Forests or green plants
(c) Lakes, rivers etc.

3. (a) The hydrological cycle

The hydrological cycle starts with the solar system heating water in the seas, oceans, and lakes or green plants causing it to evaporate into the atmosphere. The process of water escaping into the atmosphere after being heated is called evaporation. The water vapour escaping from green plants is a result of a process called transpiration. The two processes are collectively called evapo-transpiration. In the atmosphere, water vapour cools to form water droplets or clouds. The process of cooling is called condensation. As the process of cooling continues, some of the water will then fall down as rain. This process is called precipitation. Some of the rainwater will collect in the rivers and flow towards the sea/ocean. The process is called overland-flow or run-off. Some of the rain water sinks into the ground and flow towards the sea/ocean where it will once more get heated and evaporate into the atmosphere.

Exercise 2

1. (a) underground water
(b) surface water

2. (a) Settlements
(b) Mining
(c) Energy
(d) Agriculture
(e) Industries

3. In Botswana, water is mostly obtained from underground sources because of limited surface resources. Except for the Chobe, Okavango and Zambezi Rivers, the country does not have perennial rivers where dams can be made to provide water for a longer period of time. The three

perennial rivers in Botswana are also in the northern part of the country.

4. **Dams**

(a) **Advantages**

- water can be used for many purposes e.g. irrigation, sport etc.
- water is easily trapped and stored in the lake for use even in drought periods.

(b) **Disadvantages**

- displacement of settlements
- it is easy for water to be polluted e.g. from oil if boating is done in the dam.

Boreholes

(a) **Advantages**

- provision of water can be made available through different boreholes in different parts of the country.
- less expensive when compared to the construction of dams.

(b) **Disadvantages**

- unreliable e.g. often break down
- maintenance can be expensive.

Exercise 3

1. (a) Increase in human and livestock (especially cattle) populations in the country that demand the use of water.

(b) Rapid rate of urbanisation in Botswana, i.e. urban centres are growing at a fast rate and need a lot of water.

(c) Industrialization- Botswana is slowly developing industries which in turn use a lot of water.

(d) Development of the mining sector- mines as processing industries use a lot of water.

(e) High rate of rural-urban migration and the expansion of major villages.

2. (a) Price the water to ensure that those who consume excessive

amounts are penalised.

(b) Reduce water pressure in water taps especially in drought periods.

(c) Impose water restrictions e.g. in the drought period of the 1980s the use of hose pipes and watering gardens at home was not allowed.

(d) Build houses with water conservation measures in their design e.g. rainwater catchment tanks, low volume shower-heads, dual flush toilet cisterns etc.

(e) Reduce leaks in the water systems.

(f) Educate people about the need to conserve water.

3. (a) Helsinki Rules - these are rules or laws that govern the use of international rivers or water. They provide for the equitable distribution of water resources by member states that happen to share the rivers or water courses.

(b) SADC Protocol on Shared Watercourses- this is an agreement between SADC member states on the use of shared water resources in the region.

(c) OKACOM - this is an agreement between Botswana, Namibia and Angola on the use of water in the Okavango River.

(d) Ramsar Convention- this is a United Nations Convention that governs the use of all wetlands and water courses in the world.

4. (a) **Agricultural waste**

Agricultural chemicals, fertilizers and pesticides used mostly in crop fields are usually carried by running water into rivers and streams. They finally end up polluting the downstream and water resources.

They can also sink into the soil and pollute ground water resources.

(b) **Nitrate pollution**

Ground water resources are mostly polluted by nitrates. This is mostly the case of many big villages such as Mochudi and Ramotswa. The main source of nitrate is faecal matter resulting from improperly constructed pit latrines. Boreholes constructed adjacent to pit latrines in big villages record a high nitrate content.

(c) Domestic waste

Domestic waste such as refuse and garbage at times are not properly dumped. It gets dumped in rivers and streams ending up polluting water resources in these areas.

(d) Industrial waste

Some of the industries release waste water into streams and rivers. Some of the toxic waste from industries can therefore be said to be dumped in wrong areas.

(e) Aquatic weeds

These weeds were first seen in Botswana in 1986 in the Okavango Delta. The weeds destroy plant life, fish life and block the fast flow of waters in the Okavango Delta.

Total [18 marks]

Assessment



Assessment

This assessment must be done after successfully completing the unit, including the assignment. Submit or post it to your tutor for marking. You will need 1 hour to work on this assessment

Instructions

- Answer all questions
- Write your answers in the spaces provided.

1. Using arrows match the following processes with their correct definitions [8 marks]

Precipitation	The process by which moisture from plants changes into vapour and is released into the atmosphere
Condensation	Flowing of water on land surface from high to low ground.
Infiltration	The changing of water vapour to liquid
Surface runoff	The process in which water moves down filling the porous of the soil
Transpiration	The process by which underground water flows and discharges into the sea
Through flow	The changing of water from liquid to gas
Run-off	The process by which water molecules condense and forms water drops
Evaporation	The process by which ground water moves into the saturated zone below the earth's surface

2. Name **three** sources of water vapour that are important in the water or hydrological cycle. [3 marks]
3. Give **two** main types of water sources that Botswana depends on. [2 marks]
4. Name **five** areas where water is mostly used by human beings for socio-economic purposes. [5 marks]
5. State **two** advantages and two disadvantages of using dams and

boreholes as sources of water. [4 marks]

6. Explain **five** factors that influence water demand in Botswana.
[5 marks]
7. Describe **five** measures that can be taken to ensure water conservation. [5 marks]
8. Name any **two** international protocols that govern the use of shared water resources.[2 marks]
9. Name a perennial river that is shared by Botswana and the following countries [2 marks]
South Africa - _____
Namibia _____
10. Suggest **two** problems that may arise when countries share a water source [4 marks]

Total = [20 Marks]

Feedback

1. The following are matched with their correct definitions

Precipitation	The process by which water molecules condense and forms water drops , falling in the form of rain/snow/hail
Condensation	The changing of water vapour to liquid
Infiltration	The process by which ground water moves into the saturated zone below the earth's surface
Surface runoff	The process in which water moves down filling the porous of the soil
Transpiration	The process by which moisture from plants changes into vapour released into the

	atmosphere
Through flow	The process by which underground water flows and discharges into the sea
Run-off	Flowing of water on land surface down the slope
Evaporation	The changing of water from liquid to gas

2. (a) Sea/ocean
- (b) Forests or green plants
- (c) Lakes, rivers etc.

3. (a) underground water
- (b) surface water

4. (a) Settlements
- (b) Mining
- (c) Energy
- (d) Agriculture
- (e) Industries

5. Dams

(a) Advantages

- Water can be used for many purposes like irrigation and sport.
- Water is easily trapped and stored in the lake for use even in drought periods.

(b) Disadvantages

- Displacement of settlements
- It is easy for water to be polluted e.g. from oil if boating is done in the dam.

Boreholes

(a) Advantages

- Provision of water can be made available through different boreholes in different parts of the country.
- Less expensive when compared to the construction of dams.

(b) Disadvantages

- Unreliable e.g. often break down
 - Maintenance can be expensive.
6. (a) Increase in human and livestock (especially cattle) populations in the country that demand the use of water.
 - (b) Rapid rate of urbanisation in Botswana, i.e. urban centres are growing at a fast rate and need a lot of water.
 - (c) Industrialization- Botswana is slowly developing industries which in turn use a lot of water.
 - (d) Development of the mining sector- mines as processing industries use a lot of water.
 - (e) High rate of rural-urban migration and the expansion of major villages.
7. (a) Price the water to ensure that those who consume excessive amounts are penalised.
 - (b) Reduce water pressure in water taps especially in drought periods.
 - (c) Impose water restrictions e.g. in the drought period of the 1980s the use of hose pipes and watering gardens at home was not allowed.
 - (d) Build houses with water conservation measures in their design e.g. rainwater catchment tanks, low volume shower-heads and dual flush toilet cisterns.
 - (e) Reduce leaks in the water systems.
 - (f) Educate people about the need to conserve water.
8. (a) Helsinki Rules - these are rules or laws that govern the use of international rivers or water. They provide for the equitable distribution of water resources by member states that happen to share the rivers or water courses.
 - (b) SADC Protocol on Shared Watercourses- this is an agreement between SADC member states on the use of shared water resources in the region.
 - (c) OKACOM - this is an agreement between Botswana, Namibia and Angola on the use of water in the Okavango River.
 - (d) Ramsar Convention- this is a United Nations Convention that governs the use of all wetlands and water courses in

the world.

9. Perennial river that is shared by

Botswana and South Africa - Limpopo

Botswana and Namibia - Okavango and Nossop

10. Problems that may arise when countries share a water source

- Poor management of water resources

- Pollution of water resources

- Damming rivers upstream

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Unit 6

Utilisation and Management of Wildlife Resources

Introduction

Welcome to Unit 6 of the Geography 12 programme. In unit 5 you learnt about the utilisation and conservation of water resources. In this Unit, you will learn about the utilisation and conservation of another important natural resource of Botswana: wild animals. Since historic times, animals have been highly useful to us in providing food, clothing and a source of income. Animals also play an important role in the ecological and biological processes. Botswana is one of the famous African countries known for its variety of wildlife. About 90% of the country is covered by the savannah type of vegetation which supports a great variety of wild animals. In 2002, at least 164 species of mammals and 550 species of birds were recorded. Botswana has also recorded the highest number of elephants in the world. The government has availed thousands of square kilometres of land for wildlife protection. In this unit we will discuss protection of wild animals in these areas. We will also discuss the role of stakeholders in the sustainable utilisation and management of wild animals in Botswana.

This unit is relatively short and is divided into 2 topics as follows:

Topic 1 describes the environmental conditions that favour the existence of wild animals in Botswana. We will identify and locate, on a map, areas of wild animal management in Botswana. The topic further discusses the importance of wild animals to the economy of Botswana and the impact of wild animals on the environment.

Topic 2 discusses the land use conflicts between the management of wild animals and the other land use activities and conservation strategies and also evaluates the role of the stakeholders in the sustainable use and management of wild animals in Botswana.

Upon completion of this unit you will be able to:



Outcomes

- *identify* and locate on a map areas of wildlife management- case study: Botswana.
- *discuss* the importance of wild animals as a resource to Botswana's economy.
- *discuss* the impact of wild animals on the environment.
- *discuss* the conflicts between the management of wild animals and other land use activities.
- *evaluate* the role of the stakeholders (Government, Non-Governmental Organisations (NGO's) Private Sector, Local Authorities and Local Communities) in the sustainable use of wild animals.

Teaching and Learning Approach

In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experiences or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. Most libraries in your country do have some information on tourism. There are some magazines, pamphlets, books, etc which contain important information on tourism and wildlife. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near any tourism centre such as an educational centre or a national park you are advised to collect any relevant information from such centres. If you have access to the internet, you may access links given. The internet links are meant to give you more information on a particular topic. Do not worry if you have no access to the internet, as content provided in each topic is adequate. If you are registered with any distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counselling support.

Study centres are resourceful because you may have access to additional resources, maps and relevant videos. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any difficulties you experience in this unit. Note that the amount of time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or at least before you attend the tutorials. This will help you raise questions on difficult areas of your study materials.

I would like to once again emphasise that, active learning or effective participation throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions will you be in a better position to link wild animals resources with other natural resources covered in units 5, 7, 8 and 9.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the information relevant to different sections of the topic and form part of your learning.

They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately below the activity. If you do not do well in the activities do not be discouraged. You may review the section related to the activity and carry on with the topic later with more concentration. You are advised to review the sections you did not do well on before continuing with the topic.

On completion of each topic, you are advised to go to the assignment section found at the end the unit. You will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low you must not get discouraged. Instead, appreciate the score and try again by going over the topic and the exercise.

The self-assessment assignment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed the unit and the topic assignments. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information, discuss with other learners or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor then you can go on to the next unit.

Time

Each topic will require 2 hours of studying, including the time to do exercises. Since this unit has a total of 2 topics, you will then require 4 hours to complete it. Depending on your work pace, you may take longer or even lesser time to complete each topic. The 2 hours is inclusive of a topic self-assessment exercise found at the end of the unit. On completion of the unit, you are advised to go straight into the tutor-marked assessment that should take you one hour to complete.



Terminology

Adaptation:

The ability of an animal (or living thing) to live or survive in given environmental conditions.

Antelope:

Any herbivorous animal with a cloven hoof. It has its eyes on the sides of its face.

Carnivore:

An animal that feeds on other animals.
An animal that feeds on plants only.

Herbivore:

Provision of services of accommodation, food and comfort to visitors.

Hospitality:

Predator:

An animal that hunts and kills other animals to feed upon.

Protected area:

Piece of land in which natural resources are conserved.

An animal that feeds on both plants and

Omnivore:	other animals.
Sustainable development:	Using resources to meet one's own needs, and conserving them at the same time for future generations to use them as well.
Translocation:	Capturing live animals and moving them to another region or country.
Trophy:	Valuable products from animals (e.g. skin, tusks).

Topic 1: Introduction to Wild Animals Resources in Botswana

Introduction

Botswana is one of the few countries in the world which still have a variety of wild animals. Some of the big animals include elephants, zebras, lions, buffaloes, rhinos,(known as the big five), while the smaller ones include impalas, hare, foxes, hyenas, duikers and many others. In this topic, you will learn about areas used for wild animal management and how wild animals are important to the economy of Botswana. You will finally learn about the impact of wild animals to the environment.

Learning Objectives

At the end of the topic, you should be able to:

- identify and locate on a map areas of wild animal management in Botswana
- discuss the importance of wild animals to the economy of Botswana
- discuss the impact of wild animals on the environment.

1.0 Factors making it possible for Botswana to keep large herds of animals

There are certain environmental factors that make it possible for Botswana to keep a large and varied population of animals. These factors are as follows:

a) The position of Botswana in the climate system

Botswana is situated in the tropical continental climate (also known as the Savannah). The savannah is characterized by long, hot, wet summers, and short, warm, dry winters. These conditions are suitable for the growth of natural vegetation that provides vast grazing

resources for a variety of herbivores. The vegetation is predominantly characterized by grasses. Hence, it is known as the savanna.

b) A varied savanna type of natural vegetation

The natural vegetation provides both the habitat and food for animals. At least four types of savanna vegetation are found in Botswana: tree and bush savanna in the central region, bush savanna in the Kalahari region, arid savanna found further south-west, and grass savanna in the north around major depressions and river plains. Figure 1 shows elephants in the bush savanna in Botswana.



Figure 1: Elephants roaming the bush savanna in Botswana

Source: http://en.wikipedia.org/wiki/File:African_Bush_Elephants.jpg

Retrieved: 13/04/11

c) The land

Much of Botswana's land is characterized by plains, i.e. relatively flat topography with vast open land. Such plains tend to be dominated by grasses that are grazed upon by herbivores. Figure 2 shows a springbok, one of the animals found in the savannas. Why do you think antelopes prefer open plains to forests? Yes! They need to see their enemies from afar.



Figure 2: A Springbok on Botswana's Plains

Source: http://en.wikipedia.org/wiki/Wildlife_of_Botswana

(Date: 03/09/10)

d) Adaptation to the semi desert environment

Some animals such as the gemsbok (shown in Figure 3) are able to go long periods without water. As such, the animals are suited to arid conditions of western Botswana. The scenarios described in sections a) – d) suggest that the entire physical environment of Botswana is a habitat to a wide variety of wildlife resources because different species are adapted to different environmental conditions.



Figure 3: Gemsbok: adapted to arid environments

Source: http://en.wikipedia.org/wiki/Wildlife_of_Botswana

(Date: 03/09/10)

You can now see that Botswana's environmental conditions can support a large number and a great variety of wild animals. Let's now see where and how wild animals are managed in certain parts of Botswana.

2.0 Areas of wild animal management in Botswana

As already mentioned in the introduction of this Unit, Botswana is one of the few countries in the world which is still endowed with a variety of wild animals. Most of these animals are protected by the laws of Botswana in areas called **national parks** or **game reserves**. Some of the wild animals are found in areas called **Wildlife Management Areas (WMAs)** and **Controlled Hunting Areas**

(CHAs).

The map provided below (Fig 4) shows national parks, game reserves, Wildlife Management Areas and Controlled Hunting Areas in Botswana. Study the map carefully.

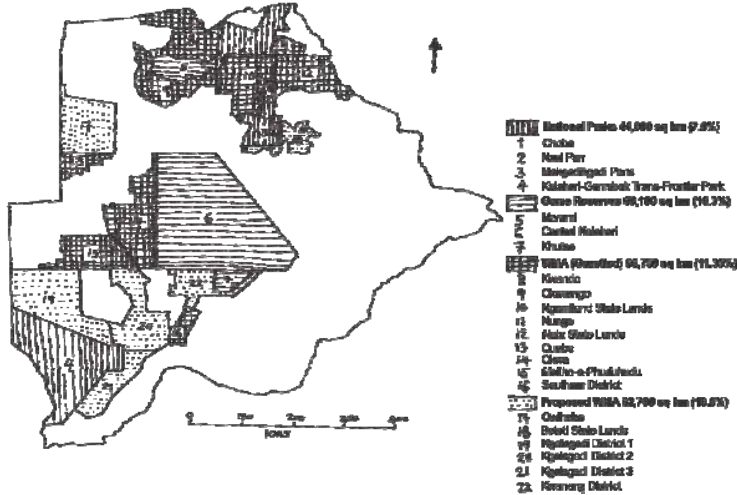


Figure 4: A Map showing protected areas in Botswana

You have studied on the above map the national parks and game reserves in Botswana. You should now move onto Activity 1, which should be easy to do because the answers can be found on the map.



Activity 1

With the aid of the Map of Botswana in Fig 4 identify and name at least **three** national parks and **two** game reserves shown. List them in the space given below. [5 marks]

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

From the map you should have realised that Botswana has many national parks and many game reserves. You should have mentioned any of the following:

- (a) Chobe National Park
- (b) Moremi Game Reserve
- (c) Gemsbok National Park

(d) Makgadikgadi and Nxai Pans National Park

(e) Central Khalahari Game Reserve

(f) Khutse Game Reserve

(g) Tuli Game Reserve

(h) Gaborone Game Reserve

All the game reserves and national parks are called protected areas and they occupy about 17% of Botswana's total surface land area. National parks and game reserves are called protected areas because all natural resources in these areas are protected by law. No one is allowed to use them or hunt without permission from the government.

As already mentioned, apart from protected areas, wild animals are also found in areas called Wildlife Management Areas (WMAs) and Controlled Hunting Areas (CHAs). Wildlife Management Areas and Controlled Hunting Areas are different from protected areas in that hunting or harvesting of natural resources in these areas is allowed at certain times of the year. However, the harvesting of these natural resources is closely monitored and licences are required. Wildlife Management Areas and Controlled Hunting Areas can be found in almost all the districts in Botswana. They cover a total of about 22% of Botswana's surface land area. As a result, about 39% of Botswana's surface land area is set aside for wild animal management.

3.0 The importance of wild animals to the economy of Botswana

Wild animals are important to Botswana's economy because of their many uses to human beings. These uses are mainly **consumptive** and **non-consumptive**. Do not worry if you do not understand the meaning of these two words. First do Activity 2 below which will make the meaning of the words clearer to you.



Activity 2

State **five** uses of wild animals which you think are important to people and to the economy of Botswana. Write your answers in the space provided below.

[5 marks]

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

Probably you mentioned any five of the following: employment creation, lease and rental fees, taxes and hunting licences. They are also a source of food, like meat for example. Animals also provide raw like skins and feathers for industries. Now let us look at each one of them in more details.

(a) Employment creation

Over 8 000 people in Botswana are employed in wildlife and tourism related sectors e.g. employed by the Department of Wildlife and National Parks, Department of Tourism, in hotels, safari companies among many others.

(b) Revenue and Foreign exchange

Wild animals in protected areas generate revenue for the Botswana Government through the following ways:

(i) Gate Fees

Gate fees are paid by tourists when entering a protected area. The table below shows what government generated from gate fees in 1996.

Table 1: Tourists numbers and revenue generated from protected areas, 1996

Protected Area	Number of Tourists	Revenue Generated in Pula
Chobe National Park	48,481	3,011,705.00
Moremi Game Reserve	23,504	2,448,316.00
Nxai Pan National Park	915	97,559.00
Makgadikgadi Pans National Park	684	42,504.00
Central Kgalagadi Game Reserve	1,164	110,392.00
Khutse Game Reserve	1,249	71,421.00
Gemsbok National Par	745	53,152.00
Total	76,742	5,835,051.00

Source: Department of Wildlife and National Parks **Annual Report of 1996/97**.

Tourists are also charged camping fees and vehicle fees when they are in protected areas. All this money goes to government coffers. **(ii) Lease and Rental Fees**

A land lease is a rental on the use of the land. Tour operators in wildlife areas are charged lease and rental fees by government. Some pay to district councils.

(iii) Taxes

Private business people such as hotel owners in wildlife areas pay taxes to government.

(iv) Hunting licences

Both commercial and subsistence hunters are charged fees for hunting wild animals. The fees are paid to the government.

c) **Developments**

Revenue earned from wild animals is used to develop the country. Infrastructure in the form of roads, airports and hotels, are some of the examples of such developments.

d) **Industries**

Some industries have emerged as a result of wildlife. Botswana is also involved in commercial wildlife production in the form of farming and ranching.

From information we have covered so far, we can conclude that wild animals are important to the economy of Botswana because of their **consumptive** and **non-consumptive uses**. Let us now move on to find out what this means in more detail.

e) **Source of Food**

Some wild animals are an important source of food. This has led to game farming. Can you name any wild animals kept by farmers in Botswana? You may have seen some ostrich and crocodile farms in Botswana. These animals are exported for their meat and other by-products.

You now understand the importance of wild animals. If they are so important to humans how are they used? In the next section we will look at the way wild animals are used.

3.1 Consumptive and non-consumptive wildlife utilisation

The way animals are used can be categorised into consumptive and non-consumptive uses or utilisation.

Consumptive use of wild animals includes activities such as hunting for commercial, sport or trophy purposes. This also refers to hunting done for subsistence purposes. Consumptive wildlife utilisation also includes game farming, live capture and export of live animals or trophy processing.

Non-consumptive wildlife utilisation mainly involves photographic tourism. This include activities such as photographic safaris, photographic camps and lodges, hotel business, air charter operators, the wildlife film industry, educational, recreational parks and religious activities.

Both consumptive and non-consumptive wildlife utilisation gives wild animals a significant role in the economic development of Botswana. Botswana's tourism industry is mostly wildlife based. Tourist activities in the country mostly involve visiting wildlife protected areas. Tourism has become the third largest industry after diamonds and beef in Gross Domestic Product (GDP) contribution to the country's economy.

You now know the importance of wildlife to the economy of Botswana. This means that wildlife has a huge impact on the economy of the country. Let us now find out about the impact of wildlife on the environment.

4.0 The impact of wild animals on the Environment

Apart from the economic impact of wild animals mentioned above, it is important for you to know

that wild animals also have negative and positive impact on the environment as well. First let us look at the positive impact on the environment.

4.1 Positive impact of wild animals on the environment

A positive impact of wild animals on the environment refers to the good and desirable things that wild animals bring to the environment. Attempt the following activity before we look at some of the positive impacts.



Activity 3

Think of some of the good things that wild animals do to the environment. Describe at least **two** of these good things in the space provided below.

(a) _____

(b) _____

Feedback

I hope you mentioned the following:

Makes the environment beautiful - the presence of wild animals in the forest makes it beautiful and full of life. In Botswana, you may have heard people saying “diphologolo makgabisa naga”, meaning wild animals, decorators of the environment. This is a common saying during the world environmental day celebrations.

Maintains balance in the ecosystem - wild animals are part of the ecosystem, that is, the environment is able to function well because of wild animals e.g. some animals feed on each other so that life for these animals can continue. Wild animals therefore, are part of the food chain.

4.2 Negative impact of wild animals on the environment

There are also negative things which occur to the environment as a result of having wildlife. This refers to the undesirable effects that wild animals have on the environment. Try activity 4 to brainstorm on what you know about the negative impacts of wild animals.



Activity 4

Think of some of the bad things which wild animals do to the environment. Write at least **three** of them in the spaces below.

- (a) _____

- (b) _____

- (c) _____

Feedback

Some of the negative effects of wild life are: overgrazing causing soil erosion, destruction of vegetation and spreading diseases. I hope you got them correctly. An explanation of these three negative effects is given below.

(a) Overgrazing and soil erosion

If too many animals occupy a small area, they can overgraze the area and cause soil erosion. The elephant population in Botswana is believed to be causing soil erosion especially in Chobe National Park and Moremi Game Reserve.

(b) Destruction of vegetation

There is destruction of vegetation especially by elephants which are assumed to be beyond the carrying capacity in Botswana. There are about 79,480 elephants in Botswana. The destruction of vegetation along the Chobe River front has resulted in a call for the reduction of the elephant population in the country by environmentalists.

(c) Spread of diseases

Some wild animals have a potential of spreading diseases to others. Buffaloes, for example, can spread foot-and-mouth to other hoofed wild animals such as wildebeests and even to domestic animals like cattle.

5.0 Summary

In this topic, you learnt that Botswana has favourable climatic and vegetation that supports a great variety of wild animals. We also looked at areas used for wild life management in Botswana, of which game parks and reserves cover about 17% and Wildlife Management Areas (WMAs) and Controlled Hunting Areas which cover about 22% of Botswana's surface land area.

You also learnt that wild animals are important to the economy of Botswana because of their

consumptive and non-consumptive uses. Through tourism, commercial hunting, gate fees, taxes and many other tourist activities, government is able to generate revenue.

Finally, you learnt that wild animals impact positively and negatively to the environment. Positive impacts include making the environment beautiful and maintaining a balance in the ecosystem. Negative impacts include overgrazing, soil erosion and the destruction of the vegetation.

Now that you have finished Topic 1, attempt the Self-Assessment Exercise 1 given at the end of the unit in the Assignment section. If you fail to get all the questions right read over the relevant sections of the topic again.

Once you have completed the exercise, checked your answers against those provided, proceed to Topic 2 if you are happy with your progress. If not happy, revise the sections where you did not do well before proceeding to the next topic.

Topic 2: Management and Sustainable use of Wild Animals

Introduction

Land use conflicts are common in wildlife areas. Land users in these areas demand the use of the same piece of land hence conflicts arise. In this topic, you are going to discuss some of the major land use conflicts in wildlife areas. You are also going to learn about the role stakeholders in the wildlife areas can play in the sustainable use of wild animals in Botswana.

Learning Objectives

At the end of the topic, you be able to:

- discuss the land use conflicts between the management of wild animals and the other land use activities
- evaluate the role of the stakeholders in the sustainable use of wild animals in Botswana.
- assess the wildlife conservation strategies in Botswana

1.0 Land Use Conflicts in Wildlife Areas

Conflicts in wildlife areas are mostly land use related. Different land users do not always agree on the use of the same piece of land.



Activity 1

Name about **five** groups of people that you think can be interested in using areas occupied by wild animals.

(a) _____

- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

Government Departments, the private sector, local communities, local authorities, researchers and conservation groups, are some of the people interested in using areas occupied by wild animals. These are not the only ones. The ones which you put are probably correct.

There are many groups which may want to use land reserved for animals differently. In the process there are likely to be conflicts. Below are some of the groups with an interest in the land reserved for animals.

- (a) Government represented by the following departments:
 - Lands
 - Wildlife and National Parks
 - Crop Production
 - Animal Health and Production
 - Tourism
- (b) Private sector represented by the following:
 - tour operators
 - safari hunters
 - hotel owners or hoteliers
 - air charters
- (c) Local communities
- (d) Local authorities represented by the following:
 - Councils
 - Land Boards
- (e) Researchers
 - University of Botswana
- (f) Conservation groups such as:
 - Khalahari Conservation Society
 - Okavango People’s Wildlife Trust
 - Conservation International

All the groups above are stakeholders in land use and are the ones most likely to have conflicts in

wildlife areas. Let us now move on to look at areas of conflicts.

1.2 Areas of conflicts over land use

Let us first brainstorm on some of the land use conflicts that are likely to be experienced in wildlife areas by attempting to do Activity 2 below. Just think of some of the quarrels the different groups are likely to find themselves into when they are sharing the same piece of land.



Activity 2

Having identified the groups that are likely to conflict in wildlife areas, explain **five** types of land use conflicts that are likely to occur.

- (a) _____

- (b) _____

- (c) _____

- (d) _____

- (e) _____

Feedback

There is no wrong answer to this exercise. Any possible cause of conflict between stakeholders should be taken as correct. However, as I have already mentioned, conflicts in wildlife areas are land use related.

Some of the common conflicts are discussed below.

(a) Conflicts between arable farmers and wildlife management

The conflicts are usually caused by such animals as elephants, zebras and hippos that destroy subsistence farmers' crops. The government offers these farmers compensation which they feel is too little resulting in conflicts. Sometimes subsistence farmers living in wildlife areas then hunt and kill the wild animals. This creates tension between them and the government which argues for the preservation of the animals.

(b) Conflict between livestock farmers and wildlife management

In a similar case to the one above regarding crop production, predators such as lions, hyenas, leopards, jackals kill livestock. Compensation from government is also considered small and hence, the conflict with wildlife management.

(c) Veterinary fences and wildlife management

The expansion of the cattle industry in Botswana and the need to protect livestock from foot-and-mouth disease in order for Botswana to have access to European markets has resulted in the erection of veterinary fences across many rangelands in Botswana. Some of the veterinary fences block wildlife movements and has resulted in the death of many wildlife species in the country. Conflict has therefore resulted between the Department of Wildlife and National Parks in the Ministry of Commerce and Industry and the Department of Animal Health and Production in the Ministry of Agriculture. Some of the fences are the Buffalo, Kuke and CBPP fences in Ngamiland.

(d) Expansion of human settlement into wildlife areas

Human settlements in wildlife areas keep on expanding causing conflict with the wildlife and tourist industries(eg.Xade and Khwai).

A related factor is that tourists expect to find complete wilderness when visiting wildlife areas. However, this is disturbed by human settlements and the presence of livestock resulting in conflict between tour operators and local communities since they negatively impact the tourism business.

Communities in or around protected areas expect to be allowed to hunt or collect veld products in national parks and game reserves. These activities are not allowed by wildlife managers and hence results in conflicts between the two.

2.0 Role of stakeholders in sustainable wildlife management

For sustainable wildlife utilization to be possible all stakeholders in the wildlife industry need to be involved in policy formulation, implementation and policy review. I hope you still remember some of the groups which are likely to have conflicts in wildlife areas. These groups can therefore be taken as stakeholders in the sustainable use of wild animals in Botswana and should be involved in policy formulation. Thus policy formulation must include:

- Government (e.g. Departments of Wildlife and National Parks, Tourism, Animal Health and Production, Crop Production, and National Conservation Strategy)
- Local Authorities (e.g. Land Boards, Councils and Tribal Administration)
- Private Sector (e.g. Safari operators, lodge and hotel owners and safari hunters)
- Local people (i.e. people living in wildlife areas who are mostly subsistence farmers)
- Conservation groups e.g. Khalahari Conservation Society
- Research groups e.g. University of Botswana.

Try activity 3 to find out how much you know about the above listed stakeholders.



Activity 3

Apart from the policy formulation, implementation, and review, what role do you think stakeholders in wildlife areas can play in the sustainable use of wild animals? Write your explanation in the space provided below.

(a) Government _____

(b) Private Sector _____

(c) Local Authorities _____

(d) Local Communities _____

(e) Conservation Groups _____

(f) Research Groups _____

Award yourself a mark for each correct response

Feedback

Some of the roles they can play include the following:

Government - through the Department of Wildlife and National Parks, the government should be responsible for the management and the development of wildlife resources taking into consideration the views of all the stakeholders. The government can also facilitate all the policy and other legislative related issues. Government should also provide empowerment of the local communities.

Private Sector - it is expected to identify business opportunities in the wildlife industry, develop effective management structures for maximum economic returns and provide empowerment of local communities.

Local Authorities - should allocate land to be used for tourist activities. They should also explain procedures to secure land rights vis-à-vis wildlife management and utilisation.

Research Groups - should do the necessary data collection and provide information on how wild animals are to be utilized without depletion.

Conservation Groups - should also conduct research, lobby for funds to enable local communities' participation in the wildlife and tourism industries and complement government efforts in facilitating conservation of the wildlife resources.

Local Communities- particularly rural communities should be involved in the management and utilisation of wildlife resources in their areas. They should re-establish themselves as managers and benefit from the natural assets of the areas in which they live.

Now that we understand the role played by different stakeholders in the sustainable use of wild animals, let us look at various wildlife conservation strategies in Botswana.

3.0 Wildlife conservation strategies in Botswana

Wildlife conservation strategies refer to different methods or ways of protecting, preserving of wildlife including their environment or natural habitat. In Topic 1 you learnt that Botswana has wildlife protected areas. This is one of the strategies used to conserve wildlife.

Botswana has developed laws and policies aimed at protecting and conserving wildlife. For example, the Wildlife and Conservation and National Parks Act was introduced in 1992 and focused on the conservation and management of wildlife in Botswana. In addition Botswana has strongly committed itself to a number of international agreements aimed at conserving natural resources world-wide. This includes the membership of the Convention on International Trade in Endangered Species (CITES): an international agreement that provides regulations on trade of wildlife and wildlife products for conservation purposes. Let's now assess CITES and see if it promotes conservation of wild animals in Botswana.

3.1 Botswana as a Member of CITES

CITES is one of the largest conservation agreements in which participation is voluntary. Member countries have agreed to be bound by the Convention known as Parties. The Convention contains lists of species grouped in different levels or appendices I, II and III which states the type of protection from over-exploitation.

Botswana is classified under Appendix II. Appendix II lists species that are not necessarily threatened today with extinction but they may become extinct unless trade is closely controlled. Botswana has over 150, 000 elephants, which is said to be the largest population in Africa. Therefore, the country feels its elephants are in no way threatened and are actually causing massive destruction to the forests. Besides destruction of vegetation, elephants are in competition for land as they continue to occupy more space and destroy crop fields. In the past couple of years, Botswana has been allowed by

CITES to reduce the number of elephants, and the profits gained by trading in products made from elephants went towards wildlife conservation.

As a strategy to conserve wildlife, Botswana is encouraged to participate and work hand in hand with non-governmental organisations. Let us now see how Botswana participates in the Cheetah Conservation.

3.2 Cheetah conservation in Botswana

Do you think there is a need to conserve cheetahs in Botswana? Definitely! There is a need to conserve cheetahs in Botswana because their numbers are decreasing. Besides being an attractive animal to view (see figure 3) cheetahs also play an important role in balancing out the ecosystem.



Figure 3: Cheetah

Source: http://en.wikipedia.org/wiki/File:Cheetah_Botswana.jpg

Retrieved: 13/04/11

We now know that cheetahs are decreasing in number because people kill them for various reasons. In Botswana cheetahs are viewed as predators with a huge impact on livestock farming.

Cheetah Conservation Botswana formed in 2003 aims to protect the nation's diminishing cheetah population through community outreach programmes, scientific research and education. The cheetah population in Africa has been classified very vulnerable endangered species by various international conservation organisations such as the International Union for Conservation of Nature (IUCN).

The cheetahs in Botswana are protected by the laws of Botswana and internationally by CITES. The

major challenge of this project is to get the communities to accept to live side by side with a predator like a cheetah (It's difficult to foster the attitude of co-existence). However, with more education programmes most farmers understand the value of such animals.

Besides the Cheetah conservation project, Botswana is also involved in conservation projects like the Community-Based Natural Resource Management Projects (CBNRMP).

3.3 Community-Based Natural Resource Management Projects (CBNRMP)

The concept Community Based Natural Resource Management (CBNRM) was introduced in 1989 to Botswana as a USAID-funded natural resource management project, coordinated by the Department of Wildlife and National Parks (DWNP) and IUCN-Botswana. The aim of CBNRM is to promote natural resources conservation and sustainable utilisation by the local communities, while reaping economic and social benefits.

The Botswana Government is currently encouraging Community Based Natural Resource Management Projects in which local communities are encouraged to participate in the conservation and efficient management, nurturing and harvesting of natural resources. In other words, these projects are meant to provide wildlife benefits to the local people living in areas where the wild life occurs. The idea is that once local people obtain the benefits they will realise the importance of wildlife and conserve them or use them sustainably. In other words, they will stop activities like poaching which are detrimental to their environment or to the survival of wild animals.

The first CBNRM projects started in 1993, called Chobe Enclave Conservation Trust. The project has grown significantly and to date there are 46 registered and developed trusts covering 150 villages with approximately 135,000 people. The various CBNRM activities created 8080 jobs and generated P16.3 million in revenue by 2006. Most of the revenue was generated by wildlife-based CBOs, particularly trophy hunting and photographic tourism. The revenues rose to P22.8 million in 2007 for wildlife-based community-based trusts alone. We can then conclude that CBNRM is a development project approach that does not only benefit local people but also promotes natural resources conservation, and because of this project some endangered species have survived total extinction.

4.0 Topic Summary

In this topic, you learnt about land use conflicts that are mostly experienced in wildlife areas. This includes conflicts such as those between local communities and wildlife officials. Wild animals destroy crops and some kill livestock resulting in the conflict with farmers. Some conflicts include those between the wildlife and tourist industry on one hand and the Department of Animal Health and Production on the other. The Department of Animal Health and Production erects veterinary fences which have become detrimental to wildlife species upon which Botswana's tourism industry is based.

In this topic you also learnt some strategies employed to bring about conservation of wildlife. We also looked at the stakeholders in wildlife areas and this includes groups such as government, private sector, local communities, non-governmental organisations and research groups. You also learnt about the role each group can play in the sustainable use of wild animals. The most important role

that all groups can jointly play is that of policy formulation or decision-making as well as the implementation of these policies regarding the utilisation and management of wild animals in the country.

Do the Self-Assessment Exercise 2 given under the assignment section. On completion of this exercise mark your own work and when you are satisfied with the results, go through the unit summary then proceed to the unit assessment exercise.



Summary

Unit Summary

In this Unit, you learnt about the environmental factors that favour wild animals in Botswana. You also learnt about national parks and game reserves in Botswana in particular, which you located. You went on to learn about land use conflicts that are mostly experienced in wildlife areas. This includes conflicts such as those between local communities and wildlife officials. Wild animals destroy crops and some kill livestock resulting in conflict with farmers. Some conflicts include those between the wildlife and tourist industry on one hand and the Department and Animal Health and Production on the other. The Department of Animal Health and Production erects veterinary fences which have become detrimental to wildlife species upon which Botswana's tourism industry is based. We also looked at various strategies in place to conserve wildlife in Botswana. Besides laws and conservation policies, Botswana has signed other agreements like CITES and Botswana are encouraged to participate in projects like CBNRM.

You also learnt about stakeholders in wildlife areas. These include groups such as government, local communities, non-governmental organisations conservation groups and research groups. You also learnt about the role each group can play in the sustainable use of wild animals. The most important role that all groups can jointly play is that of policy formulation or decision-making as well as the implementation of these policies regarding the utilisation and management of wild animals in the country.

Congratulations again! You have now come to the end of Unit 6. The reference materials at the end of the unit will help you get additional information, some of which is available on the internet and others, possibly in your local library. However, if you cannot find any of the recommended information, do not worry because this unit contains enough information on its own.

Remember that immediately after the references and the Self-Assessment exercises is the unit assessment which you must do and send or post to your tutor for marking. If you receive low marks, go over the unit again and do the necessary corrections.



Assignment

Unit Assignment

Instructions

Note that this assignment is divided into two self-assessment exercises. As mentioned in the teaching and learning approach of the unit, each self-assessment exercise is for a certain topic. For example, self – assessment 1 is for Topic 1 in this unit.

Answer all questions. On completion of an exercise, mark your own work, referring to answers at the end of the assignment.

You are advised to take **30 minutes** on each exercise.

Self-assessment Exercise 1

1. List any **five** national parks or game reserves which you know. [5 marks]

- (a) _____
(b) _____
(c) _____
(d) _____
(e) _____

2. State **five** factors that make wild animals important to the economy of Botswana. [10 marks]

- (a) _____
(b) _____
(c) _____
(d) _____
(e) _____

3. Discuss **two** positive effects of wild animals on the environment. [4 marks]

- (a) _____

(b) _____

4. Discuss **two** negative impacts of wild animals on the environment. [4 marks]

- (a) _____

(b) _____

Total = [23 Marks]

Self-assessment Exercise 2

1. Name any **five** land users in wildlife areas of Botswana. [5 marks]

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

2. Give and explain **three** examples of land use conflicts in wildlife areas. [6 marks]

- (a) _____
- (b) _____
- (c) _____

3. Name any **five** stakeholders in wildlife areas. [5 marks]

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

4. Explain **three** roles that stakeholders can play in the sustainable use of wild animals. [6 marks]

(a) Government

(b) Private Sector

(c) Local Communities

Total = [22 Marks]

Check how well you did from the answers at the end of this Unit.

Self-assessment exercise answers:

Self-assessment exercise 1

1. (more than 5 are listed here for your reference)

- (a) Chobe National Park
- (b) Moremi Game Reserve
- (c) Gemsbok National Park
- (d) Makgadikgadi and Nxai Pans National Park
- (e) Central Khalahari Game Reserve
- (f) Khutse Game Reserve
- (g) Tuli Game Reserve

2. (a) Employment creation - over 8 000 people in Botswana are employed in wildlife and tourism related sectors.

(b) Gate Fees or takings, - wild animals in protected areas generate revenue for the Botswana Government through gate fees paid by tourists when entering a protected area. Tourists are also charged camping fees and vehicles fees when they use them in protected areas. All this money goes to government coffers.

(c) Lease and Rental Fees - tour operators in wildlife areas are charged lease and rental fees by government. Some pay to district councils.

(d) Taxes - the private business people such as hotel owners in wildlife areas pay taxes to government.

(e) Hunting licences - both commercial and subsistence hunters are charged fees for hunting wild animals. The fees are paid to government.

3. (a) Make the environment beautiful - the presence of wild animals in the forest make it beautiful and full of life.

(b) Maintain balance in the ecosystem - wild animals are part of the ecosystem, that is, the environment is able to function well because of wild animals e.g. some animals feed on each other so that life for these animals can continue. Wild animals therefore, are part of the food chain.

4. (a) Overgrazing and soil erosion - if too many animals are occupying a small area, there is a likelihood that they can overgraze the area and cause soil erosion. The elephant population in Botswana is believed to be causing this problem especially in Chobe National Park and Moremi Game reserve.

(b) Destruction of Vegetation - there is a destruction of vegetation especially by elephants which are assumed to be beyond carrying capacity in Botswana i.e. about 79,480 elephants. The destruction of vegetation along the Chobe River front has called for the reduction of the elephant population in the country by environmentalists.

(c) Spread of diseases - some wild animals have potential of spreading diseases to others e.g. buffaloes can spread foot-and mouth to other hoofed wild animals such as wildebeests, and even to cattle.

Self-assessment exercise 2

1. (a) Government represented by the following Departments:

- Lands
- Wildlife and National Parks
- Crop Production
- Animal Health and Production
- Tourism.

(b) Private sector represented by the following:

- tour operators
- safari hunters
- hotel owners or hoteliers
- air charters.

(c) Local communities

(d) Local Authorities represented by the following:

- Councils
 - Land Boards.
- (e) Researchers
- University of Botswana
- (f) Conservation groups such as:
- Kalahari Conservation Society
 - Okavango People's Wildlife Trust
 - Conservation International.

2. (a) Conflict between Arable Farmers and Wildlife Management.

Crop damage by wild animals is considered unacceptable by subsistence farmers living in wildlife areas. The damage is mainly caused by elephants, hippos, zebras etc. These farmers consider government compensation very little resulting in the conflict between wildlife management and subsistence arable farmers.

(b) Conflict between Livestock Farmers and Wildlife Management.

Like in crop production, predators such as lions, hyenas, leopards, jackals kill livestock. Compensation from government is also considered small resulting in the conflict with wildlife management.

(c) Veterinary Fences and Wildlife Management.

The expansion of the cattle industry in Botswana and the need to protect livestock from foot-and-mouth disease in order for Botswana to have access to European markets has resulted in the erection of veterinary fences across many rangelands in Botswana. Some of the veterinary fences block wildlife movements and has resulted in the death of many wildlife species in the country. Conflict has therefore resulted between the Department of Wildlife and National Parks in the Ministry of Commerce and Industry and the Department of Animal Health and Production in the Ministry of Agriculture. Some of the fences are the Buffalo Fence, Kuke Fence and CBPP Fences in the Ngamiland district.

(d) Expansion of Human Settlement into Wildlife Areas

Human settlements in wildlife areas keep on expanding causing conflict with the wildlife and tourist industries e.g. Xade, Khwai etc. Tourists expect to find complete wilderness when visiting wildlife areas. However, this is disturbed by human settlements and the presence of livestock resulting in conflict between tour operators and local communities since they negatively impact the tourist business.

Communities in or around protected areas expect to be allowed to hunt or collect veld products in national parks and game reserves. These activities are not allowed by wildlife managers resulting in conflict between the two.

3. As in Answer 1 above.

4. (a) Government

Through the Department of Wildlife and National Parks the management and the development of wildlife resources takes into consideration the views of all the stakeholders.

The government also facilitates all the policy issues and other legislative related issues. Government should also provide empowerment of the local communities.

(b) Private Sector

It is expected to identify business opportunities in the wildlife industry, develop effective management structures for maximum economic returns.

Provide empowerment of local communities e.g. training local communities in business management.

(c) Local Communities

Particularly rural communities should be involved in the management and utilisation of wildlife resources in their areas. They should re-establish themselves as managers and benefit from the natural assets of the areas in which they live with.

Enforce wildlife conservation laws in their respective territories.



Assessment

Unit Assessment

Instructions

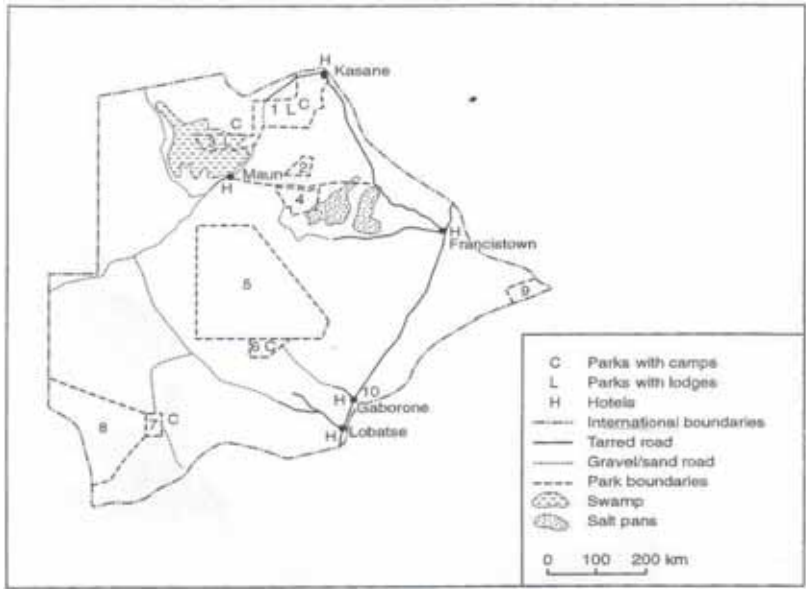
This assessment must be done after successfully completing the unit, including the assignments and the unit summary. Submit or post it to your tutor for marking. You will need 1 hour to work on this assessment.

Instructions

- Answer all questions
- Write your answers in the spaces provided.

1. Study Figure 1 below and answer questions that follow.

(a) Study **Figure 4** below which shows National Parks and Game reserves in Botswana.



Source: Macmillan Junior Secondary Geography by S.S. Vasefi

(i) What is the name of Game Reserve numbered 4?

[1 mark]

9 _____

(ii) What are the names of the National Parks numbered 2 and 8?

[2marks]

2 _____

8 _____

(iii) Mention **any** three conflicts between Wildlife Management and other land use activities in Botswana. [3 marks]

(iv) Discuss three methods that are used by government to encourage sustainable use of wildlife.

[3marks]

(v) State the main function of Wildlife Management Areas (WMA)

[1mark]

2. (a) Describe how the physical factors have enabled Botswana to become a habitat to wild animals.

[4]

3. Figure 2 is a picture of some wild animals found in Botswana.



Fig. 2

Source: http://en.wikipedia.org/wiki/File:Elephant_near_ndutu.jpg

Retrieved: 13/04/11

(a) Name the animal shown in Fig. 2.

[1]

(b) What types of environmental problems can the animal named in (a) above cause?

[3]

(c) What management strategies can the government put in place to control the populations of the animal named in (a) above.

[3]

4. Read the insert from the Botswana National Development Plan 10 and answer the following questions.

Wildlife and National Parks

11.33 The overall wildlife biomass in Botswana has increased substantially over the past 10 years. The bulk of the increase has resulted from the doubling of the elephant population between 1994 and 2006. As a result, human-elephant conflict is on the rise outside the protected areas. On the other hand, there has been a decline in populations of springbok, hartebeest, reedbuck, tsessebe and wildebeest. Some of the decreases might be attributed to increased human activities in the south-western ecosystem whose integrity is under serious threat.

11.34 The 14th Conference of Parties to the Convention on International Trade in Endangered Species (CITES) in June 2007 approved Botswana’s proposal to trade in elephant by products, such as hides, leather products, hair and ivory.

11.35 As a measure to involve communities in the management of wildlife resources, communities were introduced and mobilised to engage in projects under the concept of Community-Based Natural Resources Management (CBNRM). These community-based organisations (CBOs) cover 150 villages in 10 districts of Botswana, involving more than 135,000 people. The various CBNRM activities created 8080 jobs and generated P16.3 million in revenue by 2006. Most of the revenue was generated by wildlife-based CBOs, particularly trophy hunting and photographic tourism. The revenues rose to P22.8 million in 2007 for wildlife-based community-based trusts alone.

Source: National Development Plan 10

a) What is CITES? [2]

b) Why did Botswana ask CITES to allow them to trade in elephants products?
[2]

c) What is the aim of CBNRM?

d) What are the benefits of CBNRM?

TOTAL: 15 MARKS

Feedback : Unit 6 Assessment

1. Figure 1 questions

- i) 9 - Mashatu Game Reserve [1]
- ii) 2- Nxai Pan National Park
8- Tran frontier National Park [2]
- iii) Pastoral farming
Arable farming
Settlement
Industries
Mining [3]
- iv) Game parks / Wild life management
Licenses for hunting
Protection of endangered species
Laws and policies against poaching and illegal hunting / wild life conservation and National Parks act.
Education
Hunting seasons
Hunting quotas
Wildlife utilization schemes such as Ostrich farming [3]
- v) WMA – Encourage sustainable utilization of wildlife. [1]

2. Physical factors

- Varied vegetation across the country
- Seasonal variation of rainfall ensure provision of forage
- Well adapted to hot summers and warm winters
- The land topography ideal for most animal species

3. (a) Elephant

(b)

- destruction of trees
- Soil erosion
- Overgrazing

(c)

- Culling
- Export of live capture
- Recreational tourism

3.

a) CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

b) The population of Botswana's elephants had increased and was causing massive destruction to the vegetation

c) The aim of CBNRM is to promote natural resources conservation and sustainable utilisation by the local communities, while reaping economic and social benefits.

d) Benefits of CBNRM

- Employment creation
- Source of income
- Rural development
- Poverty reduction
- Natural resource conservation

References

Athopeng, J., Molebatsi, C., Toteng, E. and Totolo, O. (1998) **Environmental Issues in Botswana**, Lightbooks, Gaborone.

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Ministry of Commerce and Tourism, **Department of Wildlife and National Parks Annual Reports 1996/7**, Government Printer, Gaborone.

Silisthena, R.K.M. and McLeod, D (1998) **Botswana: A Physical, Social and Economic Geography of Botswana**, Longman Botswana, Gaborone.

Turner, H. (1993) **Africa South of the Sahara**, Longman, London.

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UNIT 7

Sustainable Utilisation of Forest and Veld Products

Introduction

Did you know that “almost 6 billion people from all over the world use some product or service derived from forests every day” and that “woodlands cover approximately one third of the earth’s land surface”? What do these figures show? They reflect the importance of forests to humanity. In this unit you will learn about veld and forest products that we use every day. You have probably had a taste of wild fruits or well fried or boiled mopane worms. Both of these taste great! These are some of the products that we can harvest from the veld. Some products are tangible like fruits, wood and tubers. However, some of the benefits are not tangible such as biodiversity. Check what biodiversity is in the vocabulary section. Forests help regulate climate, help in the protection of soil and water resources and are home to millions of plant and animal species. Forest and veld products are very important in reducing poverty among people who live particularly in rural areas that make a living by selling these products. Can you imagine a world without trees?

Upon completion of this unit you will be able to:



Outcomes

- *explain* the term veld and forest
- *locate* areas of forests and veld in Botswana
- *identify* veld and forest products
- *locate* where forests and veld products are concentrated in Botswana
- *explain* ways of commercialising veld and forest products
- *explain* the importance of the commercialisation of veld and forest products
- *assess* the environmental impact of the commercialisation of forests and veld products
- *discuss* the role stakeholders can play in the sustainable use of forests and veld products.

Time

You will need about two hours to study each topic. Note that this unit has 3 topics. It means you will need a total of 6 hours to study the whole unit. You might finish studying the topic in less than two hours or exceed your study time as this is determined by your reading pace and understanding of the lesson. On completion of each topic, you are required to do a self-assessed assignment. You need 1 hour 30 minutes to do these assignments. To further test your understanding of the unit, you must complete a tutor marked assessment exercise. The exercise should take you about 45 minutes to complete.

Teaching and Learning Approach

To promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experience or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. There is a variety of information that you can use to learn more about important concepts in tourism. Most libraries in your country have some information on water resources. There are some magazines, pamphlets, books, etc which contain important information on tourism. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near a power station you are advised to collect relevant information that may help you understand your topics better. If you have access to the Internet, you may look for relevant information. Remember to refer to topic objectives when searching for relevant information. If you have no access to the internet, you don't have to worry as content provided in each topic is adequate. If you are registered with a distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counseling support.

You may have access to additional resources, maps and relevant videos if there is a study centre in your area. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any challenges you may experience in this unit. Remember that the time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or before you attend tutorials. This will help you raise questions on difficult aspects of your study materials.

I would like to, once again, emphasise that active learning or participating effectively throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions will you be in a better position to understand that this unit is part of other units on utilisation and management of other resources which are covered in units 7 to 10.

Assessment

In this unit, each topic has activities based on the information relevant to different sections of the topic and forms part of your learning. These activities are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately after the activity. If you do not do well in the activities do not be discouraged. You may review the section related to the activity and later carry on with the topic with more concentration. You are advised to review the sections you did not do well on before continuing with the topic.

On completion of each topic, you will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your understanding of the whole topic.

Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low you must not be discouraged, but try again by going over the topic and the exercise.

The self-assessment exercise assignments are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the assignment. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, then go on to the next unit.



Terminology

Forest:	An area with a high density of trees.
Veld:	An open grassland area.
Commercialisation:	Buying and selling of products.
Mophane worm:	A type of worm that feeds on mophane leaves and has very high protein content.
Veld products:	Refers to plants, fruits, grass or tubers which are found in the veld but considered important either for medicinal purposes or for food or any other use.
Forest reserve:	This refers to land demarcated for the purposes of conserving trees considered important in the economic development of the society.
Soil erosion:	Washing away of the top soil by water and the wind.
Deforestation:	A situation where all trees are cut, leaving the veld bare.
Bio-diversity:	The degree of variation of life forms in a given ecosystem.

TOPIC 1: Forests and Veld Products

1.0 Forests

What is a forest? This seems to be a very obvious question particularly if you live in a rural area. After all, you may ask, who doesn't know what a forest is? However, if you live in a built up urban area, you may not readily encounter a forest. A forest is an area with a high density of trees. A forest is not only made up of many trees but is actually a complex ecosystem that covers the earth and supports many forms of life.



Figure 1: A sample of a forest (<http://www.laspilitas.com/comhabit/pictures>) Downloaded on 10/12/10

Next time when you see dense forests, remember it's not only trees but a home for many forms of life. Forests like the one shown in Figure 1 are very useful to us as and shall be seen in the next topic. If you look at the forest (Figure1) what type of life do you think can be found there?

You probably mentioned things like grass, trees, animals and insects! Remember, we said forests are habitats to millions of plant and animal life!

At Junior Certificate level you probably learnt about vegetation. Using the picture (Figure 2) and your previous knowledge, what do you think is meant by the term veld? You probably described the veld as land that is covered by grass with a few scattered trees. You were right! The term veld refers mainly to the wide open rural spaces of South Africa or southern Africa. A veld is sometimes used to describe an open grassland area. These grassland areas, just like the forests, also produce a variety of products and provide a home to different forms of life. Figure 2 shows a sample of an open grassland area.



Figure 2: A typical veldt in Southern Africa. (Adapted from <http://amakulu.co.za/Pictures/Veld-4.JPG>) Retrieved on 8/12/10

What forms of life would you expect to find in a veld like the one shown in Figure 2? You would

probably expect plant and animal life.



Activity 1

Study Figures 1 and 2 above. In your opinion, what are the major differences between forests and the veld?

Feedback

The differences are that the forests are densely populated by trees while the veld is open and has fewer trees that are not crowded. The veld is covered with grass and receives a lot of sunshine. In some forests, there is very little sunshine passing through the dense trees.

2. 0 Forest products

Forests provide a whole range of goods and services of use to mankind. In most parts of Botswana, there are forests or trees which are important to either the local communities or other interest groups in the country. Let us start by identifying some of the main forest trees in Botswana. Try the activity given below:



Activity 2

Write down at least five forest trees considered important by people in your area

1)
2)
3)
4)
5)

Feedback:

I hope it was very easy for you to produce a list similar to the one given below:

- *Mophane (colophospemum mopane)*
- *Mukusi (Baikiaea pluriga)*
- *Mukwa (Pterocarpus angolensis)*
- *Mogonono (Terminalia Sercea)*
- *Motswere (Combretum imberbe)*

Of course I don't expect you to have put down those difficult names that I have included in brackets.



Figure 3: Mophane trees

(<http://www.plantzafrica.com>) Downloaded on 12/10/10

Now, look at the Mophane trees in figure 3. What products would you get from these trees? You can use the dry branches for firewood, the leaves as medicine for indigestion, fibre for tying, branches for fencing the fields, leaves for feeding domestic animals, timber for roof trusses and you can also get mophane worms that feed on the leaves as a rich protein food. The leaves can be used for medicinal purposes and also as animal fodder. Thus, trees provide a lot of useful products for people living in the community where they are found.

Some of the main forest products in Botswana and Southern Africa are shown below:



Figure 4: Some of the main forest products (<http://siteresources.worldbank.org>) Downloaded on 10/12/10



Activity 3

In your notebook, write down the products shown in figure 4 above. What are the advantages and disadvantages of using the products shown above?

Feedback

Probably you mentioned timber as one of the forest products shown in figure 4. Timber is important in that it is used as building material, for furniture and a host of industrial, commercial and domestic applications such as in the production of fibreboard, clipboard and different forms of paper. As building material, wood is light and versatile. It can also bring foreign currency when exported. However, uncontrolled cutting of timber can result in the destruction of forests and the creation of an imbalance in the ecosystem. Animal and plant life that depend on the forest may be destroyed. The cutting of forests for wood may result in the loosening of soil and the subsequent soil erosion and loss of soil fertility.

We will discuss more on the value of forest products in the next topic. For now, let's discuss the value of veld products.

4.0 Veld products

Now, let us turn to veld products.



Activity 4

Write down what you think veld products are and list them in your notebook.

Feedback

Veld products simply refers to plants, fruits, grass and tubers that are found in the veld but considered important either for medicinal purposes or as food or any other use such as thatching, in the case of grass.



Figure 5: Some of the main veld products found in Botswana. Adapted from www.farmforfun.com/Potatoes.html on 10/12/10

Figure 5 shows some of the major veld products such as tubers, thatching grass, wild fruits and plants.

Activity 5

Write down at least five veld products considered important by people in your area and briefly say why they are considered as important in your locality.

- 1) _____

- 2) _____

- 3) _____

- 4) _____

- 5) _____

Feedback

These are some of the veld products considered as very important in Botswana:

- *Sengaparile (Kalahari Devil’s claw)*
- *Moporota (Kigelia Africana)*
- *Motshikiri (Thatching grass)*
- *Moretlwa (Grewia flava berries)*
- *Mokolwane palm leaves (Hyphaene petersiana)*
- *Mokgomphatha (Grewia flavescene’s berries)*
- *Thepe(Aamranthus hybridus)*
- *Lengana (Arremisia afra)*
- *Delele (Corchous asplenifolins)*

Note that different veld products will be used for different purposes in different communities.

The list is not exhaustive. There are quite a large number that are not mentioned here. You mentioned only five veld products in your activity. I would like you to understand that there are generally three broad categories that can be identified. These are food products, medicinal products and miscellaneous products. Food products would probably include edible berries, nuts, bark, leaves, tubers, mushrooms, game meat among many others. The medicinal category would include sengaparile (Kalahari devil’s claw), Lengana (*Arremisia afra*) and mosukudu (*Lippia scaberrina*). The miscellaneous category would include gums, oils, dyes, aromatic plants, fibres, resins and animal fodder among many. You don’t need to know all of them. However, you need to understand the importance of the veld and its products.

5.0 Topic Summary

By now I hope you can clearly differentiate between a forest and the veld. A forest is made up of dense trees which provide a home to many forms of life. A veld is an open stretch of grasslands. It also provides home to many forms of life. Both the veld and the forest produce useful products that benefit communities. Some of the main forest products include timber, medication and sculpture. Veld

products include thatching grass, tubers, fruits and honey among many others.

When you are finished, do the Self-Assessment Assignment 1 at the end of the unit. If there were areas that were not clear, either ask your study mates or your tutor. If you need to review some sections, please do so. When you are satisfied with your performance, proceed to the next topic on the commercialisation of forest and veld products.

TOPIC 2: Commercialisation of Forest and Veld Products

Introduction

In the previous topic, you learnt what forests and the veld are. You also learnt about different types of forest and veld products. If you come from the Kgalagadi and other semi-arid areas, by now you should be asking yourself where these forests are found. If you come from the north east and you have never been to the south, you should be wondering where the tree savannah is. In this topic we will study areas of forest concentration in Botswana. We will also study the importance of the commercialisation of forests and veld products to stakeholders.

Topic Objectives

At the end of this topic you are expected to be able to:

- locate areas of forest concentration in Botswana and Southern Africa.
- locate areas of veld concentration in Botswana and Southern Africa.
- explain ways of commercialising veld and forest products.
- explain the importance of the commercialisation of veld and forest products.

1.0 Location of Forests

To answer the question on where the forests are located in Botswana, you need to study the vegetation map of Botswana given below:

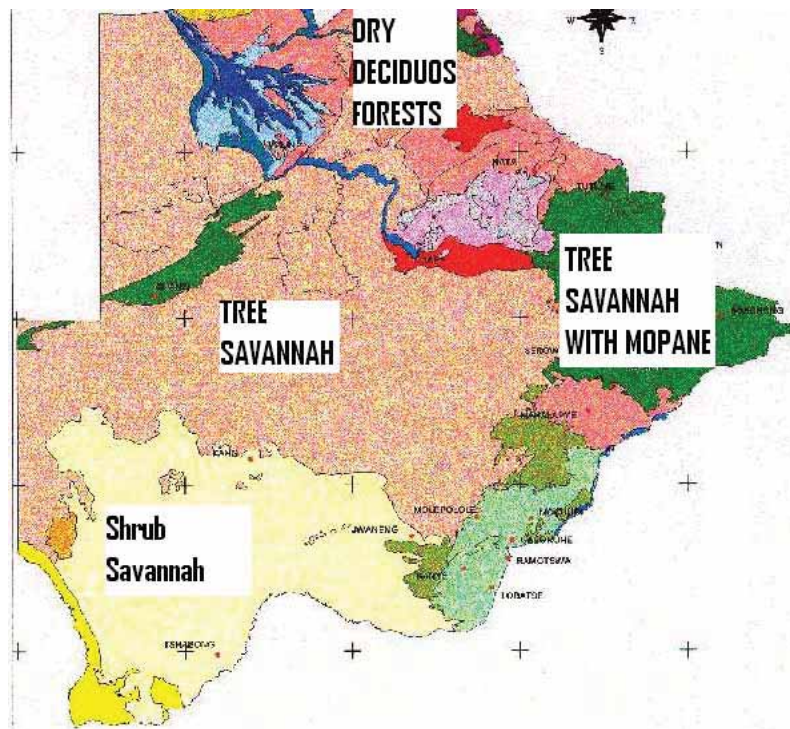


Figure 6: Vegetation Map of Botswana. Adapted from <http://www.fao.org/ag/> on 13/12/10

From the above map, you can observe that almost 75% of the vegetation in Botswana tends to be the Savannah type. Can you explain why? The forest covers largely the northern part of the country. The distribution of vegetation is largely determined by the climatic conditions of a place. Since Botswana has a predominantly semi-arid climate, the dominant vegetation is the savannah type and this is the reason why almost 75% of the country is covered by the Savannah vegetation. As already mentioned, forests are often located in specific areas where the conditions are favourable for their growth. What conditions do you think would be necessary for the growth of forests? You would probably mention high rainfall and the type of soils. This would be correct because for trees to grow tall there is need for high rainfall. In Botswana, there are areas where there is a high concentration of forests. Some of the areas are shown in the map given below:

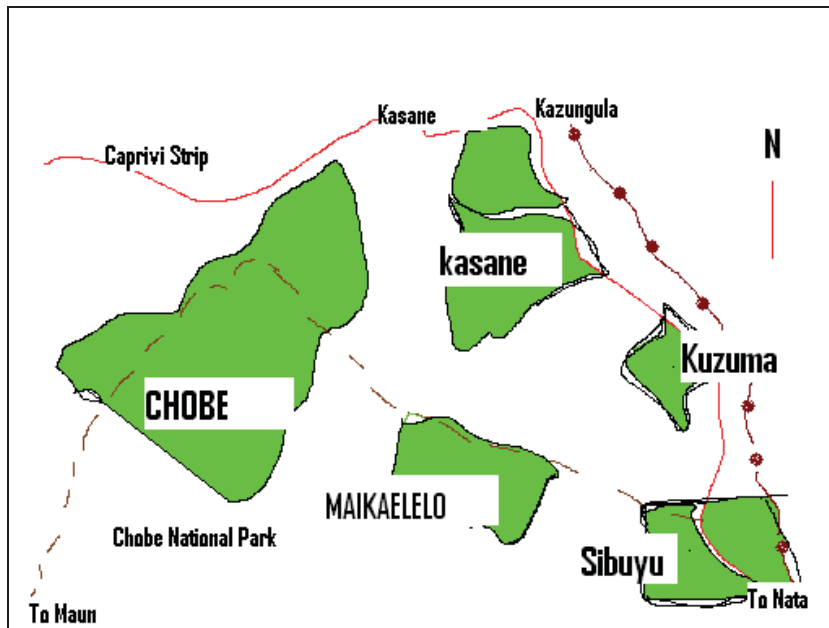


Figure 7: Forest reserves in Botswana 9. Adapted from BOCODOL, (Map Reading Unit 1).



Activity 1

1. Using the map in Figure 7, identify areas where forests are mostly concentrated. Write down some of the areas in the spaces provided below:

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____
- (f) _____

2. Why do you think the forests are located where they are?

Feedback

I hope the activity was easy for you. Your job was simply to identify the forests as shown on the map. Most of the forests in Botswana are located in the north and north west district around Pandamatenga and Kasane where there is high rainfall. These include

Kasane Forest Reserve

Chobe Forest Reserve

Kazuma Forest Reserve

Maikaelo Forest Reserve

Sibuyu Forest Reserve

The forests are located where they are because of the high rainfall, the type of soils and the temperatures in those areas.

Just by looking around you, can you name a few trees that you know? The trees that you named depend on where you are. There are many different types of tree species found in the forest areas in Botswana. These include, among many others, Mukusi, (shown in Figure 8) and Mukwa. These are found mainly in the Chobe and Kasane forests.

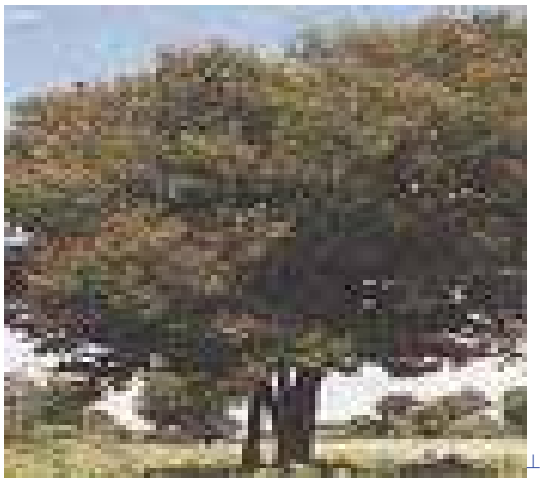


Figure 8: A sample of a Mukusi tree found in the Chobe and Kasane forests. Downloaded from <http://www.Africa.adventure.org> on 13/12/10

Just by looking at the Mukusi tree shown above, you should be able to tell why their presence is important. You should have observed that it provides a lot of shade for animals, wood for furniture and fuel, and a lot of foliage!

Another tree species that occupy large areas in Botswana is the Mophane found in a belt that stretches from Mahalapye through Francistown up to Pandamatenga. We shall discuss the products of these forests in detail in the next topic. For now, let's locate the areas where the veld products are concentrated.

2.0 Areas of Veld Products Concentration in Botswana

Veld products are found in different parts of Botswana. An example is Sengaparile which is found mostly in the Kgalagadi district. Motshikere is found in the northern part of Botswana. Moretlwa is also found in almost all the parts of the country.



Activity 2

In your notebook, draw a table and show the location of some of the common veld products in Botswana. When you are finished, compare with the location of the products shown in Figure 9.

Feedback

There may be differences. What you have put down is not necessarily wrong! It depends on your locality and the products that you have put down as common. The table may give you an idea of what most people consider as common products and their location.

Tswana Name	Type	Distribution
Nsungaphala	Herb	North east
Monepenepe	Herb	North east
Mokapane	Creeper	In sandy and drier areas
Thepe	Vegetable	Countrywide
Lengana	Natural tea	Eastern part
Mokatse	Melon	Widespread
Serepe	Herb	Widespread
Phane	Insect	North east
Delele	Vegetable	North
Mogabala	Climber	Widespread
Mosukujane	Natural tea	Eastern parts
Pan products	Salt	Delta

Figure 9: Areas of veld product concentration in Botswana (Source: Taylor and Moss, 1983)

Most of these products are harvested and sold. The next section discusses commercialisation of the forest and veld products.

3.0 Commercialisation of veld and forest products



Activity 3

Read the extract given below:

Phane is basically a larval stage of the moth which belongs to the group of emperor moth. Phane is seasonal with the first harvesting period in December and the second in April –May. Phane harvesting involves selecting and picking the larvae from the Mophane trees followed by degutting. Processing involves either roasting or boiling followed by drying. Roasting usually produces poor quality products that are dusty. The dried phane is then packed into bags for **sale**. Other products that are collected primarily for sale include Sengaparile (Grapple plant) and Mogwana (*Grewia flava*). Subsistence veld products are those that are collected specifically for consumption usually by those people who gather them.

Figure 10: Extract on the commercialisation of mophane and other veld products (Adapted from Athlhopeng et.al (1998))

Having read the extract, what do you understand by commercialisation of veld products? Which products are now commercialised in Botswana? What is the difference between commercialised products and those that are collected for subsistence?

Feedback

I hope you were able to clearly discern that commercialization refers to the buying and selling of products. Thus, commercialization of veld and forest products would entail buying and selling of products from the forest and the veld. Some of the products that have been commercialised in Botswana include phane silk which is woven into costly fine cloth or knitted into shiny materials. The cocoons themselves have a lucrative market among many communities as it is used as part of the

dancing attire for most traditional dancers. Other commercial products include the grapple plant that is used for curing ailments such as rheumatism, hepatitis and arteriosclerosis. Mokola is also used for making baskets and Motsikhiri for thatching grass.

The commercialisation of veld products has also led to more studies on the growth of trees and the processing of veld and forest products in Botswana and the Southern Africa region. These activities include community-based project initiatives as well as work on indigenous fruit, tree planting, and an increase in the agro-forestry trial plots. Sales include items such as foods, medicines, craft materials, tannins, gums, resins, dyes, essential oils, florist materials, ornamental plants, insects, horns, hides, skins and many other veld and forest products.

I believe you are already aware of the benefit of selling some of these products. Some people make a living out of selling and buying these forest and veld products. Read on about the importance of the commercialisation of forest and veld products.

4.0 The importance of the commercialisation of veld and forest products

The commercialization of forests and the veld products is very important to the people of Botswana and the various stakeholders. Who are the stakeholders? Figure 10 below shows some of the key stakeholders in the selling and buying of forest and veld products.



Figure11: Key Stakeholders in the Buying and selling of veld and forests products

The stakeholders include government, Non-Governmental Organizations, local communities, local authorities and the private sector. Let us see how commercialization of the products is important to each group.



Activity 4

Using your previous knowledge, explain the importance of forests and veld products as commercial resources to the different stakeholders given below:

(a) Government:

(b) Non-Governmental Organisations:

(c) Local Communities:

(d) Local Authorities:

(e) Private Sector:

Feedback

The commercialization of forests and veld products are important to each group as discussed below:

(a) Government

The government charges taxes to private companies involved in logging and harvesting of veld products. The government benefits in terms of revenue collected from these taxes.

(b) Non-governmental Organisations

These conduct research especially on the marketing of these resources locally and abroad. For instance, Thusano Lefatsheng and Veld Products Research buy veld products from local communities

and sell them at a profit locally and abroad. This creates employment for some people and promotes economic development of the country.

(c) Local Communities

They harvest veld products such as sengaparile and sell it to organizations such as Thusano Lefatsheng. This brings income to households and thus promotes the household budget. It also helps reduce poverty. Local communities also collect firewood in the forest and sell it for a profit.

(d) Local Authorities

Local Authorities get lease and rental fees from private companies involved in logging or harvesting of veld products e.g. Nata Timbers pays such fees to the North-West District Council.

(e) Private Sector

The private sector such as Nata Timbers harvest forest resources such as Mukwa and Mukusi to make furniture which in turn is sold at a profit locally and to neighbouring countries.

Finally, it can be concluded that the commercialisation of forest and veld products is not only important to stakeholders mentioned above but to the economy of Botswana in general.

Now, read the summary and do the Self-Assessment Exercise 2.

5.0 Topic summary

In this topic, you learnt about areas of forest and veld products concentration in Botswana. You also learnt about some of the forest reserves in the country. Most of them are in northern Botswana e.g. Chobe Forest Reserve and Maikaelelo Forest Reserve. You also learnt about some of the most important veld products and forest resources in Botswana. These include sengaparile and moretlwa while forest trees include mophane, mukusi and mukwa.

The importance of the commercialisation of forest and veld products to stakeholders was also discussed in this topic. However, the most important one is that of revenue generation to all groups and employment creation for Botswana. This helps in the economic development of the country and in poverty alleviation.

Now that you are finished with the topic, do the Self-Assessment Assignment 2 at the end of the unit before you move to the next topic where we discuss sustainable utilisation of the forest and veld products. Remember to check your answers against the ones provided and then take appropriate action before moving onto the next topic.

TOPIC 3 Sustainable Use of Forest and Veld Products

Introduction

The commercialisation of forests and veld products has both positive and negative effects on the environment. In this lesson you will learn about both the negative and positive results of the commercialisation of forest and veld products in Botswana. You will also learn about the role that stakeholders play in the use of veld products and forest resources in a sustainable way. An immediate question which you should be asking yourself is “what is meant by sustainable utilisation of forests and veld products?” Does it mean that we should stop using these products? Is it possible to stop using these products totally? I hope these and some of your questions will be answered as you read through this topic.

Topic Objectives

At the end of the topic, you should be able to:

- Explain sustainable utilisation of forests and veld products
- describe the environmental effects of the commercialisation of forests and veld products in Botswana
- explain the role of stakeholders in the sustainable use of forests and veld products.

1.1 Positive effects of the commercialisation of forests and veld products

Let us first discuss the positive environmental effects of the commercialisation of forests and veld products. First attempt Activity 1 below.



Activity 1

Suggest some of the positive environmental effects of the commercialisation of forest and veld products. Explain three effects in the spaces provided below.

(a) _____

(b) _____

(c) _____

Feedback

Here are some of the positive effects of commercialisation of forests and veld products:

(a) Afforestation –



Figure 12: A young crop of trees which have been planted. Downloaded from ctfs.si.edu/webatlas on 13/12/10

Commercialisation has led to some of the forest species and resources being grown as shown in figure 12. During afforestation, trees are planted and new forests emerge. This ensures that the resources are not depleted.

(b) Burning of the veld to reduce bush encroachment-



Figure 13: Burning to reduce bush encroachment. Downloaded from www.nasa.gov/centres on 13/12/10

Commercialisation may lead to the bush at times being burnt in order to produce fresh and strong products. The ashes provide a lot of minerals that act as fertiliser for new plants. In ecological terms, fire can be used as a management tool especially to reduce bush encroachment and to have other plant

species grow without much competition for nutrients.

(c) Domestication of veld and forest products



Figure 13: Planting some of the forest and veld products. Downloaded from <http://www.naturetrust.mw> on 12/12/10

As shown in figure 12 above, some of the forest and veld resources can be domesticated and planted in homesteads. Besides providing the much needed revenue for the people, the newly planted trees may help conserve soil through the reduction of soil erosion.

(d) Environmental laws

Commercialisation of veld and forest products may also lead to the formulation of environmental friendly laws and policies meant to regulate the buying and selling of the products. Such laws can ensure the continued existence of species which may have otherwise become depleted.

These are not all the benefits of commercialisation of veld products. These are just examples. You can add those that you, your family and friends know to this list and then move on to the negative environmental effects of commercialisation.

1.2 Negative environmental effects of commercialisation of forest and veld products

The commercialisation of forests and veld products in most cases is done with little regard to environmental effects. This is because it is done mainly to maximise profit.



Activity 2

Suggest and explain any three negative environmental effects that are likely to result from the commercialisation of forest resources.

(a) _____

(b) _____

(c) _____

Feedback

I am sure you mentioned effects such as deforestation, soil erosion and the disturbance in the ecosystem. The next section explains these in more detail and you can compare and improve your answers after reading it.

(a) Deforestation – Case study Kalahari

Deforestation is the removal of a forest or stand of trees where the land is thereafter converted to non-forest use. For instance, in the Kalahari, the existing vegetation has, in some areas such as Kang and Ghantsi been cleared for settlement and mining purposes. With the development of mines and settlements comes further cutting of trees and other vegetation for the construction of roads, fuel, building and fencing purposes. In some cases, land in the kahari has been cleared for pasture for livestock. In such cases, farmers depend on boreholes which supply water to large herds of communal cattle. For instance, in most Meraga in the Kgalagadi the provision of water for animals depends on boreholes. This has resulted in cattle congregating in large numbers around watering holes resulting in rangeland degradation. Areas such as Mopipi – Tsienyane, Gumare Etsha and Bokspits- Tsabong have greatly suffered from a combination of deforestation and the subsequent rangeland degradation. The removal of vegetation can also be caused by wildlife. For instance, in the dry season, elephants congregate near water sources in densities of up to 36 per 10 square kilometres, resulting in considerable damage to vegetation.

The removal of trees in the Kalahari without sufficient reforestation has resulted in damage to the habitat, biodiversity loss and aridity. It is believed that deforestation of the Kalahari over years has contributed to changes in climatic conditions and desertification. Deforestation in the Kalahari may lead to ecological imbalance tilting the ecological balance that has been maintained by the indigenous people for years. For instance, the introduction of mining may lead to the depletion of the vegetation and the subsequent demise of wild life which has for years sustained human life in the Kalahari.



Figure 14: A sample of deforestation. Downloaded from <http://parkhowell.com> on 7/12/10.

You should by now, have observed that deforestation is when all trees are cut, leaving the veld bare. In Figure 14 many of the trees have been cut and the soil is bare. When the wind and water come, most of the top soil will be washed or blown away. This may lead to soil erosion.

(b) Soil erosion



Figure 15: Soil Erosion. <http://www.stellaroid.co.cc/ekologija/soil-erosion-10.jpg> Downloaded on 7/12/10

Soil erosion is the washing away of top soil by water or the blowing away of top soil by wind (see Figure 15). Top soil provides plants with nutrients. Soil erosion makes the land infertile and unusable.

(c) Disturbance of the Ecosystem

Once all trees are depleted, this can lead to a disturbance in the ecosystem e.g. birds, insects and

animals feed on seeds of the forest resources. If the resources are depleted then these living organisms are likely to die. In the northern part of Botswana, the government suspended licences for some logging companies because the forest resources were getting depleted.

(d) **Extinction of rare species**

Commercialisation of forest and veld products can lead to some types of animals and plants becoming extinct.



Figure 16: A chart of endangered species. Down loaded from <http://www.wellroundedkids.com/> on 10/12/10

Some of the species can be over harvested and over hunted such that they can no longer continue to reproduce themselves in large enough numbers to continue as a species. Such species may eventually become extinct. Can you name some of the species shown in Figure 16 that may be threatened by commercialisation of forest and veld products? Attempt the activity below.



Activity 3

Suggest and explain any **three** negative environmental effects of the commercialisation of veld products.

- (a) _____

- (b) _____

- (c) _____

Feedback

Most of the negative effects on veld products are likely to be the same as those of forest resources: deforestation, soil erosion and the disturbance in the ecosystem.

In addition to the above, you could also add that:

- *Some of the veld products are harvested before they release their seeds. As a result they are likely to get depleted if no seeds are available to allow them to germinate in the following rainy season.*
- *The depletion of veld products is likely to cause some disturbance to the ecosystem since plants provide both food and habitat to some animals.*

As in all resources, it is therefore important to avoid over harvesting veld and forest resources. Let's now discuss this concept of using resources such that they can continue to be able to replenish themselves.

2.0 Sustainable Utilisation of Veld and Forest Products

Forests and veld products are resources that we cannot live without. The question then is how best can we use these resources such that they can continue regenerating themselves and not get depleted? The answer lies with sustainable utilisation of resources. What is this sustainable utilisation of resources? There is no single definition of sustainable utilisation. The Bruntland Commission (1987) defined sustainable utilisation as “utilisation that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Sustainable utilisation is therefore the exploitation of natural resources ensuring that the levels remain high enough for them to continue to regenerate themselves naturally without getting depleted. In the case of forest and veld products it means harvesting these products such that they continue to replenish themselves. Can you think of a way in which you can harvest a product such that it continues to replenish itself? You could think of fruits! When we harvest the fruits, we don't have to cut the trees! So when we harvest veld and forest products for commercialisation, we should consciously attempt to allow for regeneration. To attain this, who should be involved and in what way should they be involved? The section that follows discusses what the stakeholders may do to ensure sustainable utilisation of the forest and veld products.

3.0 The role stakeholders play in sustainable utilisation of forest and veld products

Since commercialisation of forests and veld products has some negative environmental effects, there is need for us to find ways in which these resources can be conserved. The various stakeholders involved in the utilisation of these resources are also responsible for their sustainable use. Reflect on what roles different stakeholders can play in sustainable utilisation of forests and veld products. Do Activity 4 to help you in focusing your thoughts.



Activity 4

Describe some of the roles that stakeholders can play in the sustainable use of forests and veld products.

(a) Government

(b) Non-Governmental Organisations

(c) Private Sector

(d) Local Authorities

(e) Local Communities

Feedback

I believe it was easy for you to do Activity 4 because I gave you tips on who should actually be involved. I may not have mentioned all of them but I believe you can now follow the thread! There are many suggestions which you could put forward and as long as you can justify them, they are correct.

Below are some of the roles that stakeholders can play in the sustainable use of forests and veld products.

(a) Government

They are expected to facilitate the management and development of forests and veld products taking into consideration the views of all the stakeholders. They should also facilitate the formulation of policy and other legislation related issues. Government should also empower local communities.

(b) Private Sector

They are expected to identify business opportunities existing in the forest and veld products industry, develop effective management structures for maximum economic returns while ensuring conservation of products and provide empowerment for local communities.

(c) Local Authorities

They should allocate land to be used for tourist activities. They should also explain procedures of securing land rights vis-à-vis forests and veld products management and utilisation efforts.

(d) Research Groups

They should collect data and provide information on how forests and veld products are to be utilised without depletion.

(e) Conservation Groups or Non-Governmental Organisations

They should conduct research, lobby for funds to enable local communities' participation in the forests and veld products industry. They should also complement government efforts in facilitating conservation of the forests and veld product resources.

(f) Local Communities

Rural communities should be involved in the management and utilisation of forests and veld product resources in their areas. They should re-establish themselves as managers and benefit from the natural assets of the areas in which they live. Community-Based Natural Resource Management Projects (CBNRMP) in Wildlife Management Areas is encouraged by the Botswana Government in order to benefit all stakeholders. These projects are meant to yield benefits to people living in these areas. The idea is that once local people get the benefits, they will be inclined to use forests and veld resources in their areas in a sustainable way.

It is important that all stakeholders in forest and veld products should be involved in policy formulation, implementation and monitoring. This approach is likely to lead to the sustainable use of these natural resources by all the concerned groups.

Now that you are through with the role of stakeholders in ensuring sustainable utilisation of veld products, read the topic summary and then attempt the self-assessment assignment 3 at the end of the unit.

4.0 Topic Summary

In this topic, you learnt the positive and negative impact of commercialisation of forest and veld products. One positive impact is the domestication of some of the resources. For instance, we have said that some of the resources are now being planted in gardens and fields. This is important in that the likelihood of the resource becoming depleted is reduced. Seeds are now well stored as compared to when they are just harvested in the forest. The negative impact of commercialisation on these resources is that some people harvest the resources even before they release the seeds, and as a result, the resources stand a greater chance of being depleted.

You also learnt about the role stakeholders can play in the sustainable use of forest and veld products resources. The major role that all the groups can play collectively is the formulation and implementation of policy issues in the utilisation and management of the resources.

Please do the Self-Assessment Assignment 3 at the end of the unit. Check for the correct answers at the end of the unit. If you have mastered the self-assignment exercise, read the unit summary and attempt the Unit Assessment.

5.0 Unit summary

In this unit you learned that forest and veld products can be harvested and sold to reduce poverty. Forest products include timber, firewood, medicinal roots, honey and birds among many. The forest is the home to many plant and animal species. The veld products include tubers, grass, fruits and medicinal plants such as the Sengaparile. Selling and buying of forest and veld products have both positive and negative effects. Selling these products may result in the domestication and growing of some of the trees and plants that might otherwise become extinct. The money collected can be used to improve the lives of people in rural areas. This commercialisation of the veld and forest products may also result in over harvesting of the plants and trees. Trees and grass may be cut so much that they may not be able to regenerate themselves. Soil erosion may result and some animal and plant species may become extinct because of the disturbance of the balance in the eco-system. There are many stakeholders who can help to regulate the commercialisation of the veld and forest products. Governments, the Private Sector, NGO'S and Communities can also play a role in harvesting and using the forest and veld products in a sustainable way. It is important to have laws that can effectively encourage sustainable utilisation of the veld and forest products.



Self-Assessment Assignment 1

Answer all the questions in this assignment. When you are finished, check for the correct answers at the end of the unit.

Time: 10minutes

1. Explain the term forest [2 marks].

(a) _____

2. Write your understanding of the term veld? [2 marks]

(a) _____

3. Name any eight forest and veld products found in Botswana. [4 marks]

(i) _____

(ii) _____

(iii) _____

(iv) _____

4. Explain why veld and forest products are important in your community. [6 Marks]

Total [14Marks]

Check for the correct answers at the end of this Unit



Self-Assessment Assignment 2

Answer all the questions in this assignment.

Time 10 minutes

1. List **two** tree species that are important for commercialisation purposes in Botswana.[2 marks]

(a) _____

(b) _____

2. List **two** veld products that are important for commercialisation purposes in Botswana.[2 marks]

(a) _____

(b) _____

3. Explain **two** ways in which the commercialisation of forest and veld products are important to each of the following groups.[8 marks]

(a) Government

(i) _____

(ii) _____

(b) Local Communities

(i) _____

(ii) _____

(c) Private Sector

(i) _____

(ii) _____

(d) Non-Governmental Organisations

(i) _____

(ii) _____



Self-Assessment Assignment 3

Answer all the questions in this assignment.

Time: 10 minutes

1. Describe **two** positive environmental effects of the commercialisation of forest and veld products in Botswana. [4 marks]

(a) _____

(b) _____

2. Describe any **two** negative environmental effects of the commercialisation of forests and veld products. [4 marks]

(a) _____

(b) _____

3. Discuss **two** roles that each of the following stakeholders can play in the sustainable use of forest and veld products. [6 marks]

(a) Government

(b) Non-Governmental Organisations

(c) Local Communities

Total [14 Marks]

Unit Assignment



Time: 20 Minutes

Answer all the questions in this assignment

1. Differentiate between a forest and a veld. (2 marks)

2. Mention any two major forest products and state their use. (2 marks)

3. Mention any two veld products and state what each one is used for. (4 marks)

4. Discuss at least two positive effects of commercialising forest and veld products. (2 marks)

5. Discuss any two negative effects commercialisation of forest and veld products. (2 marks)

6. Explain the role that can be played by each of the following stakeholders in ensuring sustainable commercialisation of forest and veld products:

(a) Government (2 marks)

(b) Non-Governmental Organisations (2 marks)

(c) Local communities (2 marks)

(d) Private Sector (2 marks)

(20 Marks)

If you are finished with this assessment, send it to your tutor for marking. You can then proceed to the next unit.

ANSWERS TO SELF ASSESSMENT ASSIGNMENTS

ANSWERS TO ASSIGNMENT 1

1. A forest is an area with a high population density of trees.
2. A veld is an area that is covered by grass and open trees.
- 3 These include among many others:
Sengaparile, Moporota, Motshikiri, Moretlwa, Mokolwane, Mokgomphatha

ANSWERS TO ASSIGNMENT 2

1. Any two of the following:

Mukusi, Motshikere, Mukwa and Moretlwa

2. Any two of the following:

Moretlwa, Sengaparile and Motsikere

3. (a) *Government*

The government charges taxes to private companies involved in logging and harvesting of veld products. The government benefits in terms of revenue collected from these taxes.

(b) *Non-governmental Organisations*

These conduct research especially on the marketing of these resources locally and abroad. For instance, Thusano Lefatsheng and Veld Products Research buy veld products from local communities and sell them at a profit locally and abroad. This creates employment for some people and promotes economic development of the country.

(c) *Local Communities*

They harvest veld products such as sengaparile and sell them to organizations such as Thusano Lefatsheng. This brings income to households and thus promotes the household budget. It also helps reduce poverty. Local communities also collect firewood in the forest and sell it for a profit. Local Authorities get lease and rental fees from private companies involved in logging or harvesting of veld products e.g. Nata Timbers pays such fees to the North-West District Council.

(e) *Private Sector*

The private sector such as Nata Timbers harvest forest resources such as Mukwa and Mukusi to make furniture, which in turn is sold at a profit locally and to neighbouring countries.

Finally, it can be concluded that the commercialisation of forest and veld products is not only important to stakeholders mentioned above but to the economy of Botswana in general.

ANSWERS TO ASSIGNMENT 3

1. Any 2 of the following:

Afforestation

Commercialisation has led to some of the forest species and resources being grown. During a forestation, trees are planted and new forests emerge. This ensures that the resources are not depleted.

Burning of the veld to reduce bush encroachment

Commercialisation may lead to the bush at times being burnt in order to produce fresh and strong products. The ashes provide a lot of minerals that act as fertiliser for new plants. In ecological terms fire can be used as a management tool especially to reduce bush encroachment and to have other plant species grow without much competition for nutrients.

Domestication of veld and forest products

Some of the forest and veld resources can be domesticated and planted in homesteads. Besides providing the much needed revenue for the people, the newly planted trees may help conserve soil through the reduction of soil erosion.

Environmental laws

Commercialisation of veld and forest products may also lead to the formulation of environmental friendly laws and policies meant to regulate the buying and selling of the products. Such laws can ensure the continued existence of species which may have otherwise become depleted.

2. Any 2 of the following:

Deforestation

Deforestation is when all trees are cut, leaving the veld bare. When the wind and water come, most of the top soil will be washed or blown away. This may lead to soil erosion.

Soil erosion

Soil erosion is the washing away of top soil by water or the blowing away of top soil by wind. Top soil provides plants with nutrients. Soil erosion makes the land infertile and unusable.

Disturbance of the Ecosystem

Once all trees are depleted, this can lead to a disturbance in the ecosystem e.g. birds, insects and animals feed on seeds of the forest resources. If the resources are depleted, then these living organisms are likely to die.

In the northern part of Botswana, the government suspended licences for some logging companies because the forest resources were getting depleted.

Extinction of rare species

Commercialisation of forest and veld products can lead to some types of animals and plants becoming extinct.

3.

(a) Government

They are expected to facilitate the management and development of forests and veld products taking into consideration the views of all the stakeholders. They should also facilitate the formulation of policy and other legislation related issues. Government should also empower local communities.

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(b) Non-Governmental Organisations

They should conduct research, lobby for funds to enable local communities' participation in the forests and veld products industry. They should also complement government efforts in facilitating conservation of the forests and veld products resources.

(f) Local Communities

Rural communities should be involved in the management and utilisation of forests and veld products resources in their areas. They should re-establish themselves as managers and benefit from the natural assets of the areas in which they live. Community-Based Natural Resource Management Projects (CBNRMP) in Wildlife Management Areas is encouraged by the Botswana Government to help benefit all stakeholders.

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Unit 8

Utilisation and Management of Rangelands

Introduction

Welcome to Unit 8 of the Grade 12 Geography course. This unit is the fourth among the five units on utilisation of natural resources. In this unit you will learn about rangelands. Rangelands are a very important natural resource because they provide grazing land for both livestock and wild animals. In units 6 and 7, we looked at how resources such as wildlife forests and veld products are used and managed. As we go through this unit, note the difference and similarities between the three units. You may notice that the same management strategies are used to manage rangelands and that the same stakeholders are involved in ensuring sustainable utilisation of rangelands.

Rangelands are found all over the world. In some countries they cover large areas and are known by names such as the prairies, savannas, pampas, scrublands and woodlands. We will discuss the uses of range resources and look at factors causing rangeland degradation. We will also consider what the government, the private sector; non-governmental organizations are doing in an attempt to achieve sustainable uses of rangelands. Note that most examples will be drawn from Botswana. Studying rangelands will help you gain insight into environmental management and will develop your ability to think strategically. As a responsible citizen you will be able to participate effectively in the conservation of such natural resources.

This unit is subdivided into two topics. Topic 1 introduces the terms range, rangeland and rangeland degradation. In this topic you will also learn about the human and physical factors causing rangeland degradation. Topic 2 discusses rangeland management and evaluates the role of stakeholders in the sustainable use of rangelands.

On completion of this unit you will be able to:



Outcomes

- *Define* rangeland and rangeland degradation
- *Describe* human and physical factors that cause rangeland degradation
- *Discuss* the effects of rangeland degradation
- *Discuss* the management of rangeland resources
- *Evaluate* the role that government, private sector NGOs, local authorities and local communities can play in the sustainable utilisation of rangelands

Time

In this Unit, each topic should take you about two hours to complete. However, if you have not clearly understood the topic you may need to keep on reviewing it until you master it. Remember, the aim is to understand rather than to speed up and finish. You are also given a tutor marked assessment at the end of the unit. You will only need 2 hours to complete this assessment.

Teaching and Learning Approach

In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experience or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. There is a variety of information that you can use to learn more about important concepts in rangelands. Most libraries in your country do have some information on tourism. There are some magazines, pamphlets, books, etc which contain important information on tourism. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near any agricultural centre or offices you are advised to collect any relevant information from such centres. If you have access to the internet, you may access links given. The internet links are meant to give you more information on a particular topic. Do not worry if you have no access to the internet, as content provided in each topic is adequate. If you are registered with any distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counselling support.

Study centres are resourceful because you may have access to additional resources maps and relevant videos. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any difficulties you experience in this unit. Note that the amount of time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or at least before you attend tutorials. This will help you raise questions on difficult areas of your study materials.

I would like to once again emphasise that, active learning or effective participation throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions will you be in a better position to link this unit with other units by discussing utilisation and management of natural resources such as water, wildlife, forests, veld products and energy sources.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the information relevant to different sections of the topic and form part of your learning. They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately below the activity. If you do not do well in the activities do not be discouraged, as you may review the section related to the activity and later carry on with the topic with more concentration. You are advised to review the sections you did not do well on before continuing with the topic.

On completion of each topic, you are advised to go to the assignment section found at the end the unit. You will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low you must not be discouraged, but appreciate the marks and try again by going over the topic and the exercise.

The assignment self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the self-assessment assignments. Submit or post your tutor marked assignment to your institution for marking by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more

information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, then go on to the next unit.

Glossary

At the beginning of this unit there is also a glossary of words that have been used in the unit. These are words which might be difficult for you to understand. The words are explained in simple ways or terms in this unit. You are also encouraged to refer to dictionaries available in the local libraries and study centres.



Terminology

Carrying capacity :	Refers to the ability of the land to support a given number of animals without causing degradation.
Rangeland:	Land that supplies forage (grasses, leaves, shrubs) for grazing and browsing animals
Range degradation:	Decrease in the quality of range resources.
Syndicate:	Group of people who cooperate on a project.
Stocking rate:	Number of hectares per livestock unit.

Topic 1: Utilisation of Rangeland Resources

Introduction

Rangelands are an important natural resource for any country. Rangeland quality or coverage is influenced by many factors like the type of soil and climatic factors. For example, Botswana is a semi-arid country whose average annual rainfall is low, averaging from 225mm in the south west to about 675mm in the north east. As a result, the natural vegetation which makes up the range mainly consists of poor grass cover and thorn shrubs.

The types of rangelands found in the country include: grasslands, woodlands and shrub lands. In this topic, you will define range, rangelands and rangeland degradation and learn about factors of range degradation and the effects thereof.

In Unit 6 you learnt that a rangeland provides a natural environment for wild animals. It is also used for grazing livestock. In this topic, you will learn more about rangeland in Botswana and the human and physical conditions that contribute to rangeland degradation.

Learning Objectives

On completion of this topic you should be able to:

- define the terms range, rangeland and rangeland degradation
- describe the human and physical factors responsible for range degradation
- discuss effects of range degradation on the environment

1.0 Range and Rangelands

Let us start this topic by understanding the terms **range** and **rangeland**. We will start with the term **range**. The term range means vegetation, that is, grasses, shrubs, forbs and trees growing naturally in an area where domesticated and wild animals graze and or browse.

First let us look at types of vegetation found in Botswana.

1.1 Types of Vegetation Found in Botswana

I am sure you have come across the term ‘type of vegetation’ at primary school or in other subjects like Social Studies. Earlier in this course, geography Unit 6, you learnt about forest vegetation of Botswana.

There are three types of vegetation found in Botswana namely; **savanna, woodland and forest**. How do these differ from each other? Let us now look at them one by one.

a) Savanna Type of Vegetation

The savanna type consists of a mixture of grasses and other small plants that form the ground layer with scattered trees and shrubs. The density of trees, shrubs or grass varies and depends on the amount of rainfall and the soil found in a given area. There are three types of savanna type of vegetation namely **grassland savanna, shrub savanna** and **mixed tree and shrub or bush savanna**. Although they are all savannas they differ in composition.

- **Grassland savanna**- This consists of mainly mixtures of grasses, sedges, herbs and scattered trees and shrubs.
- **Shrub savanna**-The main feature are shrubs with scattered trees.
- **Mixed tree and shrub or bush savanna**- It has few shrubs with many scattered trees but these do not form a ground cover.

b) Woodland Type of Vegetation

In this type of vegetation the main features are scattered trees with good grass cover.

c) Forest Type Vegetation

Here the main feature is trees which form a close canopy over the ground.

The map below shows how these different types of vegetation are spread over Botswana.

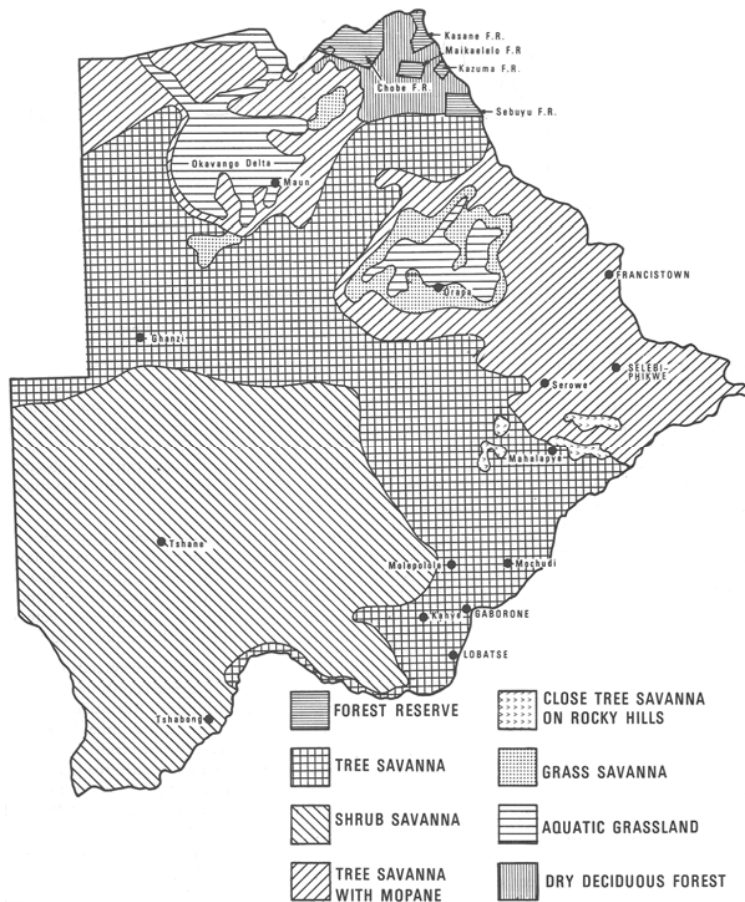


Figure 1: Types of vegetation in Botswana

Source: NDP 8

As we have been looking at the types of natural vegetation found in Botswana we have described each by only mentioning the main features in that type of vegetation. I must point out that there are other plants that are found in these types of vegetation. So now we will look at rangeland and study its composition. The word composition means things that make up something. So we are going to discuss the plants that make up the range in rangelands of Botswana.



Activity 1

If range is vegetation, what do you think Rangeland is? Write your answer in the space below.

Feedback

If you said rangeland is the area or is land where range grows, you are on the right track.

Rangeland is a piece of land which is not cultivated and is covered by vegetation which is growing naturally and is used for grazing by domesticated and wild animals.

A good surface area of Botswana is covered by such type of land. Because most land is not suitable for cultivation and crop production, indigenous vegetation grows there and is grazed by domesticated and wild animals. From what you have learnt so far, you can see that Botswana has got vast areas used as rangelands. These areas are set aside specifically for livestock grazing and wild animals. Some of these areas are used as forest reserves.

In Units 6 and 7, you learnt that areas set aside for wildlife management, mainly in the form of game parks and reserves cover up to 17% of Botswana's land surface area. Wildlife Management Areas and Controlled Hunting areas cover up to 22%, while forest reserves cover about 0.6%. Livestock grazing areas cover up to 34% of the country's land surface. This means rangelands cover up to 70% of Botswana's surface land area (the total area of Botswana is about 582,000 square kilometres).

Now that we understand what vegetation is, let us look at what makes up a range. This will help you differentiate range from vegetation.

1.2 Range Composition

The vegetation or range in Botswana consists of different plants including grasses, herbicious legumes, woody plants, sedges, forbs and trees.

a) Grasses

Grasses are the main component for rangelands. There are two types of grasses namely **perennials** and **annuals**. **Perennial grasses** live for two or more years and are better range plants because they last longer and therefore provide for grazing animals. They are mostly **palatable** and **nutritious**. **Palatable** means something that the animals enjoy to eat. **Nutritious** means they have a lot of nutrients. Because they last longer, they hold the soil and protect it from agents of erosion better. The following are examples of perennial grasses that are palatable to livestock: guinea grass, *lesotwe*, and finger grass. Are there any that you know of that I have not mentioned?

Annual grasses are grasses that live for only one season or year and produce seeds. They are poor soil protectors because they die within a short time leaving the soil uncovered and not protected from agents of soil erosion. They are mostly unpalatable to animals. Animals graze them when good quality perennials are scarce or have disappeared. However, there are a few palatable and nutritious annual grasses such as *urochloa trichopus* (*poka* or *sugwagaga*).

Grasses can also be classified into three groups and these are **decreasers**, **increasers** or **intermediates** and **invaders**. **Decreasers** are grasses that are palatable to animals. They are mostly nutritious and good for animals because they are desirable to animals. **Increasesers or intermediates** are less palatable or not palatable to animals. As animals over graze the palatable grasses, these less desirable plants have more space and land to increase in population because they are less grazed or not grazed at all. **Invaders** are grasses which were not found in the rangeland originally but because the desirable grasses are killed by over grazing new grasses come up which are usually found undesirable by the animals. Invader plants are, therefore, plants that come up and grow in rangeland where they did not originally grow. They are usually undesirable, not nutritious and poor soil protectors.

b) Herbaceous legumes

There are many legumes growing in the rangelands in Botswana. However, most of these are not palatable to livestock. Examples of palatable and nutritious legumes include *bauhinia*, *macrantha* (*mogosa*), *tylosema fassoglensis* (*morama*), and *leucaena leucocephala* (*lablab*). Legumes are important in the rangeland as they provide a good source of proteins to livestock and improve the nitrogen content of the soil.

In the range we also find woody plants.

c) Woody plants

These are trees and shrubs. These compete for space and other requirements for plant growth with grasses. However, they are a desirable feature in the rangeland as they provide shade for animals when it is hot and they also provide browse. Desirable woody browse plants include acacia giraffe (the common name is camel thorn, *mogotlho*), *boscia alibitrunca* (the common name is shepherd's tree, *motlopi*) and so on.

d) Forbs and sedges

Forbs are common in grasslands. They are broad leaved and produce flowers. In Botswana you may have seen the veld looking beautiful with a variety of flowers. The yellow flowery forbs are common. Sedges are similar to grasses but their leaf patterns and stems differ.

e) Other plants

There are other plants that grow in the range that we have not mentioned above. Animals eat many of these plants some of which are undesirable as they are weeds which compete for plant requirements with desirable and palatable plants. Some of these plants are even poisonous.

So you can see that the rangeland in Botswana is composed of a wide range of plants forming different types of natural vegetation. As we said in the introduction to this topic the livestock industry depends on the range found in the rangeland. The industry benefits depending on the type of range, the quality of the range and how productive the range is. Because the range is the source of food for animals, the productivity of the livestock industry depends on the productivity of the rangeland.

We now know the composition of rangelands so next we are going to look at the uses and value of rangelands.

2.0 What are the Uses and Value of Rangelands?

Before we discuss the value and uses of rangelands, do the following activity to assess how much you know already about this sub-topic.



Activity 2

Knowing what rangelands are, a) Do you think they are a valuable resource? b) How are rangelands used in your local area or country? If you do not have access to rangelands, you may

find agricultural officers and wildlife officers and ask them about the values and uses of rangelands in your country. Write the answers in the space provided below.

Feedback

Rangelands are valuable and useful resources in the following ways:

- *They provide food and fibre material*
- *They provide pastures or forage for both domestic and wild animals*
- *They provide open space land for recreational/sporting activities*
- *Are a tourist attraction because of abundance of wild animals*

We do not know how rangelands are used in your specific local area or country. However, the section below explains some of their general uses in Botswana.

Though most rangelands appear to be unproductive and barren, they provide multiple uses. Rangelands provide food and fibre for people. For example, in Botswana people living in the rangelands gather berries, worms and wild fruits. Recreational activities such as bird watching, racing, hunting, fishing and other sporting activities are common in rangelands.

We have already mentioned that the main use of rangeland is to provide forage for both domesticated and wild animals. Botswana's semi-arid region which covers the central and western parts forms the rangeland of the country. This is where most livestock farming particularly ranching takes place. The biggest national parks and game reserves are also located in this part of the country.

You may be aware that most families in the rural areas of Botswana keep domestic animals (or livestock). How do they acquire the land for grazing their animals? You are right if you said they do not need to apply for, buy or rent the land. The lands they use belong to all members of the community. Therefore, everybody has the right to graze his livestock on communal land. Under this land use system, nobody takes the initiative to ensure that the land is used sustainably. In the process, there may be too many animals for the range resources to sustain – this concept is termed **overstocking**. Where there is overstocking, range degradation is likely to occur. In the next section we shall look at range degradation.

3.0 What is rangeland degradation?

Rangeland degradation refers to the decrease in the quality of the rangeland. This is caused by both human and physical factors. Range degradation results in the decline in the productivity of the rangeland. Animals would lose weight because the pastures are poor and cannot sustain them. In Unit 6, you learnt how wild animals cause range degradation. This section is going to take you further to discuss factors leading to rangeland degradation. These are the human and physical factors that you learnt about in Unit 6. Before we discuss these factors further, try this activity to see if you still remember what you learnt.



Activity 3

In the table below list the physical and human factors leading to range degradation

Physical Factors	Human Factors

Feedback

The following subsections will provide feedback to Activity 3. Go through the subsections and check your answers.

3.1 Human factors leading to rangeland degradation

These are conditions that are created by the actions of people that eventually make it easy for rangelands to be damaged. They are:

- a) **Overstocking** – too many animals in a limited grazing area will lead to overgrazing and soil erosion. It goes without saying that the rangeland will be degraded. Fig. 1 shows overgrazed rangeland. From this picture you can see almost bare land with very little vegetation cover..

Most cattle producers in Botswana keep their animals under the communal grazing system where all the animals in a village graze in the same grazing areas. This tends to overstock the rangeland as there is no limit to how many animals a farmer should keep and even how many animals should be allowed to graze in a particular rangeland. Since there are too many animals in the rangeland, plants are always overgrazed and are not given a chance to recover from the grazing. This ends up killing the desirable and palatable plants. Productivity of a rangeland which is overstocked and overgrazed is very low.



Fig. 2: Degraded range resources

<http://upload.wikimedia.org/wikipedia/commons/6/65/Cattle.jpg> (01/02/2010)

- b) **Deforestation** – removal of vegetation cover, if done without due care, for the environment, will certainly result in rangeland degradation. Plants in general protect soil from being eroded. Their roots bind soil particles and as a result the soil is not easily carried away by either water or wind. Plants also reduce water run-off allowing the water to move slowly and as a result giving the plants a chance to absorb the water for their own benefit. However, if the soil has been eroded and is bare it makes it very difficult for new plants to grow well. Therefore, productivity in an eroded rangeland will be very low.
- c) **Veldt fires** – veldt fires can be caused by humans as well as by natural lightening. I am sure you have seen a rangeland before being burnt. Many times the rangeland is burnt by accident. People who smoke carelessly throw away cigarette stubs and burn the veldt. Sometimes an unlimited area of the rangeland is burnt this way. Where controlled veldt fires are practised, they help to keep the rangeland productive. Controlled veldt fires are meant to burn the veld for a reason, such as to control ticks or to burn off grass sward to encourage new plant re-growth. But where uncontrolled veldt fires are practised, when dry vegetation is burnt, the fire kills the plants. Once the rangelands are burnt, there will be no vegetation cover, grazing resources will be scarce and of poor quality. This is range degradation.
- d) **Over-harvesting of veldt products** – humans can cause range degradation by uncontrolled harvesting of resources such as thatch grasses. In Botswana, this is common in the eastern and northern parts of the country which experience higher amount of rainfall. Range products overharvested include grasses used for thatching and wood used

for fuel. Commercialisation of such range products has intensified the problem of overharvesting range products.

- e) **Population growth** – results in encroachment of human activities into rangelands. Can you give an example? Yes, one example is that of clearing spaces for settlement or cultivation. Mining towns like Jwaneng and Orapa were once rangelands for communal farmers. Vast rangelands were cleared to give way to such towns.
- f) **Government policy** – communal land tenure is the system of ownership of rangelands by the community as practiced in Botswana. Under such a system it means no one takes the responsibility to manage the range resources. In other words, there is no policy to control the use of communal rangeland. As a result, they will be over-utilised to the point of degradation. This concept may be described as “the tragedy of the commons”.

Go back to Activity 3, [human factors section](#), and check if you have listed the above human factors. Make the necessary corrections and then let us move on to look at the physical factors in the next subsection.

3.2 Physical factors of rangeland degradation

The physical or environmental factors are not caused by humans but are rather natural. They include:

- a) **Drought** – prolonged periods of drought result in poor or insufficient range resources. This is because during drought there is no rainfall to support plant life. During the first year of drought, overgrazing occurs. The following years are characterised by complete loss of vegetation cover, especially grasses and small shrubs.
- b) **Floods** – flooding suffocates plants due to too much water and insufficient aeration of the soils. Torrential rains often results in flooding. In Botswana we have had cases of flooding in Mahalapye, Palapye and Shoshong areas. Small trees, grasses and shrubs were badly damaged.
- c) **Temperature** – plants need moderate temperatures for them to grow well. Too high or too low temperatures can cause wilting and eventual dying of plant matter. In Botswana, high temperatures are common during drought periods. Such high temperature and lack of rainfall result in loss of vegetation. The central part of Botswana is prone to intense heat.
- d) **Veld fires** – note that we said veld fires can be caused by people, but they can also be caused by lightening which is a natural phenomenon. You may have seen or come across areas affected by veld fires. In the year 2009, large area covering the Central Kalahari Game Reserve was badly affected by the veld fires.
- e) **Increased wildlife populations**

Increased wildlife populations, as is the case with Botswana’s elephant populations can result in serious land degradation. This again is a question of overstocking. Botswana is believed to have an elephant population of over 120 000 which is assumed to be beyond the carrying capacity of the land. As a result, the elephants degrade most of the land along the Chobe River.

All factors discussed have had a negative impact on rangelands. These factors still continue to destroy the rangelands. I am sure you would agree with the researchers who claim that the rangeland currently is not the same as 50 years ago. Before you move on to the next section, check your answer to Activity 3, physical factors section, and add any of the factors that you may have omitted.

Let's now look at the effects of rangeland degradation.

4.0 Effects of rangeland degradation

You have just learnt about the factors causing range degradation. You may have seen some of the effects of range degradation. Before we discuss them, try the activity below.



Activity 4

You may know of or be living in an area where the effects of range degradation are visible. If not, ask for information from colleagues or look for other sources of information on this topic. Write down the possible effects of range degradation on the environment below.

[3]

Total = 3 Marks

Feedback

The three that I have thought of are:

1. *Low quality of animals*
2. *Low productivity milk and meat products*
3. *Growth of unpalatable species*

You could have mentioned other effects that may also be correct.

Let us now discuss some of the effects of range degradation

a) **Soil erosion**

It is the removal of top soil by agents such as wind and water. Once the rangeland is degraded, the vegetation cover will be weakened, and the soil, having lost the protective vegetation cover, will be easily carried away. Figure 3 shows the impact of soil erosion on the valley. What do you think is the main agent of soil erosion in this valley? Yes it is water as you can see in Figure 3. Wind is also one of the agents of soil erosion. In Botswana, wind erosion is common in the desert area, where the rich top soil is blown away, resulting in large areas bare of any vegetation.



Fig. 3: Soil Erosion

Source: <http://upload.wikimedia.org/wikipedia/commons/7/7b/Erosion.jpg>
(01/02/2010)

b) Destruction of soil structure

Soil structure refers to how individual soil granules or particles bind together. Soil structure affects water and air movement in the soil, as well as seedling emergence and root growth. In areas with large stock of animals, the soil structure is affected by animals as they trample or walk on the soil. Once the soil is loose, it can be easily washed or blown away. Therefore poor soils on degraded rangelands cannot support growth of good pastures. In Botswana, soil is affected this way in cattle posts, where overstocking is common.

c) Salination

Salination is the same thing as soil salinity which refers to the concentration of salts in the soil. Salination can be induced by human activity. Can you think of any human activities that can cause salination. I hope you have mentioned land clearing, and irrigation. Clearing trees for farming is one the major reason for what is known as dryland salination. This is common in the Ghanzi area with high levels of salt in the soil.

d) Bush encroachment

Bush encroachment normally results in an area where there is too much livestock especially cattle. The bushes that usually grow in the area are acacia plants. As the bushes occupy the area, it means other plant species are unable to grow easily. Areas that have bush encroachment usually make the land unproductive except for those acacia bushes found in the area. The forests and woodlands of Botswana are prone to bush encroachment because that is where problems of overgrazing occur.

e) Low quality of animals

Once the rangeland has been degraded animals would lose weight and may not fetch good prices. Even the milk output will be low.

5.0 Summary

In this topic you learnt that

Range is vegetation growing naturally and grazed by both domestic and wild animals.

Rangeland is an area that is not good for cultivating. **Range** grows there and grazing takes place there.

The natural vegetation found in Botswana is savannas. These are grass savanna, shrub savanna, mixed tree and bush savanna, woodlands and forests. The composition of the vegetation or range in Botswana consists of different plants including grasses, sedges, forbs and trees.

Rangeland degradation refers to the decrease in the quality of the rangeland. This is caused by both human and physical factors. Range degradation results in decline in the productivity of the rangeland.

Some of the effects of range degradation include soil erosion, bush encroachment, soil salination and low quality of animals.

You have now come to the end of Topic 1. Refer to the Assignment section at the end of the unit and complete the first self-assessment exercise. Thereafter, check your answers against those provided in this section of the unit. Depending on your progress either review the sections you found difficult or if your progress was satisfactory, continue to the next topic.

Topic 2: Management of Rangeland Resources

Introduction

Students, once again I welcome you to another exciting topic in Unit 8. In the previous topic we defined the concepts range and rangelands. We discussed how rangelands are used and degraded.

In this topic you are going to learn about factors affecting range management. We will see how overgrazing, stocking rate, carrying capacity and so on influence or affect the productivity of the range and the rangeland.

So you will need knowledge gained from Unit 6 and Topic 1 of this unit in order to understand this topic better. As we progress through this topic, now and again we will refer to the previous unit and topic 1. Note that this may seem like repetition to you but remember that in Unit 6 the focus was on wild animals and their impact on the environment. We briefly mentioned rangelands as a part of the environment.

Learning Objectives

By the end of this topic you should be able to

- explain range management and the principles of range management
- discuss the physical and human factors affecting range management.
- explain sustainable rangeland utilization practices in Botswana.
- evaluate the role of government, private sector NGOs, local authorities and local communities can play in the sustainable utilisation of rangelands.

1.0 What is Range Management?

I am sure that now you can tell what range management means. Let us first try and understand what the term management means. Management means taking care of something or using something in such a way that it continues to be useful to you for a long time. We have already said that range is natural vegetation used for grazing both wild and domesticated animals. So combining the two, range management means a well-planned care and use of range and rangeland so that the highest animal production can be obtained without deteriorating the condition of the range. If anything the condition of the rangeland should improve.

If range land is not properly managed, that is, if it is not carefully used, the vegetation will become scarce. If this happens, the land will not provide enough food for the same number of animals it had been supporting before.



Activity 1

Pause and think about how rangeland is generally used in Botswana. Do you think it is used in a way that keeps the range in a good condition or even improve its condition? State yes or no.

Why do you think range management is not good in Botswana? Write your answer in the space below.

Feedback

If your answer was no you are right

I hope you said that there are a number of factors which affect range management in Botswana and you mentioned some of the factors I will mention next.

Now we will look at the factors that affect range management in Botswana.

2.0 Factors Affecting Range Management in Botswana

The following are some of the factors that affect range management in Botswana:

- the land tenure system or grazing systems used
- livestock unit
- carrying capacity
- stocking rate
- overstocking
- overgrazing
- lack of knowledge by farmers
- population growth
- climatic conditions
- tree and bush encroachment
- availability of capital

Attempt the following activity before we discuss them in more detail. It will help you review what you learned in the first topic.



Activity 2

Go over the list of factors affecting range management. These factors can be categorised into physical and human factors. Physical factors, as you will remember from Topic 1, are those that are naturally occurring and human factors are those that are influenced or resulting from human actions. In the table below, categorise the above listed factors into human and physical.

Physical Factors	Human factors

Feedback

I hope this was an easy task for you.

You probably noticed that we have discussed some of the above factors before, particularly the factors causing range degradation. We are now going to discuss these factors, starting with the human factors.

You will now see how the same factors influence efforts to manage rangelands in Botswana. First let us discuss the human factors in more detail.

3.0 Human Factors Affecting Range Management

You have come across human factors in Units 4, 5, 6 and 7. You learnt how those factors influence a type of environment or management of a particular resource. We are now going to look at or assess how human resources affect the management of rangelands in Botswana, starting with the land tenure system used in the country.

3.1 Land Tenure System

Land tenure means how land is owned. In Botswana there are three types of land tenure: there is the communal land tenure, freehold land tenure and lease hold land tenure.

- (a) **In Communal land tenure** the land is owned jointly by the ethnic group or a community and not by an individual farmer. Animals for the people in the village graze in this area. No one can fence off any part of the area for grazing his or her animals. However, if anyone wants to grow crops in the communal land s/he must apply to the Land Board for crop farming or for drilling a borehole. This makes it difficult for anyone to practice good range management as no one has control over the grazing land.
- (b) **In Freehold land tenure** the farmers own the land they use and therefore the farmer can fence off the land to prevent other people's animals coming to graze there. He or she can also drill a borehole and carry out other management practices which can help keep the range in a good condition for a long time.
- (c) **In Leasehold land tenure** farmers do not own the land but they rent it from the owner which might be the government or the state. They pay rent per month or per year. Farmers are encouraged to adopt good management practices like drilling boreholes, fencing to restrict the number of animals that graze there.

So you can see that the land tenure system that is in force or in use can restrict or limit the farmers' ideas of using the range without causing damage.

Below is a map showing land tenure systems as practiced in different parts of Botswana.

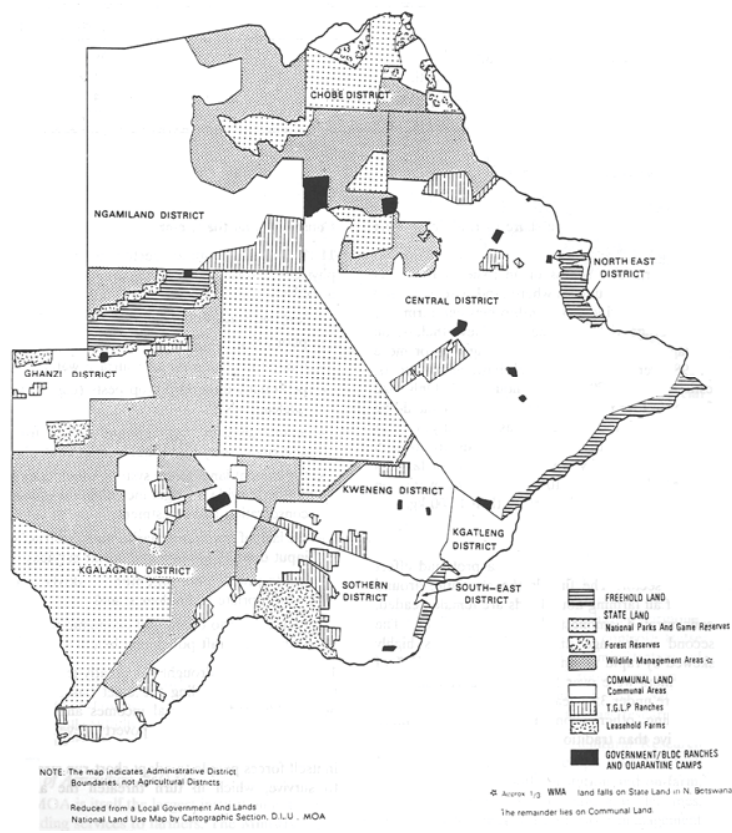


Figure 1: Land Tenure System of Botswana

Source: Botswana NDP 7

From this map you can tell what type of land tenure is practiced in your area or in the area you want to carry out farming activities.

3.2 Livestock Unit

What do you think a livestock unit (LSU) is? I hope your answer was correct. It is an equivalent of a mature animal with a live weight of about 500kg. It is taken as an equivalent of one cow or ox with about 500kg live weight. When dealing with smaller animals for example small stock like sheep and goats or young cattle, a livestock unit cannot be an equivalent to one animal because their weights are far below 500kg. So we work out a LSU by finding how many of those animals, if their weights are added, would add up to about 500kg.

What is the importance of understanding or knowing LSU? Well it helps in comparing grazing requirements for different kinds of animals because we will be using one unit for different animals. We will not be changing the units when we talk about different animals like goats, cattle, sheep, and so on. So if we talk about 1 LSU and we are dealing with cattle it means one adult animal. If we are dealing with goats it is 6 or 7 animals and if it is donkeys it is about 2 animals and so on.

Now let us look at the term carrying capacity and see how it relates to LSU.

3.3 Carrying Capacity



Activity 3

What comes to your mind when you hear the term carrying capacity? Write your answer in the space below.

Feedback

Now look at my explanation and see if yours was similar to it. The word carrying means to hold something while moving from one place to another or to support something. The word capacity means the ability to do something.

Now let us put these words together and see how they are used in range management. Carrying capacity is defined as the amount of grazing and browsing hectares which will support 1 LSU so that optimum production is obtained while sustaining the range and the rangeland.

This means that carrying capacity is how much area should be available to 1 LSU so that the animal(s) have enough to eat without overgrazing or under grazing the range.



Activity 4

Do you think that carrying capacity is the same from one place to another? State whether Yes or No

Why do you think the carrying capacity differs from one place to another? Write your thoughts in the space below.

Feedback

If you said No for the first question, you are right. Carrying capacity differs from one place to another.

I hope your explanation will be similar to mine below.

Remember that in Topic 1 we learnt that Botswana is covered by different types of natural vegetation, which differ from place to place. We also learnt that the composition of the range differs from one place to another. So it is the composition of and types of natural vegetation which determines plant population and density in the rangeland. Therefore, they determine the carrying capacity or the area of the rangeland that can support 1 LSU without causing overgrazing or under grazing. Because these differ from one place to another, the carrying capacity differs from one place to another. For example, look at Table 1 below which shows the carrying capacity of rangeland in some districts of Botswana (as recommended in 1997).

Table 1: Carrying capacity of rangeland in some districts of Botswana

District	Carrying in Hectares Per L.S.U
Central	16
North East	24

North West	9
Chobe	9
Ghanzi	21
Kgalagadi	26
Kweneng	12
Kgatleng	12
South East	12
Ngwaketse	16

It must be noted that the carrying capacity may change from time to time due to changes in the range composition.

The next question that we should answer is, do farmers follow the recommendations of the given carrying capacity? What do you think? The answer as you may have guessed correctly is no, most farmers do not, especially those keeping their cattle under communal grazing land tenure. This takes us to the next term to learn, which is stocking rate.

3.4 Stocking Rate



Activity 5

In the space state what you think is meant by stocking rate.

Feedback

I hope you have the correct idea. Now continue and read my explanation.

Stocking rate is defined as the area of grazing land in hectare available per livestock unit at a particular time. This refers to how much land an animal or a livestock unit is allowed to graze or browse.



Activity 6

Situation: A farmer is keeping 5 cows in a 30 hectare farm. What is the stocking rate? Using the knowledge you have acquired work out the solution to the above question and the one which follows after this one.

Feedback

The answer can be worked out as follows;

5 cows grazing 30 hectare

1 cow is grazing 30 hectare divided by 5

So 1 cow is grazing 6 hectare

Therefore the stocking rate at this farm is: 6 hectare per cow which is 6 hectare per livestock unit.

Now consider the following situation:

Another farmer is keeping 5 cows in 1 hectare of rangeland. What is his stocking rate? Given that 1 hectare equals 10000 metres squared, work out the answer by showing your work.

Answer:

Feedback

5 cows are grazing 1 hectare which is the same as 5 cows are grazing 10000 square metres.

Therefore, 1 cow is grazing 10000 metres squared divided by 5 which equals 2000 square meters.

1 cow is grazing 2000 square metres.

To change to hectare- 1 cow is grazing 2000 meters squared divided by 10000 meters squared equals 0.2 hectares.

Therefore, 1 cow is grazing 0.2 hectares and that is the stocking rate being used by that farmer.

Now think about this, in the North East District we are given the carrying capacity as 9 hectares per LSU which means that 1 cow should be allowed 9 hectares to graze. Now if a farmer is only allowing 0.2 hectares per animal he is not giving enough grazing land to his animals. Even a farmer who has decided to use 6 hectares to an LSU, if he is in the North East District, he will not be giving enough grazing area to the animals.

Having understood the terms carrying capacity and stocking rate, we are going to look at overstocking.

3.5 Overstocking

You have come across the concept overstocking in your JC Social Studies. Before we discuss it further, try Activity 7 below to assess your previous knowledge.



Activity 7

So what do you think overstocking is? Write your thoughts in the space below.

Feedback

If you said that overstocking is when the stocking rate is more than the carrying capacity of an area then you are right.

In the examples that we have discussed above, both farmers are allowing less grazing area per LSU than the carrying capacity of the area. This is overstocking.

For example, the carrying capacity of South East District in Table 1 is given as 12 hectares per LSU. A farmer keeping 20 heads of cattle will need 240 hectares of land if he is to practice correct stocking. In other words, in this area for 20 animals to get enough food without causing damage to range and rangeland the farmer needs 240 of hectares of land. If he keeps these 20 cows in an area less than 240 hectares, say 150 or 200 hectares, he is overstocking. This means that he is keeping more animals than the range and the rangeland can support on a sustainable basis. On the other hand, if he keeps less than 20 animals say 12 to 15 in area of 240 hectares then he is **under-stocking**. This means that he is keeping fewer animals than the area is able to support. This is not good because it does not allow full and economical use of the rangeland resources. Under-stocking leads to poor plant re-growth and selective grazing by animals. What do you think **selective grazing** is? Well, selective grazing is when animals select or choose to graze or eat only palatable plants and leave other plants not grazed. Grazing works like pruning of plants. So, well grazed plants get new re-growth and sward which is good for animal feeding.

Selective grazing leaves some plants to overgrow and get old before being grazed. Old plants are low in nutritional value. Also, a veld full of under grazed vegetation does not have space for the growth of new plants. As a result the general production of animals is low.

Now think of a farmer who is keeping the animals in an area at the recommended carrying capacity.

For example, according to the table, in Chobe the carrying capacity is 9 hectares per LSU. If a farmer in Chobe keeping 20 animals has 180 hectares of land to graze his animals, he is keeping the number of animals that the rangeland can support on a sustainable basis. This is correct stocking.

I am confident that by now you can see how these practices impact or affect the range and rangeland. Let us now talk about overgrazing. Since this is a familiar topic, try Activity 8 to see how much you already know.

3.6 Overgrazing



Activity 8

To start, let us ask ourselves what overgrazing is. Can you define it in the space below?

Feedback

I am sure you got it right. Overgrazing is when animals eat most of the plants or eat all the plants in the rangeland.

Overgrazing is usually a result of overstocking the rangeland for a long period and this leads to severe **defoliation** of grazing and browsing plants. **Defoliation** means removal of leaves, branches and twigs from grasses, shrubs and browsing trees.

What do you think will happen when rangeland plants are defoliated due to overgrazing? Overgrazing affects plants, soil and animals in the rangeland. Let us see how this happens. We will start with the effect of overgrazing on the soil and then discuss the effects on plants and animals.

The soil: The foliage of plants provides shade for the soil by protecting it from direct heat from the sun and direct impact of rain drops. Foliage also slows down speed of the wind over the rangeland, slows down the speed of running water allowing the soil to absorb and use it. When the plants are overgrazed or plant foliage removed or reduced, the soil is left bare and exposed to agents of soil erosion, allowing soil erosion to occur. Soil erosion results in the loss of the top soil. The loss of top soil is not good for plant growth. As a result plants will grow poorly, slowly or they may completely fail to grow. Reducing water intake by the soil may result in floods for low lands and reduction of underground water reserves. The water holding capacity of the soil becomes poor, and because water runs off the soil this does not allow plants to absorb water and use it for their growth so plants grow poorly or do not grow at all. Poor plant cover on the soil leads to low humus content in the soil which results in poor soil fertility. Also, when the soil is not covered we said it is exposed to direct heat from the sun. This results in soil temperature being too high which is not good for plant growth and other beneficial organisms that live in the soil. The picture below shows a piece of land where soil erosion has occurred because it has been overgrazed.

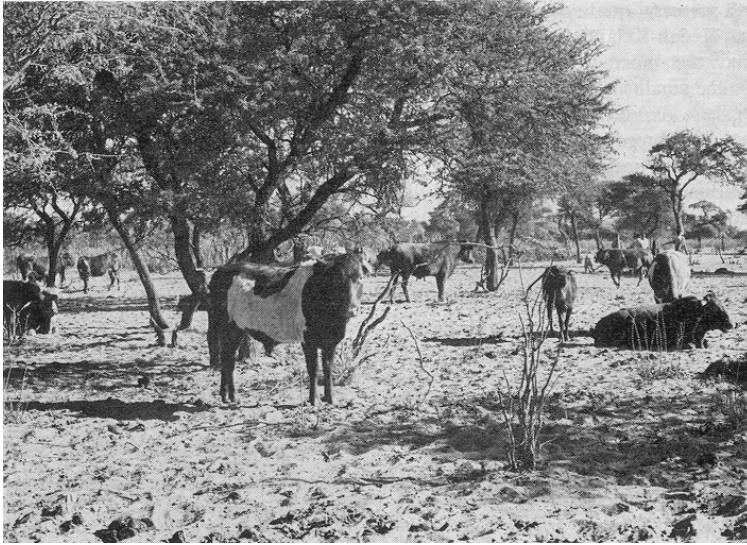


Figure 3: a piece of land where soil erosion has occurred because it has been overgrazed.

Source: Botswana NDP 7

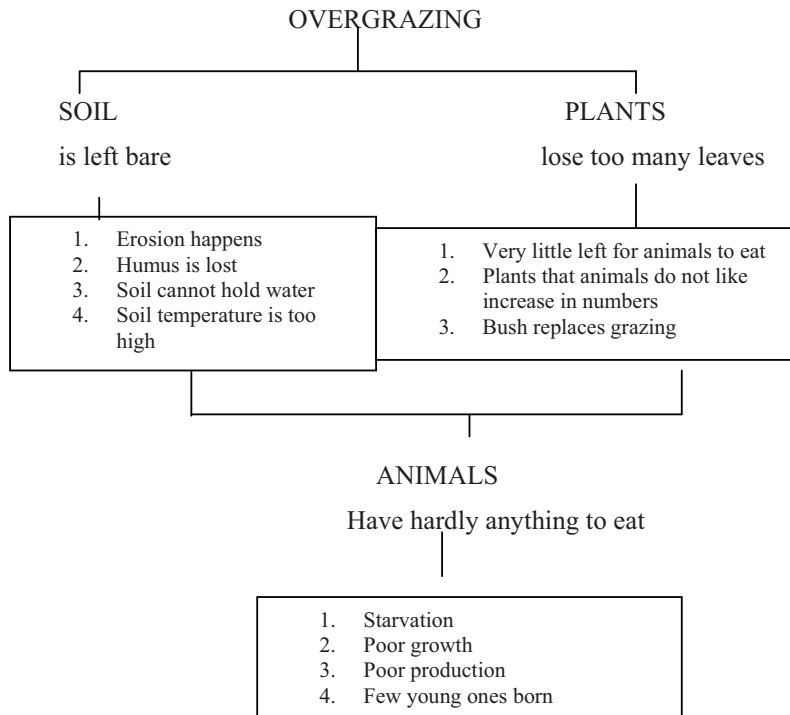
Look at the photo again and think of how overgrazing affects the plants. I am sure your thoughts included some of the things I am going to discuss below.

- (a) **Plants-** they lose too many leaves or the whole plant is eaten up. When plants lose too many leaves, processes like photosynthesis and transpiration which take place in the leaves are affected and this in turn affects the general condition of plants. In an overgrazed rangeland there is very little foliage or leaves left for animals to eat. Plants that animals do not like increase in numbers, and bushes replace the plants for grazing. How does this affect animals? Read on.

- (b) **Animals-** animals do not have enough to eat and they starve and die due to starvation. They also grow poorly. As a result animal general production is low due to poor health and few young ones are born in the herd which leads to economic loss for livestock farmers.

Table 2 below illustrates the effects of overgrazing as we have discussed above.

Table 2: Effects of Overgrazing



I am sure you now understand the effects of overstocking and overgrazing on the rangeland. I hope you have noted the end results of the effects of overgrazing. Let us now look at other human factors affecting rangelands.

2.7 Population growth, lack of knowledge and capital

Other human factors affecting rangelands are population growth, lack of knowledge and capital. Let's look at each one of these factors.

(a) Population growth

As the human population grows the range is affected. Usually the human population occupies better areas for human activity and this reduces the area for grazing. Also, as human population grows, it means that more people are keeping animals and therefore the population of animals increases as well.

(b) Lack of Knowledge by Farmers

Farmers do not know good range management practices. For example, most farmers do not know how many animals should be kept in an area without damaging the herd or what could

be done in the rangeland to improve the condition of the range as those practices are not profitable.

(c) Lack of Capital

Good range management includes having watering places so that animals do not walk long distances and also so that not too many animals drink from the same watering point trampling vegetation badly. During droughts, grazing lands should be irrigated. However, most farmers cannot afford to do this as they do not have enough capital.

You now understand the human factors influencing range management, particularly in Botswana. In the next section we look at the physical factors.

4.0 Physical Factors Affecting Range Management

Other physical factors affecting rangelands include climate, soils and bush encroachment. Before we look at each one of these factors try the following activity to consolidate what you already know about the topic under discussion.



Activity 9

Considering the fact that Botswana has an average low rainfall, unfavourable temperatures and poor soils, what type of vegetation do you think is found in Botswana?

Feedback

I hope you have remembered the answer from Topic 1. Botswana is covered mainly by savanna, woodland and a bit of forest vegetation. This type of vegetation is generally poor because of low rainfall and infertile soils.

(a) Climate

Plants need enough water, optimum temperatures and nutrients from the soil in order to produce good grazing pasture for animals.

Botswana's rainfall is unreliable, that is, sometimes the quantity of water is not enough. Usually when there is rain a lot falls within a short period so that it is not well distributed over the growing period of the plants. Again when a large amount of rain falls at one time it may not be good for plant growth. Too much rain may cause floods which will kill plants.

Vegetation grows well and is productive under optimum temperatures. Botswana climate is characterized by high summer temperatures which average between 20 and 38 degrees Celcius and very low winter temperatures. These high temperatures damage range. As transpiration is too high the range wilt and die, and in addition, the high temperatures kill microbes in the soil. Very low temperatures also kill plants. Because of these extreme temperatures in Botswana, the range is generally poor.

(b) Soils

Generally Botswana soils are poor in fertility, water holding capacity, water retention, and humus content. These factors affect the quantity and quality of the range growing in an area. The soil determines the type of plants that grow well in an area.

(c) Bush Enchroachment

When the land is mostly overgrazed, the types of plants that animals do not like to eat tend to increase in the land because they are eaten less by the animals. But these are usually of little use to the animals both in terms of palatability and nutritional value. Animals do not eat them so they gradually increase and establish themselves in the area. Such plants are usually difficult to control and may take over a good space in the rangeland.

We have discussed both the human and physical factors affecting rangeland management. In a way, we have discussed what makes it difficult to manage rangelands in Botswana. We know that the best solution to rangeland management problems and degradation is to ensure sustainable use of range resources and this is what we are going to look at in the next section.

5.0 Sustainable Utilisation of Rangelands

To understand sustainable utilisation of rangelands in Botswana, it is important to first look at the general principles of good range management.

5.1 Principles of Good Range Management

To start, let us work out what the word principles means. The word principle means, the basic general rules about something. So principles of good range management are basic rules or guidelines which if followed will result in good range management.

The aim of good range management is to make sure that livestock are productive and profitable. This can only happen if the rangeland is productive. So, under good range management the value of the land should increase and soil erosion should be prevented. These can be achieved by following the principles or rules of range management.

These principles are:

- balance the animal population with available forage
- use the kind of livestock most suited for the available forage
- practice rotational grazing

- distribute animals evenly over the entire rangeland
- control bush encroachment
- distribute watering points evenly over the rangeland
- conserve some forage for dry season feeding
- replace dead or old plants with new ones.

Now I will try and explain how these guidelines help a farmer to achieve the aim of having productive and profitable livestock in a productive rangeland.

Balancing the animal population with available forage

This means that when stocking the rangeland we should not exceed the carrying capacity of the rangeland, as doing so might result in overstocking and overgrazing. Also, we should not under stock. In other words, we should not keep fewer animals than the carrying capacity as this leads to under grazing. Under grazed land is not very productive as plants become too old and not very nutritious for the animals. It also encourages bush encroachment.

Use the kind of livestock most suited for the available forage

It enables the animals to have enough to eat. For example, animals that browse like goats should be kept where there are enough browse plants; grazers should be kept where there is enough grass.

Practice rotational grazing

This allows the rangeland to have periods of grazing alternating with periods of rest. This helps to maintain production of high quality forage thereby keeping animal productivity high. It also assists in controlling parasites.

Distribute animals evenly over the rangeland

This is to avoid some areas being overgrazed if there are more animals and other areas being under grazed if they have fewer animals.

Control bush encroachment

As we said in the previous lesson, bush encroachment occurs when decreases or palatable plants are overgrazed and die off. These new plants which come up take the place of palatable plants resulting in animals not having enough to eat.

Distribute watering points evenly over the rangeland

Activity 7

Do you remember what we said in the previous lesson about why we should distribute

watering points evenly in the rangeland? Write one of the reasons in the space below.

Feedback

You were correct if you said to avoid overcrowding watering points or to avoid soil erosion around watering points which results from too many animals walking around these points, loosening the soil and making it prone to erosion. Animals trekking to the same watering points also cause over grazing and soil erosion along the paths.

Conserve some forage for dry season feeding

This will maintain animal productivity even when the condition of the range has gone down. Also, if animals have enough food they will not over graze the rest of the rangeland. The question is how is this done? It can be done by reserving or keeping some paddocks un-grazed where the rangeland is divided into paddocks. Where the paddocking system is not used animals are prevented from grazing a part of the rangeland when forage is plentiful. In the dry season when the condition of the vegetation that the animals had been grazing becomes poor then the animals are made to graze the reserved paddocks or area for grazing. This also prevents overgrazing and soil erosion.

Replace dead and old plants with new plants

This is important for the rangeland to remain productive. In Topic 1 we realized that most rangeland in Botswana is not managed properly and as a result over the years it has deteriorated. Vegetation loss occurs during drought. Most old plants die during the dry seasons. Some plants also die when range is eroded. Figure 4 below shows rangeland erosion cycle. This cycle results in complete loss of some plants.

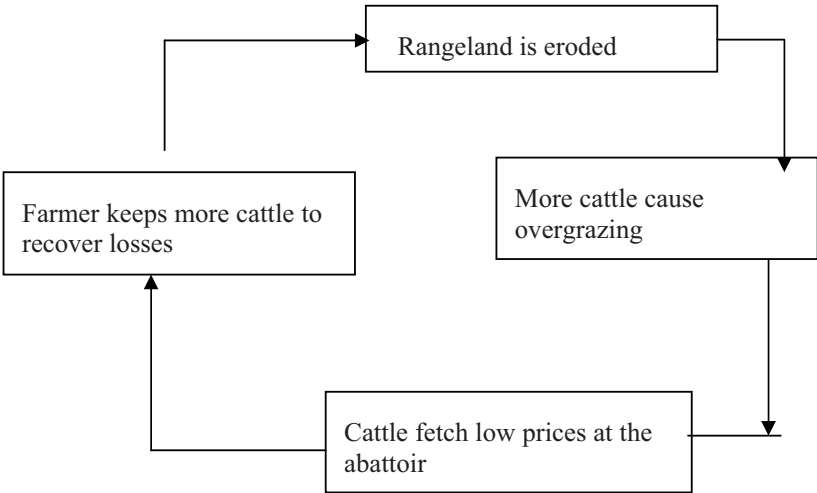


Figure 4: how bad grazing practices resulting in complete loss of some plants

To break this cycle dead plants must be replaced, or the remaining vegetation must be reserved for some time to allow recovery or regeneration of plants.

The next item we are going to look at how a rangeland that has deteriorated can be brought back to a good and productive condition. This is called **range improvement**.

5.2 Range improvement

As mentioned already, this is the process of bringing back a rangeland that has lost condition or state of high productivity. We are going to look at some of the things farmers can do in order to improve the range in the rangeland and increase rangeland productivity. There are many things that farmers can do and these include:

- Ploughing, planting, and reseeding the rangeland.
- Introducing new plant species in the rangeland.
- Using fertilizers.

Now let us discuss how the things we have mentioned will help improve range or pasture.

- (a) Ploughing, replanting and reseeding the rangeland:** If a rangeland is covered with poor quality vegetation it should be ploughed so that the poor quality plants can be replaced completely with better range plants like grass, legume mixture and so on. This practice is not common in Botswana, but it is one way of effectively improving the quality of the range.
- (b) Introducing new plant species in the rangeland:** Here you do not have to remove natural vegetation. The new species of grasses and legumes are planted in the rangeland while the natural vegetation is still growing there. It helps to increase the plant population and it also brings more desirable and palatable plants thereby increasing rangeland productivity.
- (c) Using fertilizers:** Adding organic or inorganic fertilizers to the soil improves the nutrient content of the soil and therefore generally plant growth and the animal population improve.

After the rangeland has been brought back to the condition of high productivity, it is important to maintain it or keep it in that condition so that it continues to be productive. The following management practices will keep it in that condition.

- practicing correct stocking
 - fencing grazing land
 - controlling the spread of trees and shrubs
 - controlling veld fires
 - providing enough water
 - controlling soil erosion
 - controlling weeds
 - controlling grazing.
- (d) Practicing correct stocking:** Means the land is stocked according to its carrying capacity. There will be no overgrazing and soil erosion.
 - (e) Fencing the range or grazing land:** This has many advantages which help in good range or pasture management. For example, it prevents trespassing by stray stock which will increase animal population in a rangeland. It is easy for a farmer to practice correct

stocking in a fenced area. Fencing helps to separate animals into different groups for better management. It also helps to practice rotational grazing and reserving or conserving pasture for dry season grazing. It also makes it possible to fence out a problem area. For example, an area with poisonous plants can then be ploughed and reseeded.

- (f) **Controlling the spread of trees and bush:** This encourages population increase of palatable plants especially the decreaser perennial grasses.
- (g) **Controlling veld fires:** We have already discussed this earlier in this unit when we said that uncontrolled veld fires destroy the vegetation and should be discouraged.
- (h) **Providing enough water points:** I am sure you know the importance of water to both animals and plants. Therefore, it is important to have enough water supplies which could be achieved through the building of dams or sinking of boreholes. These sources of water can then be used to supply animals with drinking water and water to irrigate plants.
- (i) **Controlling soil erosion:** Again we saw the effects of soil erosion earlier in this topic. Therefore, it is important to prevent and control soil erosion if the range has to be improved.

Try activity 8 to find out how soil erosion is controlled.

Activity 8

Carry out a small research on ways of controlling soil erosion in your local area. You may go further to find out how effective these measures are in controlling soil erosion and improving the range. Write a report of your findings and discuss with your tutor.

It will be helpful to gather information from books, agricultural officers and teachers, local farmers and other agricultural institutions. You may also find relevant information from the internet.

- (j) **Controlling weeds:** One may wonder how some plants can be classified as weeds in a rangeland when we said that in a rangeland plants grow naturally. But remember in Unit 5 we defined weeds as plants growing where they are not wanted. So plants that we do not prefer, growing in a rangeland either because they are poisonous or they are of no value to the animals, are weeds. These should be removed to give chance to palatable and more valuable plants to grow.
- (k) **Correct grazing:** It helps to maintain the range or pasture thus providing enough feed for the animals and keeps the rangeland in a state of good health and balance.

The application of good principles of range management and ways of improving the range are all examples of sustainable use of rangelands. You may have noticed that they are the same. Are these practised in your country? I expect your answer to be a “yes”, in that there are individuals, groups or organisations that practice sustainable use of rangelands. All parties involved in the use or benefit from rangelands are known as stakeholders.

We now understand what should be done to ensure sustainability of range resources. The question remains: who is responsible? We know that it is the responsibility of all citizens but mainly stakeholders. Let us now look at these key stakeholders and evaluate their role in the use of rangelands.

6.0 Roles played by Stakeholders in sustainable utilization of Rangelands

Stakeholders are all parties who may include an individual, a group, an institution or organisation with a common interest in a particular business or system. In Botswana, the following are important stakeholders involved in the sustainable utilisation of rangelands:

- Government
- Non-Governmental Organisations (NGOs)
- Private companies
- Local Authorities
- Local communities

You may have witnessed the roles played by the above mentioned stakeholders in ensuring sustainable use of rangelands. If not, you may visit the relevant officers to find out. For example, you may visit the Department of Animal Production in the Ministry of Agriculture to find out how they ensure sustainable use of rangelands. You may also visit the following for a small interview on this subtopic:

- Departments of Wildlife and Tourism
- Botswana Conservation Society
- Botswana Farmers Association
- Local Administration Office (The Kgotla)
- The Village Development Committee
- Botswana Farmers Association

Your visit is important as it will help you to do the following activity.



Activity 10

Fill in the table below in order to evaluate the role of stakeholders in ensuring sustainable use of rangelands. You may visit some of the stakeholder in your local areas and discuss with them.

Stakeholder	Examples of sustainable uses of rangelands	Evaluation of their attempts to use rangelands sustainably

Government		
Local communities		
Local Authorities		
Private sectors		
Non-Governmental Organisations		

Feedback

I am sure your answer included some of the things we are going to discuss below.

(a) Botswana Government

In 1975, the Government introduced Tribal Grazing Land Policy (TGLP) with an aim to separate big cattle owners from small farmers. The idea was to cause large herds of cattle to move out of communal areas to commercial areas so that only small herds could remain in communal areas thereby reducing overstocking and overgrazing. The objectives of TGLP were to:

- educate traditional farmers on proper ranching and stock management
- divide commercial farming areas into ranches and allocate them to individuals or farmer syndicates (farmers were responsible for fencing and drilling boreholes)
- ensure that some land is reserved for future use
- maintain cattle health through careful disease control measures

To achieve these objectives aimed at sustainable utilisation of land, Botswana’s grazing lands were zoned into 3 categories as follows:

- Commercial lands held by ranchers or big farmers with large stocks
- Communal areas held by small farmers with few stocks
- Reserved areas kept for future use or reserved for future generations

To some extent, the policy was successful in that it:

- encouraged the growth of the livestock industry,
- encouraged the ranching system; and more importantly,
- encouraged livestock owners to adopt better range management practices.

However, there were problems as well: big herd owners were reluctant to move to commercial areas, farmers lacked farm management skills, and there was a lack of effective monitoring programs.

You probably are aware that in Botswana the land used to be allocated to members of the community by traditional leaders, the chiefs. Nowadays, the land is distributed by the government through local Land Board authorities. This is to ensure that the distribution of the land is monitored and documented.

Land Boards also ensure that the land is apportioned equitably while at the same time ensuring that the land will continue to be available for future generations.

(b) Non-Governmental Organisations (NGOs)

NGOs such as Kalahari Conservation Society (KCS) and Harry Openheimer Okavango Research Centre (HOORC) are actively involved in research work. They provide information on the state and conditions of rangelands to local authorities and communities. KCS is known for leading community action in projects that are geared towards saving the environment such as afforestation.

They disseminate environmental education to communities and encourage the spirit of community involvement in the management of natural resources through Community Based Organisations (CBOs) and Community-Based Natural Resource Management (CBNRM) approaches. CBNRMs are community trusts that are established in rural areas to ensure that they take the responsibility of managing the resources in their localities.

(c) Local Communities

Local communities in Botswana are involved in many activities which have both a negative and positive impact on the environment, particularly rangelands. They harvest veld products such as grasses, medicinal herbs such as Sengaparile and sell them to organisations such as Thusano Lefatsheng. They also collect fire wood in the forest. Some people cause veld fires which destroy large areas. These activities need to be monitored because otherwise they could lead to rangeland degradation. In order to combat such problems, some activities like harvesting of veld products are now licensed. The community environmental education committees are set up to create awareness on natural resources conservation. They actively participate in putting out veld fires that damage the rangelands.

(d) Local Authorities

Local authorities in Botswana include, Land Boards, District Councils and District Administration Officers. They are charged with the responsibility of land use planning and management in rural areas. They also engage experts to determine carrying capacities of their rangelands. They are responsible for ensuring that members of their respective communities adhere to set stocking rates.

District Administration Officers such as chiefs and Headmen encourage collective responsibility in preventing agents of range degradation such as veldt fires. They also monitor proper use of the land.

(e) Private Sector

The private sector such as Nata Timbers harvest forest resources such as Mukwa and Mukusi to make furniture. There are small companies which harvest thatch grass to provide thatch services to communities. They ensure that they collect these forest resources on sustainable bases so that they continue to make a living out of these resources while ensuring that the resources continue to regenerate.

Finally, it can be concluded that the sustainable utilisation of rangelands is not only important to stakeholders mentioned above but to the economy of Botswana in general.



Activity 11

Explain what each of the following statements mean:

1. Monitoring proper use of land

2. Setting stocking policies

3. Collective community action

Total = 3 Marks

Feedback

1. *Some authorities are tasked to curtail destructive practices on range resources. Such tasks include monitoring the proper use of land. In other words, they are charged with the responsibility of checking and ensuring that people use land according to the laws of this country.*
2. *This includes coming up with guidelines and regulations to ensure optimum herd sizes on rangelands. In Botswana we have policies like Tribal Grazing Land Policy meant to control the use of grazing lands.*
3. *Collective community action refers to the acting together of all members of the community to ensure sustainable utilization of natural resources in their localities. Examples of collective community actions include plating of trees during the National Tree Planting Day, and putting out veld fires.*

You can now see that the role played by different stakeholders are all aimed at ensuring sustainable utilisation of rangelands. Let us now conclude this topic by going through the topic summary.

7.0 Topic Summary

In this topic you have learnt that:

Range management is well planned use and care of the rangeland.

There are several factors that affect range management in Botswana. We have categorised these factors into human and physical factors. Physical factors include climatic conditions, encroachment of trees and bush and human factors include the land tenure system in use, poor stocking rates, overgrazing, lack of knowledge and capital. We also discussed general practices that could bring about sustainable use of rangelands after looking at the general good principles of range management and ways of improving range. This includes controlled stocking, supplementary feeding and afforestation.

We finally discussed the roles played by various stakeholders in ensuring sustainable rangeland utilisation practices. For example, government can facilitate policy formulation and proper rangeland management while the conservation groups and non-governmental organisations conduct research on sustainable use of rangelands and complements government efforts in the conservation of rangeland resources.

Well done! You have successfully sailed through the 2 topics of this unit. Before you move on to the unit summary, go to the assignment section at the end of the unit and do Exercise 2. After marking your work and if pleased by your performance go through the summary and complete the unit by doing the unit assessment. If you need to review the topic, feel free to do so.

Unit Summary

Summary



In this unit you learnt the following important points.

- Range means natural vegetation where domesticated and wild animals graze and or browse. Rangeland is a piece of land or area where range grows.
- Botswana's rangeland mainland comprises of grasses, herbaceous legumes, woody plants and a variety of few other plants.
- Rangelands are valuable resources and can be used for other purposes besides grazing livestock of wild animals.
- Human factors leading to rangeland degradation include overstocking, deforestation, veld fires, overharvesting of veld products, population growth.
- Physical factors leading to rangeland degradation include drought, floods, temperatures, veld fires, increased wildlife population.

- Rangeland degradation refers to a decrease in the quality of rangeland resulting in the decline of production of range.
- Human factors affecting range management in Botswana include land/tenure system, livestock unit, overgrazing, overstocking, lack of knowledge and capital.
- Physical factors affecting range management in Botswana include climate, soils, bush encroachment.
- Sustainable utilization of rangelands practices include controlled stocking rates, afforestation, constructing fire breaks, use of supplementary feeds, ranching.
- Key stakeholders in the sustainable utilization of rangelands include government, NGOs, private sector, local authorities and local communities.

Assignment



Assignment

The assignment comprises of self-assessment exercises related to each topic in this unit. Remember that these exercises should be done on completion of a related topic. For example, self-assessment Exercise 1 should be done after successfully completing Topic 1. Check for the correct answers at the end of these exercises. You are advised to take 30 minutes on each exercise.

Self-assessment Exercise 1

1. (a) Define the following terms:

i) Range [1]

ii) Rangeland [1]

2. Rangelands are known by different names around the world. Give any **three** names of world rangelands. [3]

3. How much of land is reserved for the use of rangelands in Botswana? [1]

4. What are rangelands used for in Botswana? [4]

5. What is rangeland degradation? [2]

6. Describe **three** human factors that can lead to rangeland degradation. [6]

7. Explain **three** physical factors that can lead to rangeland degradation. [6]

Total = [24 Marks]

Self-assessment Exercise 2

This exercise must be done after successfully completing Topic 2.

1. What is a livestock unit? [1]

2. Suggest **two** ways by which rangeland destruction can be prevented. [2]

3. State **three** effects of overgrazing on the soil in a rangeland. [3]

4. Mention **two** effects of under-stocking a rangeland. [2]

5. TGLP was a deliberate effort by the Botswana Government to control grazing and conserve range resources.

a) What are the successes of TGLP? [2]

b) What are the limitations of TGLP?[2]

5. State **two** factors that affect rangeland productivity.

[1]

6. State **three** factors that affect range management. [3]

7. State **five** sustainable range management practices that will keep range in a good condition. [5]

8. (a) Name at least **four** stakeholders that are important in the sustainable utilisation of rangelands in Botswana.[4]

(b) Describe the role of at least **two** stakeholders in the sustainable use of rangelands. [4]

Total = 28 Marks

Feedback - Self-assessment Exercise 1

1. i) Range is the vegetation growing naturally on which domesticated animals graze and browse.
ii) Rangelands are vast natural landscapes or natural open spaces in the form of grasslands, woodlands, shrublands and deserts.
2. Pampas, prairies, steppes, savanna, tundra, deserts, veldt.
3. Rangelands cover 70% of Botswana's surface land.
4. Recreational activities, livestock, game parks and reserves, mining, tourism.
5. It is the reduction of land productivity resulting from inappropriate use of the land.
6. Human causes are:
 - Veld fires
 - Land clearance for other activities
 - Overstocking
 - Deforestation
 - Poor land management
7. Physical Factors are:
 - Drought
 - Bush encroachment
 - Increased wildlife populations
 - Veld fires

Feedback – Self-assessment exercise 2

1. It is an equivalent of a mature animal with a live weight of about 500kg.
2. Ways by which rangeland destruction can be prevented:
 - Practicing correct stocking.
 - Controlled grazing.

- Having enough watering points which are well distributed in the rangeland.
- Using the kind of animals suited for the available forage or vegetation.
- Distributing animals evenly in the rangeland.
- Protect range and rangeland from soil erosion.
- Avoid uncontrolled and indiscriminate burning of the rangeland.
- Control bush encroachment.
- Providing supplementary feeding to livestock.

3. Effects of overgrazing on the soil include:

- Exposes the soil to agents of soil erosion.
- Leads to occurrence of soil erosion.
- Animal hooves easily loosen the soil making it get easily eroded.
- Reduces water intake by the soil.
- Leads to low content of humus in the soil.
- Leads to poor soil fertility.

4. Effects of under-stocking a rangeland include:

- Leading to selective grazing by animals.
- Poor plant re-growth.
- Poor plant sward.

5. TGLP

a) Successes

- encouraged the growth of the livestock industry,
- encouraged ranching system; and more importantly,
- encouraged livestock owners to adopt better range management practices.

b) Limitations

- big herd owners were reluctant to move to commercial areas
- farmers lacked farm management skills
- there was a lack of effective monitoring programs.

6. Factors affecting range management include: land tenure system, lack of

knowledge by farmers, soil factors, population growth, stocking rate, tree and bush encroachment, and availability of capital.

7. Sustainable range management practices that will keep range in a good condition.

- fencing grazing land
- controlling the spread of trees and shrubs
- controlling veld fires
- providing enough water
- controlling soil erosion
- controlling weeds
- controlling grazing.

8. (a) Stakeholders

- Government
- Non-governmental organisations
- Private sector
- Local authorities
- Local communities
- Research groups

(b) Roles of stakeholders (see notes)

- Government – facilitates the management and development of rangelands. Also facilitate policy and other legislative issues related to sustainable utilisation of rangelands.
- Non-governmental organisations – promote awareness and facilitates conservation of rangelands.
- Private sector – identify business opportunities existing in the use of rangelands.
- Local authorities – allocates land.
- Local communities – use rangelands for grazing livestock.

Assessment



This assessment must be done after successfully completing the unit, including the assignment and the unit summary. Submit or post it to your tutor for marking. You will need 1 hour to work on this assessment.

Assessment

Instructions

Answer all questions

Write your answers in the spaces provided.

SECTION A

Answer the following questions by circling the letter of the correct answer.

1) Which one of the following is not rangeland?

- A. Deserts
- B. Tundra
- C. Steppe
- D. Forests

2) Which land tenure system is commonly used in Botswana?

- A. Leasehold land tenure
- B. Private ownership
- C. Communal land tenure
- D. Freehold

3) Plants which animals enjoy to eat are _____

- A. Palatable
- B. Poisonous
- C. Increasers
- D. Invaders

4) Which of the following limit rangeland productivity in Botswana?

- A. Practising correct stocking
- B. Controlled veld fire
- C. Protecting the range from soil erosion
- D. Distribution of rainfall

5) Which of the following prevents range and rangeland destruction?

- A. Uncontrolled veld fires
- B. Prevention of soil erosion
- C. Exceeding the carrying capacity of the rangeland
- D. Population increase

6) In which grazing system is the land divided into paddocks?

- A. Continuous grazing
- B. Rotational grazing
- C. Strip grazing
- D. Zero grazing

7) Which one of the following is not a human factor affecting range management in Botswana?

- A. drought
- B. overstocking
- C. overgrazing
- D. land tenure

8) A land tenure system where a community shares the rangeland for grazing animals is called

- A. Lease hold
- B. Private ownership
- C. Communal ownership
- D. Free hold

9) What is the amount of grazing and browsing land that can support a livestock unit without causing destruction?

- A. Stocking rate
- B. Carrying capacity
- C. Overstocking
- D. Under-stocking

10. What will be the stocking rate of a rangeland if a farmer is keeping 10 cattle in a rangeland which has 90 hectares?

- A. 1 hectare per animal

- B. 10 hectares per animal
- C. 9 hectares per animal
- D. 90 hectares per animal

SECTION B

Answer the following questions (#7-15) in the spaces provided.

7) Define

a) Rangeland

_____ [1 mark]

b) Range management

_____ [2 mark]

8) State 3 factors that affect range management.

_____ [3 mark]

9) Why is the rangeland important in livestock farming?

_____ [1 mark]

10) What natural vegetation is characterised by a mixture of grasses with scattered trees and shrubs?

_____ [1 mark]

11) a) What is rangeland productivity?

_____ [1 mark]

b) What is livestock unit?

_____ [1 mark]

12) State 2 advantages of strip grazing.

_____ [2 mark]

13) State 2 principles of good range management.

_____ [2 mark]

14) Mention 3 things that can be done to improve a rangeland that has deteriorated in condition.

_____ [3 mark]

15) Explain the role of the following stakeholders in the sustainable utilisation of rangelands (i) Government

_____ [3 mark]

(ii) Local Authorities

_____ [3 mark]

(Total Marks

30)

MARKING SCHEME FOR UNIT ASSIGNMENT

SECTION A

- 1) D
- 2) C
- 3) A
- 4) D
- 5) B
- 5) B
- 6) B
- 7) A
- 9) B
- 10) C

SECTION B

7) A) Rangeland-A piece of land, which is not cultivated, covered with vegetables growing naturally where animals graze.

B) Range management- Using the range and rangeland carefully so that animal production can be high.

8) Factors affecting range management include:

Land tenure systems or grazing systems used.

Lack of knowledge by the farmer.

Soil.

Population growth.

Climatic conditions.

Stocking rate.

Tree and bush encroachment.

Availability of capital.

9) Rangeland is important to livestock farming because it is the source of food for livestock.

Or

Livestock productivity depends on how much food the livestock can get from the rangeland.

10) Savanna.

11) a) How much food the range produces for the livestock.

b) Livestock Unit- Is the weight of an adult livestock equivalent to about 500kg live weight.

12) Advantages of strip grazing include:

It reduces selective grazing. As the animals are restricted to a small area, they have no choice but to graze what is available.

It is possible for the land to be fertilized. After moving the animals from the strip it can be fertilized to make the grass grow quickly.

Parasites and diseases are easily controlled.

Allows the land to be well manured(fertilized). Grazing animals as they spend time in a small area pass dung there.

The backup fence prevents animals from grazing strips they have been in which prevents overgrazing and grazing grass before it is well established.

It reduces pasture wastage and improves pasture utilization.

Animal productivity is high.

Animals can be separated into smaller groups for example of the same sex.

13) Principles of range management include:

Balance the animal population with available forage.

Use the kind of livestock most suited for the available forage.

Practice rotational grazing.

Distribute animals evenly over the entire rangeland.

Control bush encroachment.

Distribute watering points evenly over the rangeland.

Conserve some forage for dry season feeding.

Replace dead or old plants with new ones.

14) Improvement of rangeland needs the following:

Practicing correct stocking.

Fencing grazing land.

Controlling the spread of trees and shrubs.

Controlling veld fires.

Controlling soil erosion.

Controlling weeds.

Controlling grazing.

Ploughing, planting, and reseeding the rangeland.

Introducing new plant species in the rangeland.

Using fertilizers.

Providing enough water.

15) Stakeholders in the sustainable utilisation of rangelands

(i) Government (see notes)

Botswana Government ensures sustainable utilisation of rangelands through its policies on land control and management policies like TGLP. The rangelands are divided into 3 categories namely; commercial, communal and reserved.

(ii) Local Authorities (see notes)

Local authorities in Botswana include, Land Boards, District Councils and District Administration Officers. They are charged with the responsibility of land use planning and management in rural areas. They also engage experts to determine carrying capacities of their rangelands. They are responsible for ensuring that members of their respective communities adhere to set stocking rates.

District Administration Officers such as chiefs and Headmen encourage collective responsibility in preventing agents of range degradation such as veldt fires. They also monitor proper use of the land.

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Unit 9

Utilisation and Management of Water, Coal and Sun Resources

Introduction

Welcome to Unit 9 of the BGCSE Geography course which is the last of the five units that discuss the utilisation and management of natural resources. I would like you to note that this Unit discusses almost the same issues as those raised in Units 6, 7 and 8. It discusses natural resources and ways in which we can conserve them. Remember, in Unit 7 we discussed the different types of products we get from the veld and the forests that are useful to the community. Some of the main forest products include timber, medication and sculpture. Veld products include thatching grass, tubers, fruits and honey among many others.



Figure.1: A water fall showing flowing water (Free Source: <http://www.ourscreensavers.com/images/waterfall>) Retrieved 20/03/10

This unit looks at how we can use water, coal and the sun as sources of energy. Africa has large coal reserves, a lot of sunshine and many flowing rivers. Did you know that we can use the energy from flowing or falling water just like the one shown in the picture in Figure 1 for generating electricity? In this unit you will understand how we can use flowing water, coal and the sun for generating electricity.

Upon completion of this unit you will be able to:



Outcomes

- *discuss* factors that influence the location and development of Hydro-Electric power (HEP) schemes and Thermal power stations in Africa
- *describe* the processes involved in generating electricity from water, coal and sun
- *discuss* the advantages and disadvantages of generating power from water, coal and sun
- *evaluate* the importance of hydro-electric power schemes and thermal power stations to the economy of a country where they are located
- *evaluate* the role of stakeholders such as Government and private sectors in the sustainable use of coal
- *explain* the energy conservation strategies in Botswana.

Time

You will need about two hours to study each topic. Note that this unit has 3 topics. It means you will need a total of 6 hours to study the whole unit. You might finish studying the topic in less than two hours or exceed your study time as this is determined by your reading pace and understanding of the lesson. On completion of each topic, you are required to do a self-assessed assignment. You need 1 hour 30 minutes to do these assignments. To further test your understanding of the unit, you must do a tutor marked assessment exercise. The assessment should take you about 1 hour to complete.

Teaching and Learning Approach

In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experience or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. There is a variety of information that you can use to learn more about important concepts in tourism. Most libraries in your country have some information on water resources. There are some magazines, pamphlets, books, etc which contain important information on tourism. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near a power station you are advised to collect relevant information that may help you understand your topics better. If you have access to the Internet, you may look for relevant information from various websites. Remember to refer to topic objectives when searching for relevant information. If you have no access to the internet, you don't have to worry; content provided in each topic is adequate. If you are registered with a distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counseling support.

You may have access to additional resources, maps and relevant videos if there is a study centre in your area. In addition, a study centre provides an opportunity to meet and discuss the subject with other learners. Furthermore, remember that your tutors are available to assist you with any challenges you may experience in this unit. Remember that the time allocated for tutorials is very limited and you are therefore advised to read

the course material well in advance or before you attend tutorials. This will help you raise questions on difficult aspects of your study materials.

I would like to, once again, emphasise that active learning or participating effectively throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions will you be in a better position to understand that this unit is part of other units on utilisation and management of other resources which are covered in units 7 to 10.

Assessment

In this unit, each topic has activities based on the information relevant to different sections of the topic and forms part of your learning. These activities are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately after the activity. If you do not do well in the activities do not be discouraged, as you may review the section related to the activity and later carry on with the topic with more concentration. You are advised to review the sections you did not do well on before continuing with the topic.

On completion of each topic, you will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low, you must not be discouraged, but try again by going over the topic and the exercise.

The assignment self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the assignment. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, then go on to the next unit.



Terminology

Hydro-Electric Power:	Electricity that is produced by the force of falling water.
Penstock:	A pipe that is used to carry water from the reservoir to the turbine for the generation of a force that will lead to electricity production.
Turbine:	A wheel with curved blades that water falls onto from the penstock. The force of falling water turns the wheel; hence power is produced by the generator.
Reservoir:	A lake or a pool of almost stagnant water.
Thermal Power:	Electricity that is produced from the burning of coal.

- Fossil fuel:** This refers to the remains of living organisms which lived millions of years ago. These remains have since been compressed by the pressure from the soil and have turned into minerals such as coal, oil and natural gas.
- Solar Power:** This refers to electricity that is produced using direct light .
- Photovoltaic cells:** This is a technology that can convert light energy directly into electricity.

Topic 1: Utilisation and Management of Water as a Source of Energy

Introduction

In Unit 6 you learnt that Botswana depends on two main water sources. Do you remember what these two sources were? These were surface and ground water. I would also like you to reflect on the uses of water. From your own experience and what you learnt in unit 6, what would you say are some of the important uses of water? In unit 6 we said water is used in agriculture, mining, wildlife, energy as well as for domestic purposes. Note that one of its uses is providing energy. Have you ever seen a flooded river washing away heavy objects such as trees, branches, mud and even cars as shown in figure 2? This potential power is sometimes harnessed and used in the generation of electricity.



Figure.2 A flooded river has a lot of potential power

(Source:<http://www.wsmweather.co.uk.wp.content> uploads) Retrieved 12/03/10

The type of power that is produced from flowing water is referred to as Hydro-Electric Power (HEP). Electricity plays a very important role in the economic development of any country.

In this topic, you will understand the factors that influence the location and development of HEP schemes as well as the process involved in the production of electricity using running water. You will also learn the advantages and disadvantages of generating power from running water. Finally, you will learn about the importance of HEP schemes to the economy of the country in which they are located.

Topic Objectives

At the end of this topic, you should be able to:

- distinguish between renewable and non-renewable sources of energy
- locate on a map of Africa one HEP scheme in Uganda, Ghana or Zambia/Zimbabwe

- discuss factors that influence the location and development of HEP schemes
- describe the process of generating electricity from running water
- discuss the advantages and disadvantages of generating power from water resources

1.0 Renewable and Non-renewable Sources of Energy

Renewable energy is energy that is generated from natural resources. Can you name any natural resources that can generate energy that you know? You probably mentioned wood, crops, garbage, and alcohol fuels (Figure 3). These are known as biomass. Biomass is not the only source of energy. Other sources of energy include sunlight, wind, flowing water and heat generated from the earth's crust (geothermal heat). All these sources are renewable and can be naturally replenished over time.

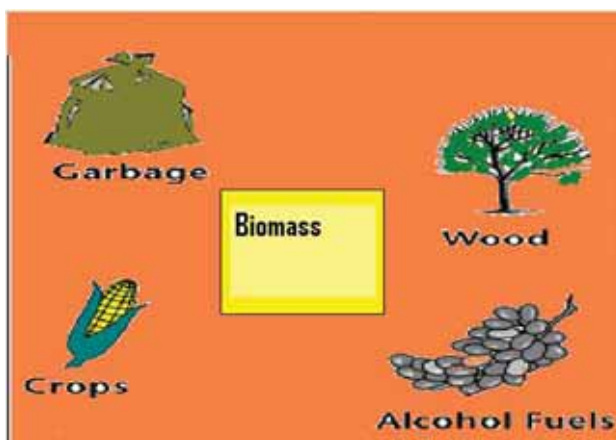


Figure 3 Types of Biomass

Renewable resources are sometimes living resources such as vegetation, animals and oil which can restock (renew) themselves if used sustainably. There are also non-living resources that are renewable such as hydroelectric power, solar power and wind power. If renewable resources are consumed at a rate above their natural rate of replacement, the standing stock will diminish and eventually run out. As you read through the above section on renewable energy you may have started thinking about sources of energy that are not renewable. Now let's discuss those sources of energy that cannot be replenished.

A non-renewable source of energy is a natural resource that cannot be produced, re-grown, regenerated or re-used on a scale which can sustain its consumption rate. Coal is a non-renewable source of energy.

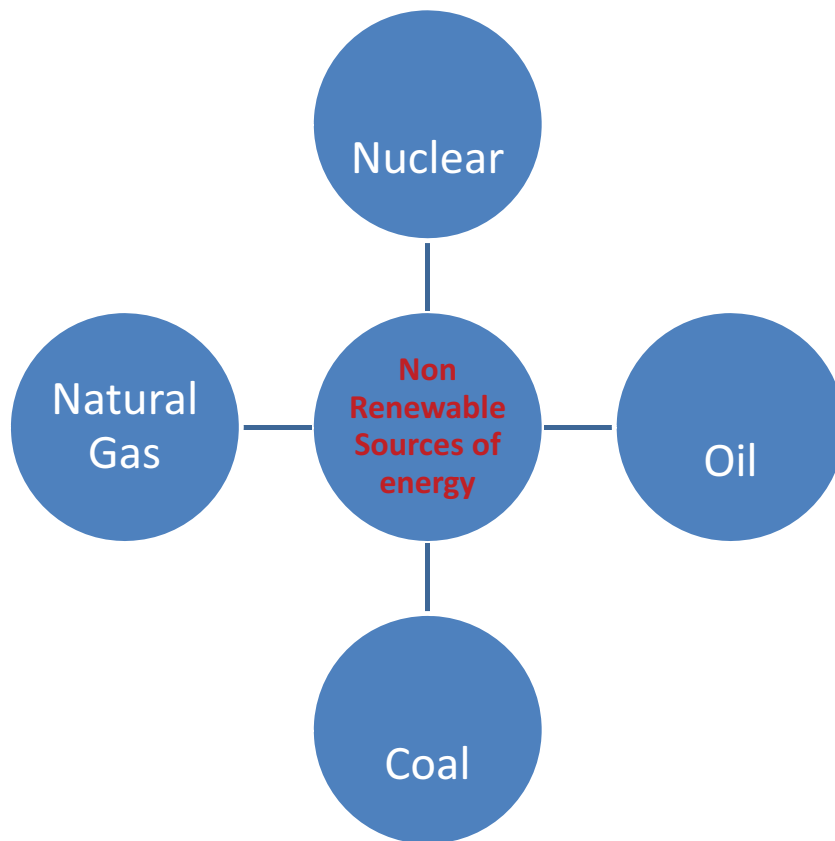


Figure: 4 Non- renewable sources of energy

What do you think would happen to the coal if people continued to dig it? Of course you are right, it may eventually run out. Examples of non-renewable fossil fuels include coal, petroleum, natural gas and nuclear fuel as shown in the Figure 5 above.

These resources often exist in fixed amounts, or are consumed much faster than nature can recreate them. What you have learnt here is that non-renewable sources of energy can get depleted if we do not use them sustainably. You have now learnt the difference between renewable and non- renewable energy and you may now even be wondering how power is generated from each of these sources. That is exactly what we are going to discuss in the section that follows.

2.0 Generating Hydro-Electric Power from Running Water

Hydro-Electric Power (HEP) refers to the production of electricity using the force of flowing water. Look again at the picture showing flowing water. Do you remember what we said about flowing water? We said that flowing water has a lot of potential energy. If you do not understand how the force of water can be used to produce electricity, do not worry as the whole process will be explained to you later in the lesson. What is important for you now is to understand that flowing water can be used to turn the turbines that generate electricity.

Let us look at how electricity is produced using the force of water. The process is very

simple; you will understand it better if you carefully follow the diagram (Figure 5) below. First, study the diagram of an HEP station before we move on to the explanation of the process of using the force of water to generate electricity. From the diagram below identify the following: the **dam**, **reservoir or lake**, **penstock**, **turbine** and the **generator**.

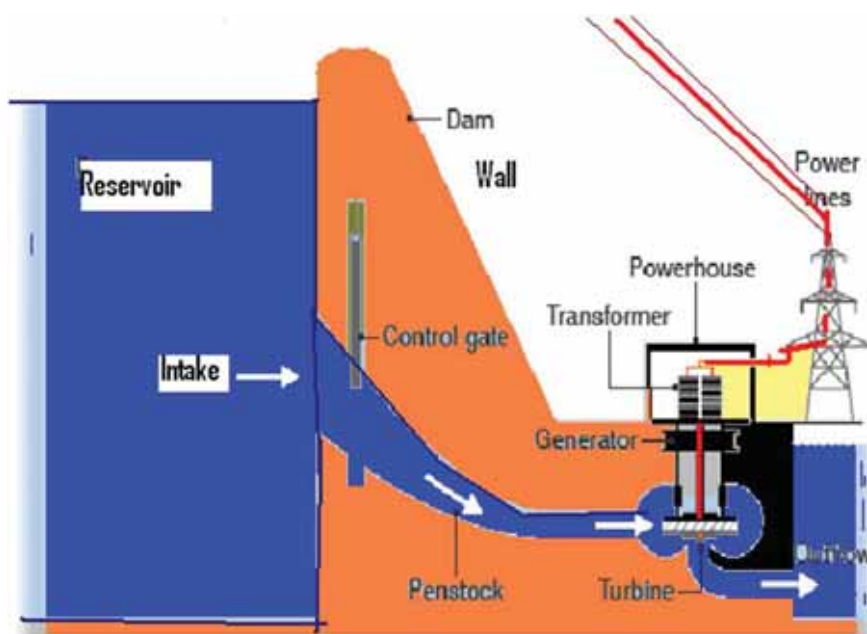


Figure 5: A Hydro –electric generation plant

(Adapted from <http://newsmig.bbc.co.uk/media/images>) adapted on 12/04/10

When you looked at the above diagram you probably noticed the huge reservoir. The reservoir is important for storing a lot of water. In fact, you may have observed that a reservoir is water that is kept back by the **dam wall**. Can you see it? It is apparently the wall that is holding the water back. The control gate regulates the amount of water that flows out of the reservoir. If you again look carefully at the diagram, you will see an outlet that allows the water to pass through that is called the **penstock**. This is a large pipe that carries water from the reservoir. The water under great pressure flows down this large pipe onto a wheel with curved blades called a **turbine**. A shaft connects the turbine to a generator. The water makes the turbines turn at a very high speed turning the **generator** or alternator producing electricity. It is the generator that produces electricity when the turbine is spinning.

Once the electricity is produced power is transformed by the **transformer**, from a high current with low voltage to a low current with a high voltage. Power is transported through **power** or **transmission lines** to areas where it is needed in a country. You have probably seen some of these power lines in your locality. After the water has passed through the turbine, it is discharged into a passage called a **tail race**, and water is allowed to flow once

more into the river. Why should the water be sent back to the river? Of course the water flows back into the river for use downstream. You must note that the higher the dam is, the greater will be the force of the falling water, and the greater will be the amount of electricity produced.

I hope the explanation on the process of producing electricity using the force of flowing water was clear to you. However, if you did not understand it, study the diagram of the HEP station once more and go over the explanation several times until you fully understand. You may discuss this with your colleagues in your study group. In fact, if you explain the whole process to your friends and draw your own diagram, you are most likely to better understand it yourself. Having understood how flowing water can be used to produce electricity, you should by now be asking where these schemes are located. It's possible, you may have heard about some of the popular ones such as the Kariba on the Zambezi. If you read the next section, then you will not only become familiar with the Kariba but you will be able to locate many more Hydro Electric Power stations in Africa.

3.0 Location of HEP schemes in Africa

Study the map of Africa. Can you name some of the hydro-electric power schemes shown? See if you can locate the Kariba/ Kafue scheme, the Owen Falls, the Volta project, the Aswan Dam project and the Hendrick Verwoerd scheme.

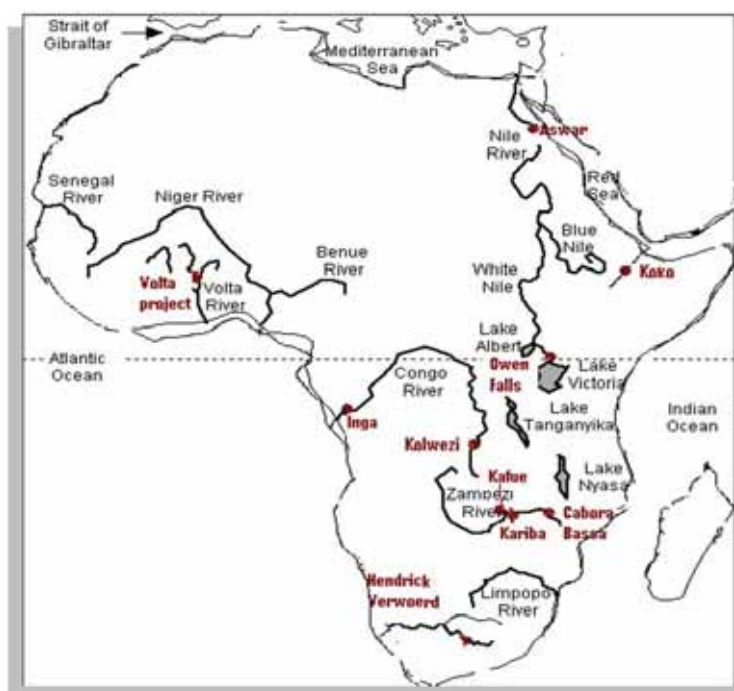


Figure 6 Location of Hydro Electric Power Stations in Africa

Did you notice that those hydro-electric schemes are located where there are rivers? Can you say in which river each of the schemes you mentioned earlier is located? The Kariba is on the Zambezi River, the Aswan is on the Nile River, the Volta is on the Volta River and the Owen Falls is on White Nile. Why do you think they should be located in rivers? The main reason is that hydro-electric schemes use flowing water to drive the turbines that generate electricity.

Look at the map again and see if you can try this activity.



Activity 1

Look at the hydro-electric schemes shown in the map (Figure 6). Can you say in which country each of the hydro stations is located?

<i>Hydro-electric Power Station</i>	<i>Country</i>
<i>Kariba</i>	
<i>Kafue</i>	
<i>Volta</i>	
<i>Cabora Bassa</i>	
<i>Hendrick Verwoed</i>	
<i>Aswan</i>	
<i>Owen Falls</i>	

Feedback

I hope you found this short exercise interesting. Kariba Dam is found in the Zimbabwe/Zambia Border, the Volta project is in Ghana, the Cabora Bassa is in Mozambique, the Owen Falls is in Uganda and the Aswan project is in Egypt.

By now you should be familiar with sources of energy, differences between renewable and non-renewable energy, HEP schemes and their location in Africa. Why do you think these HEP schemes are located where they are? What do you think are the key factors influencing the location of these schemes? If you are unable to provide the answers to these questions do not worry because the next section discusses the factors that influence the location of HEP schemes.

4.0 Factors that Influence the Location and Development of Hydro-Electric Power (HEP) Schemes

Before we discuss the factors that influence the location and development of HEP schemes, let us take an example of someone who wants to build a milling industry. This person will have to find a suitable place for building this industry. S/He will probably choose a place with many people to buy the product, good communication routes to transport the products or near the source of raw materials. This also applies to HEP stations, like industries have specific suitable places where they can be located. Attempt Activity 2 and explain factors that you think are likely to influence the location and development of an HEP station.



Activity 2

In the space provided below, list and explain at least five factors which influence the location and development of HEP schemes.

- (a) _____

- (b) _____

- (c) _____

- (d) _____

Feedback

I hope you made a good attempt. Here are some of the factors that influence the location and the development of HEP schemes are the following:

Rivers that flow throughout the year – HEP schemes need a constant and large supply of water throughout the year (Perennial River) in order to generate electricity without failure. As a result, a river that flows throughout the year is important for the construction of a dam wall, which will provide a big lake for the supply of water throughout the year. HEP stations, therefore, need to be located on large rivers that flow all year round and where a big dam wall can be constructed to store a lot of water in a reservoir or dam.

High amounts of rainfall – Since HEP schemes need a lot of water, it means that they are suitable in areas which have high amounts of rainfall throughout the year. The equatorial or tropical climatic regions with average rainfall of over 1500mm a year are suitable regions for the location of HEP stations. This makes it possible for the river to flow all year round.

A deep narrow valley with a strong and impermeable rock – Dams constructed for HEP schemes need to be located in a place where a large lake will form without the water flowing away in another direction. As a result, rivers with deep narrow valleys are good sites for the location and construction of dams to be used for HEP schemes. The presence of a strong impermeable rock (hard rock) in the river valley that prevents water from sinking too fast is also considered an important factor for the location of an HEP station.

Steep and upland gradients – Fast flowing water is needed to generate energy needed for the production of electricity. As a result, steep and upland gradients are important areas where HEP schemes can be located. Steep upland areas make rivers flow very fast providing the necessary force to make the production of electricity very easy.

Rivers which are free from ice throughout the year and have a low sediment load – HEP schemes need to be located on rivers which are free from ice throughout the year. Rivers that have ice for most parts of the year mean that during these periods, water cannot flow, hence making them unsuitable for the production of electricity through HEP schemes. The rivers that are suitable for HEP schemes should also have a low sediment load so that siltation does not occur quickly to reduce the amount of water in a reservoir or dam.

In your earlier attempt at listing the factors that influence the location of HEP schemes, how well did you fare? Go back to the activity that you did and see where you need to put more detail taking into account the factors that we outlined above. Now that you appreciate why HEP schemes are located where they are, you need to know the benefits of using Hydro Electric Power.

5.0 Advantages of HEP Schemes

There are several advantages of generating electricity using flowing water. Some of the advantages of HEP schemes are presented in Figure 7:



Fig 7: A chart showing advantages of HEP Schemes

The advantages are explained below.

(a) Water is a renewable resource; hence it can be used for a longer period of time

Since water is a renewable resource, it means that as long as there is rainfall, it is possible to have HEP schemes because large rivers will always have sufficient water. Water is not like coal that can be used up making power production a problem. HEP schemes provide cheap electricity since the water is inexhaustible.

(b) HEP schemes are cheap

Although it is expensive to construct a HEP station, once it is finished, the cost of maintaining it is very low when compared to that of a thermal power station.

(c) HEP schemes are clean and minimize the amount of environmental pollution

When compared to thermal and nuclear power stations, HEP schemes are a clean source of energy in the sense that they minimize the amount of environmental pollution. HEP schemes do not produce smoke or nuclear radioactive waste that can be harmful to human and wildlife as well as the environment.

(d) Provide fishing and irrigation opportunities

HEP lakes or reservoirs provide the opportunity for economic activities such as fishing and irrigation. Fishing and irrigation are very important for the economic development of the country. Water from the lake can be used for farming, such as for irrigation.

(e) Provide the opportunity for recreation and tourism

Some of the countries with HEP schemes have a lot of tourists and some people visit the sites for recreational purposes. HEP lakes provide the opportunity for recreation especially

boating and angling. HEP lakes usually attract wildlife thus tourists visit the lake sites. Tourists pay some fees to visit these areas and this generates revenue for the country.

(f) Provide revenue or foreign exchange

Excess electricity may be exported to neighbouring countries and this leads to the generation of foreign exchange or revenue.

(g) Flood control

HEP schemes are very important in controlling floods especially in the lower parts of the river. In times of floods, the reservoir can hold water that would otherwise be dangerous to people in the lower parts of the river.

(h) Water transport

The man-made lakes or reservoirs created are also used as means of water transport. Some boats on these lakes transport both passengers and goods between settlements.

To better appreciate the uses of HEP schemes you may read about the advantages from any textbook from the library. However, if there is no library or such a textbook in your locality don't worry as what you already know is adequate for this course. Having understood the advantages you now need to think about the disadvantages.

6.0 Disadvantages of HEP Schemes

Despite the advantages discussed above, HEP schemes also have disadvantages. Some of them are the following:

(a) HEP schemes usually result in re-location of settlements since the reservoir covers a large area. Re-location of settlements disturbs the socio-economic development of the people since they have to re-locate their homes, farmland and other related economic facilities. Re-location is also expensive in that governments usually pay compensation to people who are forced to move their settlements.

(b) The Construction of HEP stations is very expensive; as a result, some countries cannot afford them even when they have good sites for the location of the schemes.

(c) Lakes that are created become breeding areas for mosquitoes or water borne diseases such as malaria and bilharzia.

(d) Very large HEP schemes may occasionally flood whole villages and force people to leave their homes. That is, if there is a lot of rainfall in a particular year, flooding might occur resulting in high volumes of water in the reservoir. Hence nearby settlements could get affected.

(e) Variations in rainfall affect the amount of electricity that can be produced. That is, if there is an exceptionally low rainfall in a particular year, the amount of electricity produced in that year might be very low. This can slow down the development of the industry in a country.

To better understand the advantages and disadvantages of constructing HEP schemes, we are going to study at least two HEP schemes in more detail.

7.0 Case Studies of Hydro-electric Power Schemes in Africa

In this section, I would like you to choose only **one** of the three: the Owens Falls, Volta or

Kariba HEP project. I will, then, discuss with you factors that influenced the location of the Kariba HEP scheme and the Owens Falls. You should find out more about the Volta HEP scheme on your own as it is not discussed here.

7.1 The Kariba HEP scheme

The Kariba HEP project started in 1955 with a dam construction across the Kariba gorge on the Zambezi River. The project was built at a cost of about \$160 million. This project came as a result of increasing demand of electric power by Zambia's copper mines and Zimbabwe's mines and farms. Industrial development was also expanding in both countries and the use of coal for thermal power production was becoming expensive. As soon as a suitable site was identified, a huge concrete wall of about 126m high and 570m long was built across the Kariba Gorge.

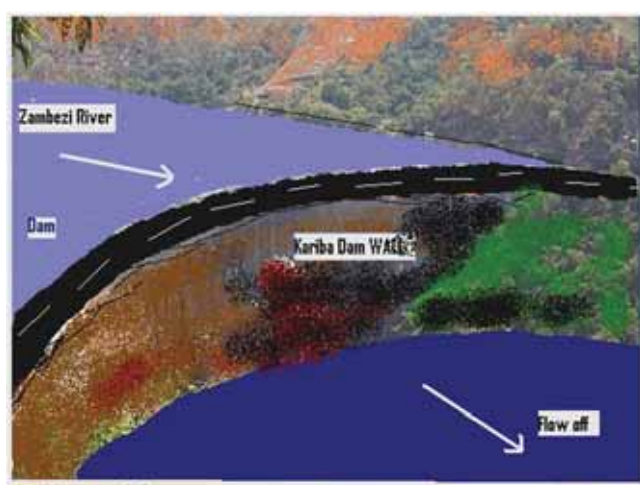


Figure 8: Kariba Dam <http://www.internationalrivers.org/chi/kariba> adapted 12/03/10

This dam was built in the form of an arc in order to be strong enough to hold back enormous head of water dammed up behind it. The dam took 3 years to build. The dam had six (6) spillway gates through which water was allowed to escape. The lake behind it is 280 km long and it is one of the largest man-made lakes in the world.

7.1.1 Location Factors

Some of the factors that influenced the location of the Kariba HEP project are the following:

- **The location on the large perennial Zambezi** – We have so far noted that HEP schemes are located on large rivers that flow throughout the year to provide large amounts of water needed for power production. The large Zambezi River is a typical perennial river with a HEP on it.
- **The deep narrow Zambezi Valley** – The Zambezi River has a narrow valley that has made it possible for the construction of a dam wall. A large lake has as a result been created.
- **Considerable high rainfall amounts** – The northern parts of Zambia where the Zambezi River originates receive a considerable amount of rainfall in a year. This has made

the Zambezi River flow throughout the year.

- **The Zambezi River does not experience any icing** – The Zambezi River is located in the tropics and it does not experience any icing. The river is therefore able to flow all year round to provide the necessary water needed for the HEP project.

There are many more reasons why the Kariba HEP scheme is located in Zambia/Zimbabwe. I hope you will be in a position to find more information for yourself. Please note that we say the Kariba HEP project is located in Zambia and Zimbabwe because the river forms the boundary of the two countries; hence the dam wall and the reservoir are also in the two countries. The project as a result produces electricity for both countries.

7.2 The Nalubaale (Owen Falls) HEP scheme

The Owen Falls Hydro-electric, see Figure 9 below, scheme was built in 1954 across the White Nile near the town of Jinja in Uganda. **It is commonly known as Nalubaale** Power Station. Maintenance and availability of the station declined seriously during the government of Idi Amin. Before that, water levels on Lake Victoria were moderated by a natural rock dam on the north side of the lake.

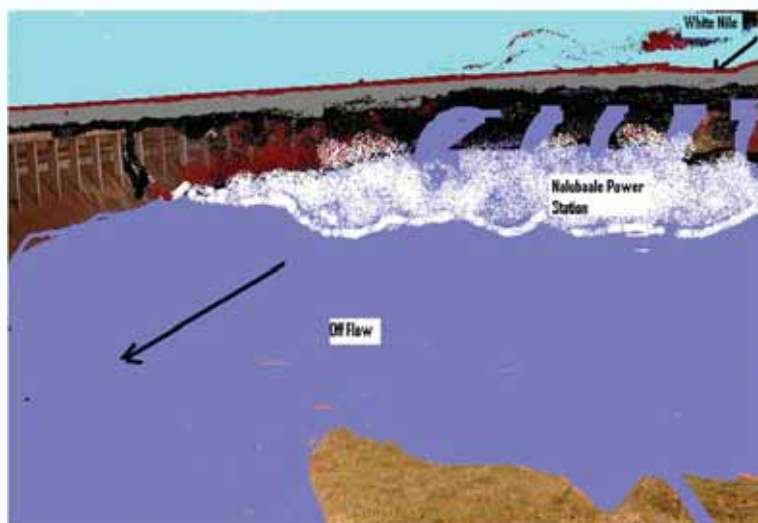


Fig 9 Nalubaale Hydro-electric Power Scheme adapted from en.wikipedia.org/wiki/Nalubaale_Hydroelectric on 14/05/10

Rising lake waters would spill over the natural dam into the White Nile, which flowed through Uganda, Sudan and Egypt before emptying into the Mediterranean Sea. The station was repaired in the 1980s. During the repairs the output power of the generators was increased. A second power house was built in 1993 and was completed in 2000. The rating of the Nalubaale power station is 180MW. It supplies electricity to Uganda and parts of neighbouring Sudan and Kenya.

7.2.1 Location factors

The location factors for the Nalubaale (Owen falls) hydro-electric scheme are almost the same as those of the Kariba hydroelectric station. Look at the location of Nalubaale hydroelectric scheme below, Figure 10:

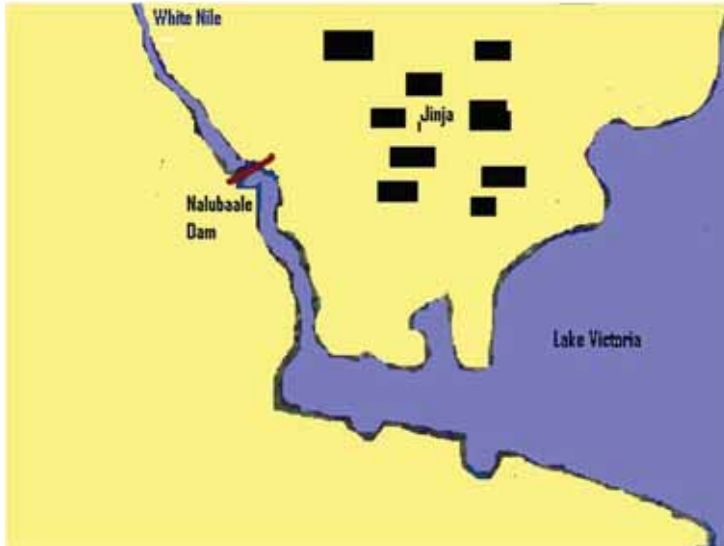


Fig 10: Location of Nalubaale (Owen Falls) hydroelectric scheme adapted from [news.bbc.co.uk on 17/03/10](https://www.bbc.com/news/17/03/10)

Can you give any three reasons why the Owen Falls Scheme was built where it is? I hope you mentioned availability of water from Lake Victoria. Some of the location factors are given below:

- A lot of water from Lake Victoria
- High rainfall amount
- Fast flowing White Nile river
- Deep narrow gorge at Ripon falls
- Nearness to the town of Jinja
- White Nile does not experience icing

There are many more reasons why the Owen Falls HEP scheme is located where it is. I hope you will find more information for yourself. The project as a result produces electricity for both countries. As can be seen from the Owen Falls, several countries benefit from HEP schemes. The next part of the Unit will give a summary of the benefits from HEP schemes in general.

8.0 The Importance of HEP Schemes to the Economy of a Country

As you might be aware, almost everyone in society needs energy in one way or the other. Energy makes life more comfortable. Electricity is of great importance to all of us and it is

often seen as a good indicator of economic development of a country. Let us now discuss why HEP schemes are important to the economy of countries in which they are located. First brainstorm the idea by doing Activity 3 below.



Activity 3

Discuss at least **five** reasons why HEP schemes are important to the economy of a country. Write down your answer in the spaces provided.

- (a) _____

- (b) _____

- (c) _____

- (d) _____

- (e) _____

Feedback

I hope you found the above activity simple, since you have already learnt about the advantages and disadvantages of the Zambezi and the Owen Falls scheme in the preceding sections and from your own personal experiences in your country. Some of the reasons why HEP schemes are important to the economy of a country where they are located include the ones discussed below.

- **Development of Industrial Areas** – HEP schemes provides electricity to a country; hence it can promote industrial development. For example, the Owen Falls Dam on the Nile River in Uganda has contributed a lot to the industrial development of Jinja by creating employment.

- **Urban and Industrial Water Supply** – The construction of dams for HEP have resulted in water from the dam or lake being made available for urban and industrial areas e.g. the Owen Falls in Uganda supply cities such as Jinja with water for domestic and industrial development.

- **Irrigation** – Reservoirs or dams constructed for HEP purposes are usually important sources for irrigation water supply. The Kariba Dam supplies water for irrigation purposes in Zambia and Zimbabwe. Irrigation of crops is important for the provision of food and revenue generation in countries such as Zimbabwe and Zambia.
- **Recreation and Tourism** – Some of the reservoirs like that of the Kariba Dam usually attract large numbers of tourists; thus they are important for recreation purposes. Communities living near the reservoir can also use the water for sporting activities. These leisure activities generate income for the country.
- **Fishing** – Fishing is one of the activities associated with man-made lakes. Fishing can be important for subsistence, commercial and recreation purposes. The Kariba HEP scheme has fishing activities being carried out on the lake.
- **Water Transport** – Some of the reservoirs provide a small shipping service for countries. This therefore helps in improving the communication links between centres in a country. The Kariba HEP scheme has a small shipping service.
- **Flood Control** – the dam controls floods since flood-water from heavy rains is diverted to the lake.
- **Cheap Power** – HEP provides cheap power.



Summary

9.0 Summary

You have now come to the end of Topic 1. In this topic, you learnt about electricity that is generated from the force of running water. This electricity is referred to as hydro-electric power (HEP).

You also learnt the factors that influence the location and the development of HEP schemes. These include large water supplies. Hence HEP schemes are located on large rivers that flow throughout the year. This topic also dealt with the process of generating electricity from running water. The advantages of generating electricity from running water were also dealt with. You now know that HEP schemes use water which is a renewable resource. However, there are disadvantages as well. These include the relocation of settlements and farmland which in most cases is expensive. The re-location is done to give way for the construction of the dam and creating man-made lakes. Examples of HEP schemes in Africa were given. These are the Owen Falls in Uganda, Volta in Ghana and the Kariba in Zambia/Zimbabwe. The reasons for the location and development of the Kariba HEP schemes were discussed. These include the large amount of continuous water supply from the Zambezi River, deep narrow Zambezi valley and the fact that the Zambezi River does not experience any icing.

The Owen Falls (Nalubaale) hydro-electric scheme was located where it is because of water from Lake Victoria and the steep sides of the White Nile as it leaves Lake Victoria.

Finally, in the lesson we evaluated the importance of HEP schemes to the economy of a country where they are located. This includes the fact that HEP schemes encourage industrial development, and the fact that water from the reservoir is important for irrigation and fishing purposes.

Now that you have finished topic 1, attempt the self-Assessment Exercise 1 given at the end of the unit. If you fail to get all the questions right read over the relevant section(s) of the topic again.

Once you have completed the exercise, proceed to the next topic that discusses the production of power from coal.

Before moving on, let's quickly consider this issue:

Suggest with examples two problems that may arise when countries share water resources

Example

- The Okavango river basin shared by Angola, Botswana, Zambia and Namibia
- Orange river basin shared by South Africa, Lesotho

You may have come up with the following problems stemming from conflicts and water shortages due to

- continuing population growth increased water demand
- pollution
- rapid urbanization
- rapid industrialization
- increased commercial uses of water
- power generation (HEP)
- dam construction upstream
- irrigation due to increased demand of food

Hence, careful planning and preparation needs to occur before utilizing natural resources.

Topic 2: Production of Power from Coal

Introduction

In Topic1, you learnt about the production of power using the force of running water known as hydro-electric power. In this topic, you will learn about the production of electricity from coal resources. At the junior secondary level, you learnt the location of coal mines in Botswana. Do you still remember some of the major coal mines in Botswana? You probably mentioned Morupule coal mine. From your knowledge, what is coal used for? You probably mentioned that it is used as a fuel. Coal can also be used to heat water for driving turbines that are attached to generators. In the previous lesson, we discussed how these turbines are driven by flowing water. The type of electricity that is generated from coal is known as thermal power. You will also learn about the process involved in the generation of this type of electricity. The advantages and disadvantages of thermal power production will also be dealt with. Finally, the lesson evaluates the role stakeholders can play in the utilization of coal resources in a sustainable way.

Topic Objectives

At the end of this topic you should be able to:

- discuss the factors that influence the location and development of thermal power stations
- locate Morupule Power Station on a sketch map
- describe the process of generating power from coal in Morupule
- discuss the advantages and disadvantages of generating power from coal
- evaluate the role of stakeholders in the sustainable use of coal resources.

1.0 What is Thermal Power?

Thermal power is electricity that is generated from the burning of fossil fuels such as coal. Fossil fuels are the remains of living organisms such as plants and animals. These remains have been buried under ground by the soil. Hence, they were compressed and turned into minerals such as coal, oil and natural gas millions of years ago. The burning of coal produces electricity called thermal power. In Botswana, the major thermal power station is the Morupule Power Station located at Morupule near Palapye.



Figure 15: A typical thermal power station (Adapted from [istockphoto.com](https://www.istockphoto.com)) 12/03/10

Have you ever been to a thermal power station? Figure 15 shows a typical thermal power station. You can always identify thermal power stations by their huge boilers, tall chimneys and tall pylons. We will discuss the production of thermal power later. For now let's discuss factors that affect the location and development of power stations.

2.0 Factors Affecting the Location and Development of Thermal Power Stations

Like hydro-electric power stations, there are several factors that affect the location and development of thermal power stations. For the purposes of brainstorming, attempt Activity 1.



Activity 1

Discuss at least **four** factors which influence the location and development of thermal power stations. Write down your answers in the spaces provided.

- (a) _____

- (b) _____

- (c) _____

(d) _____

Feedback

Having done the first topic, I hope that this activity was rather simple for you. However, some of the factors considered for the development and location of thermal power stations are the following:

- **Large amounts of Coal Deposits** – *Thermal power stations are located near large amounts of coal deposits. As a result, most thermal power stations are located near coalfields and coal mines. This is because coal is bulky and expensive to transport. Hence, thermal power stations are located near the coalfields and mines to reduce transport costs. Morupule Power Station for example is located near a coal mine. As a result, the coal is transported by conveyor belts to the power station.*
- **Flat sites (areas) are required** – *Flat sites and areas are required for the location of thermal power stations. This is to enable high chimneys to be constructed in order to release smoke or pollutants high in the atmosphere without obstruction of mountains or upland areas. It is assumed that when chimneys are long, they are able to deposit pollutants in the atmospheric layers, which are high. Hence it is of little harm to the environment.*
- **Large Human Populations and Industrial Centres** – *Thermal power stations in most cases are located near large industrial cities. This is because thermal power is usually cheap and produced in large quantities to support industrial development. This is also done to support domestic electric supply.*

Please, note that some of the factors above might not be applicable to Morupule Power Station in Botswana. Morupule Power Station is relatively small when compared to the thermal power stations in South Africa, Zimbabwe or in Europe. However, you must understand that there should have been reasons why Morupule was located where it is. The next section discusses the location of Morupule power station.

3.0 The Location of Morupule Power Station in Botswana

Morupule Power Station is a coal fired power station located in the Central District of Botswana. It is roughly 15 kilometers west of Palapye along the Palapye-Serowe Road. Study the map of Botswana showing Morupule Power Station (Figure 16). The power station is located in that site because there are large coal deposits in Morupule. Water is available from boreholes in the area.



Figure 16: A Map of Botswana showing Morupule Power Station

From the map (Figure 16), which of the factors discussed above can you say relate to the establishment of Morupule power Station? You probably noted the availability of coal deposits as one of the key factors that influenced the development of a thermal power station. Morupule Power station is situated near a large coal mine with vast coal deposits. A factor that you probably observed is the accessibility of the power station by road and rail. You can think of many other factors that you can deduce just by carefully studying the map. Another possible factor could be the large population in either Serowe or Palapye.

From the map, you can also note that Morupule is not very far from the major cities of Gaborone and Francistown. Can you say how far the two cities are from Morupule? If you have forgotten, go back to Unit 2 on Map Reading and see how we used a scale for measuring distance. If you have an atlas, you may even use the scale given in the atlas and you will get the same distance. From the map you can see that electricity from Morupule can be easily accessed for use in Gaborone and Francistown. What distance did you get? The distance is approximately 300km from Gaborone and 150km from Francistown. Note that there are also other towns that may benefit from the proximity of Morupule Power Station such as Palapye, Mahalapye and Selebi Phikwe.

By now you should be ready to learn how thermal power can be generated using coal. Read on.

4.0 The Process of Generating Power from Coal

Do you still recall how hydro-electric power is generated? You can draw a rough diagram showing how hydro-electric power is generated. Your diagram will probably show the water reservoir, the dam wall holding water back and water turning the turbines that ultimately generate electricity. In order for you to fully understand the generation of power from coal

resources, you need to first study the diagram (Figure 17) which shows a thermal power station. In order to produce electricity from coal, there are several steps that need to be taken.

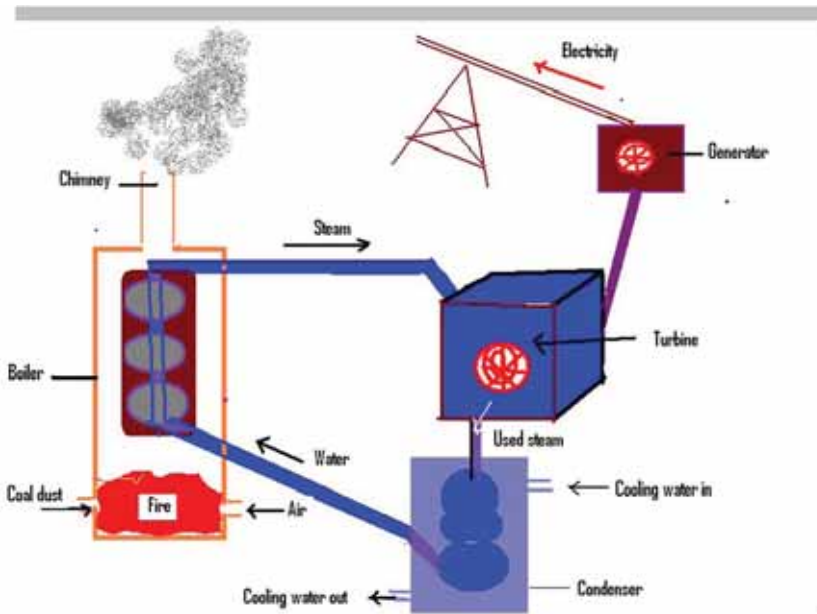


Figure17: The process of generating power from coal. (Adapted from - jpgprojectmidori.com) on 12/03/10

First, coal that comes from the mine is crushed into fine powder. The fine powder, which in most cases is referred to as coal dust, is then blown into the furnace at the base of the boiler. At the base of the boiler, it burns in a continuous sheet of flame. The burning coal produces a lot of heat that is used to heat water in the pipes. When the water in the pipe is heated, it turns into steam. The temperature of the steam reaches roughly 700° - 800°C. The heated steam is forced onto the turbine at a very high speed. The force of the steam on the turbine makes it rotate at a very high speed. The turbine is connected to a generator that rotates and produces electricity. From the generator, electricity is taken to transformers and through transmission lines and then it is distributed to areas where it is needed.

Do you notice the similarities between the production of hydroelectricity and thermal electricity? In the production of hydroelectricity, flowing water turns the turbines that turn the generators. In thermal electricity, it is the steam that turns the turbines that turn the generators. So, basically, in both processes, turbines are forced to rotate at high speed turning the generators that produce electricity.

Please note the following:

- The burning of coal in the furnace results in a fine dust which must be disposed carefully. It can be easily blown away to pollute the surrounding area if care is not taken.
- When the steam has passed through the turbines, it is condensed back to water. This is done by passing the pipes containing the steam through large quantities of cold,

flowing water. The water can thus be returned to the river or be used in the thermal power station again. When water has been cooled in this way and released to the river, it has little harm to the plant and animal life or to the environment in general.

- It is also important for you to note that the two main raw materials required by a thermal power station are **coal** and **water**. Coal is burnt to produce heat while water is heated to produce steam. Water is also used for cooling purposes.

This completes the process of generating electricity from the burning of coal. Note that the process of burning coal to produce electricity is the same for almost all the power stations in the world. What is different is the size of the power station. Some thermal power stations are very big especially in South Africa, Zimbabwe and Europe while others are very small as is the case with Morupule Power Station in Botswana. Now that you have learnt how coal is used in the production of thermal power, we need to discuss the advantages of generating power from coal.

5.0 Advantages of Generating Power from Coal

There are several advantages of generating electricity from the burning of coal. Some of the advantages include the following:

- Many countries have rich coal reserves. These coal reserves are likely to last for long periods of time before depletion. e.g. Coal reserves in Botswana are estimated to be over 100 billion tones.
- Since most countries have large coal reserves thermal electricity becomes very cheap. This has resulted in many countries having many thermal power stations to encourage industrial development. Now try the activity given below.



Activity 2

In order to enhance your learning, find and discuss **two** more advantages for yourself. Write down the answers in the spaces provided below.

(a) _____

(b) _____

Feedback

In your answer you probably included that the prices of coal are relatively stable, the extraction of coal and generation of thermal power from coal uses well known technology.

Having learnt the advantages of using thermal power you should now find out the disadvantages of using it.

6.0 Disadvantages of Generating Power from Coal

There are also several disadvantages of generating electricity from coal resources. Some of the disadvantages include the following:

- Burning of coal results in the release of nitrogen oxides and large amounts of carbon dioxide. The release of these oxides into the atmosphere can be harmful to the environment since in most cases it is done in large quantities. Too many oxides affect plants and some living organisms.
- The burning of coal also results in the release of sulphur dioxide into the atmosphere. Sulphur dioxide is linked to acid rain, that is, when sulphur dioxide cools in the atmosphere it forms water droplets. If the sulphur dioxide is in large quantities, the water droplets reach saturation point resulting in precipitation. The rain that falls is called acid rain. This type of rainfall is very harmful to the environment and to people.
- The burning of coal is also linked to global warming. This is a situation whereby global temperatures go up. Global warming also results in the rise of water in the sea, which might flood the settlements along the coast.
- The burning of coal results in pollution, that is, there is a lot of ash that is produced which can also pollute the environment or the soil if not disposed properly. The burning of coal therefore pollutes the environment either through the ash or through smoke that is released into the atmosphere.

We have already said over extraction of coal can lead to depletion. We need to identify stakeholders who can ensure sustainable utilisation of coal. These are identified in the section that follows.

7.0 The Role of Stakeholders in the Sustainable Use of Coal Resources

In the previous units, you learnt that there are stakeholders in the sustainable use of natural resources such as wildlife, veld products and forest resources, water and rangelands. There are also stakeholders in the use of coal resources. Before we can discuss the role of stakeholders in the use of coal resources, let us first identify who the stakeholders are.



Activity 3

Make a list of **five** stakeholders that are important in the use of coal resources in Botswana. Write down your answers in the spaces provided below.

- (a) _____
- (b) _____
- (c) _____

(d) _____

(e) _____

Feedback

I hope the activity above was very simple for you. Listed below are some of the stakeholders in the use of coal resources.

- *Government e.g. Ministry of Mines, Energy and Water Affairs.*
- *Private Sector / Parastatal Corporations e.g. Botswana Power Corporation.*
- *Local Communities i.e. mostly rural people where coal deposits are found.*
- *Local Authorities e.g. Land Board that allocates the land.*
- *Non-Governmental Organisations e.g. conservation groups.*

Now that we have identified some of the stakeholders in the utilization of coal resources, let us now discuss the role that each plays for the wise use of coal resources.



Activity 4

Complete the table by describing the role of each stakeholder in the sustainable use of coal resources.

Stakeholder	Role
Government	
Private Sector/Parastatal Corporations	
Local Authority	
Local Communities	
Conservation Groups	

Feedback

I hope this was very easy for you. Some of the roles that these stakeholders can play in the wise use of coal resources are the following:

- *The Government through the Ministry of Mines, Energy and Water Affairs facilitates policy formation and implementation on the use of coal resources. That is, government is responsible for making sure that there are laws and legislation governing the use of coal resources.*
- *Private Sector / Parastatal Corporations such as the mining companies (e.g. Anglo-American and suppliers of electricity such as Botswana Power Corporation) have the responsibility to ensure that environmental standards are observed in the*

production of electricity.

- *Local Communities, which include rural people where coal deposits are found, should participate in decision-making on how resources found in their local environment can benefit them. They should also participate in how mining can be less harmful to their local environment.*
- *Local Authorities e.g. Land Board allocates the land to companies for the purpose of establishing either a mine or a thermal power station or for any other use. They also have the responsibility to ensure that the land is used on sustainable basis without much destruction to it.*
- *Non-Governmental Organisations e.g. conservation groups should ensure that both the mining and burning of coal are done under recommended environmental standards.*

The above are measures that can be taken to ensure that coal resources in a country are used in a wise way. Coal should be used in such a way that some stocks are left for future generations since coal is not a renewable resource, unlike in the case of wildlife, rangelands, veld products and forest resources. The best way, therefore, would be to make investments in capital so that future generations can benefit from it once coal resources are depleted. Investments should come from revenue generated from coal supplies.

8.0 Summary

In this lesson, you have learnt about thermal power production. This is electricity that is produced from the burning of coal. Botswana depends mostly on thermal power produced at Morupule Power Station. You have also learnt the factors that influence the location and development of thermal power stations. These include large supplies of coal deposits and water. In Morupule water is obtained from boreholes in the area. This topic also dealt with the process of generating power from the burning of coal. Coal is crushed into fine dust and then burnt in the boiler. The burning coal heats water which is turned into steam. The pressure of the steam on the turbine turns the turbine which is linked to a generator. The generator then rotates and produces electricity.

The lesson also dealt with the advantages and disadvantages of generating power from coal. Advantages include the fact that coal is plentiful in most countries and hence it is cheap. The disadvantages include the fact that the burning of coal results in the release of oxides that can pollute the environment. Finally, the lesson dealt with the role stakeholders can play in the sustainable use of coal resources. The most important role that they can play is the formulation and implementation of policies in the use of the coal resources. All the stakeholders can thus be made to benefit from the policies. Ideally, once all stakeholders obtain benefits from the resources, they will be bound to use them sustainably.

Now that you have completed this topic, do the Self-Assessment Exercise 2 at the end of the unit before proceeding to the next topic. Don't forget to go over those areas that you have not mastered.

Topic 3: Solar Power

Introduction

By now you know that we can use water to drive turbines to generate hydroelectricity and coal to produce thermal power. There is another very important source of energy that can also be used to generate electricity: the sun! The sun is very important to life on earth mainly because it provides light energy. This light energy can also be used for the production of power. In this topic, you are going to learn about electricity that is produced using light energy from the sun. You will also know about the process used to produce this type of electricity and its advantages and disadvantages as well. Finally, you will learn about some of the energy conservation strategies in Botswana.

Topic Objectives

At the end of this topic, you are expected to be able to:

- explain the meaning of solar power
- explain the uses of solar power
- describe the process used in the generation of solar power
- discuss the energy conservation strategies in Botswana.

1.0 What is Solar Power?

Solar power refers to electricity that is produced using energy from the sun. The technology that is used to generate electricity using light energy from the sun is called **photovoltaic (PV)**. Photovoltaic (PV) therefore is a technology that can convert light energy directly into electricity. Remember that in both hydroelectric and thermal power, water and steam were used to drive the turbines and the generators. In solar power, light energy is converted directly into electricity and stored in batteries ready for use.



Figure 18: Photovoltaic cell (Source: <http://deoxy.org/gif/sol>) downloaded 14/03/10

If you look at the photovoltaic cell (Figure 18) above, there are no moving parts like generators to generate electricity. The cells capture the light energy directly from the sun. Again, you can see that the cell is laid out in the open to capture as much light as possible. We have attempted to explain what solar power is below. Before we discuss in detail the process of generating solar power, let us start by discussing some of the uses of solar power.

2.0 Uses of Solar Power

Since you have already learnt about hydro-electric power in Topic 1 and thermal power in Topic 2, the uses of solar power will be easy for you because they are almost the same. Attempt Activity 1 below.



Activity 1

Explain at least **four** uses of solar power. Write your answer in the space provided.

- (a) _____

- (b) _____

- (c) _____

- (d) _____

Feedback

I hope this was an easy exercise to do. Solar power systems are being used in developing countries to provide power for water pumping, lighting, vaccine refrigeration (used mostly in clinics in Botswana), electrified livestock fencing, telecommunications and many other applications.

In order to enhance your understanding, let us discuss at least three uses of solar power in detail:

- **Domestic Lighting**

Solar power is used mostly in rural areas for domestic purposes. It is used to provide lighting in homes. This is because it is expensive to provide thermal power or hydro-electric power in rural areas because the settlements are scattered. Governments find it cheaper to provide solar power in rural areas. In recent years solar power is being encouraged in Botswana. e.g. Motshegaletau Village is provided with solar power.

- **Water Pumping**

Solar power is also used to drive solar water pumps. This is common in irrigation schemes, drawing water from boreholes or wells and for livestock watering. Solar with pumps are used in many villages of Botswana especially for agricultural activities.

- **Livestock and crop fencing**

Photovoltaic power is also used for the electrification of crop and livestock fences. Crop fields such as Talana farms in the Tuli Block and Chobe farms in Kasane have electrified fences to prevent wild animals from destroying crops.

- **Cooking and heating water**

In Botswana, solar power is also used for cooking and heating water. Solar panels are usually installed on house roofs especially in towns to produce power. Almost all government houses in rural areas and schools in Botswana have solar panels to generate power mostly for heating water. Solar stoves for cooking have been developed for domestic use.

By now you know the various uses of solar power. However, you still need to know how it is generated. It is not enough to just know the uses. The part of the topic that follows outlines how solar power is generated. Read it carefully and where possible compare with the generation of hydro-electric power.

3.0 The Process of Generating Solar Power

As already mentioned, the process of generating power using solar energy is called photovoltaic system. Although this system can be used to produce electricity for various purposes such as lighting, heating and cooking, driving water pumps and for electrifying crop and livestock fences, the process of generating power is similar in each case. When using photovoltaic systems, solar panels are exposed to sunlight during the day, thereby generating electric energy which is then stored in a battery for use at night or for immediate use, as in the case of pumping and fence electrification.

To understand how photovoltaic systems work, study the diagram below and then read the

explanation below.

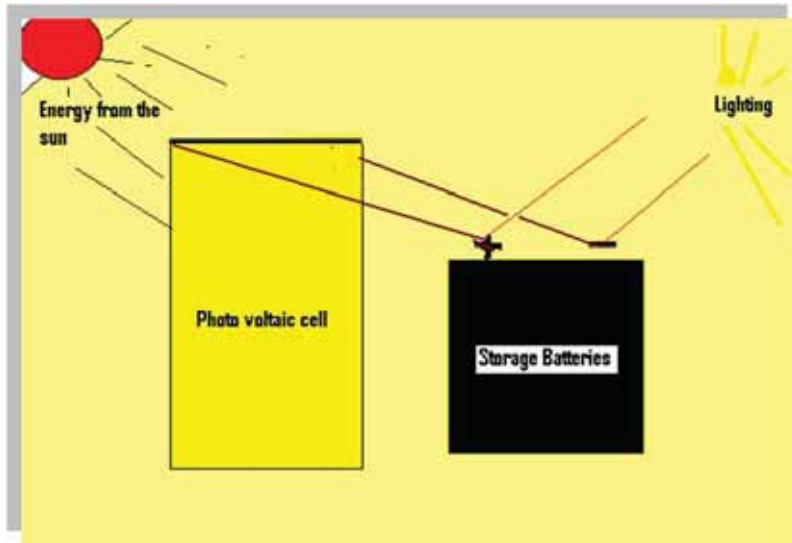


Figure 19: The process of generating solar energy using a mono-crystalline silicon panel

Figure 19 shows the production of solar energy using a mono-crystalline silicon cell. The material commonly used to make photovoltaic cells for power applications is crystalline silicon, either in mono-crystalline or more recently, in semi-crystalline form.

A mono-crystalline silicon cell is made from a thin wafer of high-purity silicon crystal, doped with a minute quantity of boron. Phosphorus is diffused into the active surface of the wafer. A metallic grid, at the back, makes electrical contact; contact usually covers the whole surface. An anti-bacterial reflective coating is applied to the front surface.

When solar radiation or light energy falls on the active surface, the electrons in a solar cell become energized in proportion to the intensity and spectral distribution of the light. When the energy level exceeds a certain point, a potential difference, or open circuit voltage, is established across the cell. This is then capable of driving a current through an external load.

In the diagram, you can see the arrow showing the flow of the current to a load which in this case is a bulb. The load can either be a water pump, vaccine refrigerator, or electric fence. Now we need to look at some of the advantages of solar power.

4.0 The Advantages of Solar Power

Having looked at hydro-electric power and thermal power, I hope you can draw on the knowledge gained to explain some of the advantages of solar power.



Activity 2

Explain at least **four** advantages of solar power. Write down your answers in the spaces provided below.

- (a) _____

- (b) _____

- (c) _____

- (d) _____

Feedback

I hope Activity 2 was very easy for you. Some of the advantages of solar power are shown in the chart and the explanation below:

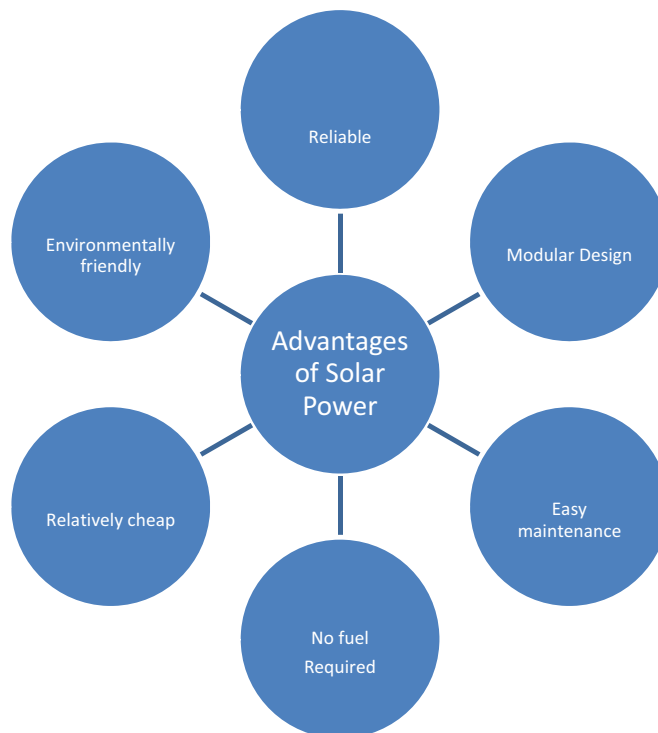


Figure 20: A chart showing the advantages of solar power

Provision of solar power is relatively cheap

The provision of an electric supply to rural areas or remote locations is difficult and expensive; the extension of the mains grid over difficult terrain is seldom economic for small power loads. As a result, solar power becomes cheaper since it does not require much grid lines.

- **No fuel requirements**

In remote areas, diesel or kerosene fuel supplies are erratic and often expensive. The recurrent costs of operating and maintaining PV systems are small.

- **Solar power is cheap**

It is cheaper to use solar power than using thermal and hydro-electric power. Photovoltaic modules provide an independent, reliable electrical power source at a point of use, making them particularly suited for remote locations.

- **Modular Design**

A solar array is composed of individual PV modules which can be connected to meet a particular demand.

- **Reliability of PV modules**

PV modules are more reliable than that of diesel operated system to meet a particular demand.

- **Easy to maintain**

Operation and routine maintenance requirements of photovoltaic cells are simple.

- **Long Life**

With no moving parts and all delicate surfaces protected, modules can be expected to provide power for 15 years or more.

- **Environmentally friendly**

There is no pollution through the use of a PV system.

- **Solar power is inexhaustible**

Solar power is inexhaustible since it depends on the availability of the sun. The sun is generally available throughout the year in Southern Africa (tropics).

It is always important to study both the advantages and disadvantages of any given system. Now that you have looked at the advantages, it is time for you to look at the disadvantages.

5.0 The Disadvantages of Solar Power

(a) High costs required

The main disadvantage of PV systems is their high capital costs. That is, the process of producing efficient solar cells is costly due to the use of expensive pure silicon and the

energy consumed.

(b) May fail to work in cloudy days

Cloudy days can cut the supply of the sun's energy to the panels hence temporarily disabling the panels or the system.

(c) Special batteries used are expensive

Specifically made batteries are required to store the solar power for night usage or during cloudy days. Batteries are usually needed for solar lighting. These batteries are expensive.

6.0 The Energy Conservation Strategies in Botswana

As you might have learnt in other lessons of this unit, it is very important to conserve and use natural resources sustainably. This is important in that future generations must also find stocks of natural resources available to use as well. Energy sources such as water, coal and solar should also be used wisely. For this to be possible there is need for strategies to be developed in the country. You may already know some of these strategies. Activity 3 encourages you to discuss some of the strategies that you already know.



Activity 3

Discuss at least **four** strategies that are important as energy conservation measures in Botswana. Write down your answers in the space provided.

(a) _____

(b) _____

(c) _____

(d) _____

Feedback

I hope you managed to complete Activity 3 without many problems. The principal source of energy in Botswana is fuel wood. Other sources include paraffin, petrol, diesel, electricity

and coal. Some of the energy conservation measures include the following:

- *There should be organizations and institutions in Botswana that are designed for the management of energy resources, e.g. the Energy Unit in the Ministry of Mineral Resources, Energy and Water Affairs and Botswana Power Corporation.*
- *There should be policies that are designed to ensure the wise use of energy resources, e.g. Energy Policy of Botswana which state that rural areas should be provided with alternative sources of energy thus reducing the time and effort expended on the collection of firewood and the resulting ecological damage.*
- *There should be monitoring and pricing of petroleum products. The Ministry of Commerce and Industry is responsible for the supply and pricing of petroleum products. This therefore provides control of the resources hence they are not subject to abuse and over use.*
- *There is also need for laws and legislation that controls the trade of energy resources. This helps in the proper use of the resources. The Ministry of Commerce and Industry is responsible for the issuing of licenses to individuals who trade in energy products such as petroleum.*

7.0 Summary

In this topic you have learnt that solar power is electricity that is produced using direct light from the sun. The advantages are that it does not need fuel, is cheap and individual PV modules can be connected to meet a particular demand. PV modules are more reliable than that of diesel operated system to meet a particular demand. It is also easy to maintain and can last over a long period of time. There is no pollution through the use of a PV system. Solar power is inexhaustible since it depends on the availability of the sun. The sun is generally available throughout the year in Southern Africa (tropics). The main disadvantage of PV systems is their high capital costs. That is, the process of producing efficient solar cells is costly due to the use of expensive pure silicon and the energy consumed in making them. Cloudy days can cut the supply of the sun's energy to the panels temporary disabling the system. Batteries are usually needed for solar lighting and these batteries are expensive. The use of solar power include lighting, vaccine refrigeration, water pumping, electrified livestock fencing, telecommunications and many other applications. There is need to conserve energy sources as some of them can easily become depleted.

Unit summary



In this Unit, you learnt that there are two types of energy sources; renewable and non-renewable. Minerals like uranium and fossil fuels like coal, oil and natural gas are examples of non-renewable sources of energy. Their formation took millions of years and conditions under which they were formed may never occur again. These resources can be depleted if they are not used carefully. These non-renewable sources of energy are used to heat water to produce steam. The steam is released under great pressure and is used as power to turn generators that generate electricity. Renewable resources of energy include solar power, water and wind power. The sources that produce this power are natural and self-replenishing. These sources of energy are used to generate power differently. For instance, solar energy used in the generation of solar power is captured through the use of PV panels. The panels are then used to convert the solar energy into electrical energy that is stored in batteries. Bio fuels from dried plant matter are also sources of renewable energy.

Now that you have completed this topic, do assignment 3. When you have completed the self-assessment exercise, refer to the answers to see how well you have mastered the topic. Where you did not get the correct answer, refer back to the relevant section and make sure that you understand the section before you proceed.

If you have finished the self-assessment exercise 3, do the Tutor Marked Assignment which is the last activity of this unit. This assignment should be sent to your institution for marking.

Before moving on, let's reflect back on all the power generating systems we learned about in this unit. If you were in charge of distributing power to the people of your country, which generating system will you use? Try discussing your choice with your peers and your tutor or instructor.

Assignment



Assignment

Please note that this assignment is divided into three self-assessment exercises. As already mentioned in the teaching and learning approach of the unit, each self-assessment exercise is for a given topic. For instance, Self-Assessment Exercise 1 is for topic 1 while Self-Assessment Exercise 2 is for Topic 2 in this unit.

Self-Assessment Exercise 1

1. What is the electricity that is produced from the force of running water called?

[1 mark]

2. Discuss **four** factors that influence the location and development of HEP stations.

[8 marks]

(a)

(b)

(c)

(d)

3. Describe the process involved in generating electricity using flowing water.

[5 marks]

4. Name any **one** HEP scheme you know and give **two** reasons for the site of HEP.

[5 marks]

(i)

(ii)

(iii)

5. Discuss **two** advantages and **two** disadvantages of HEP schemes.

[8 marks]

Advantages

(i)

(ii)

Disadvantages

(i)

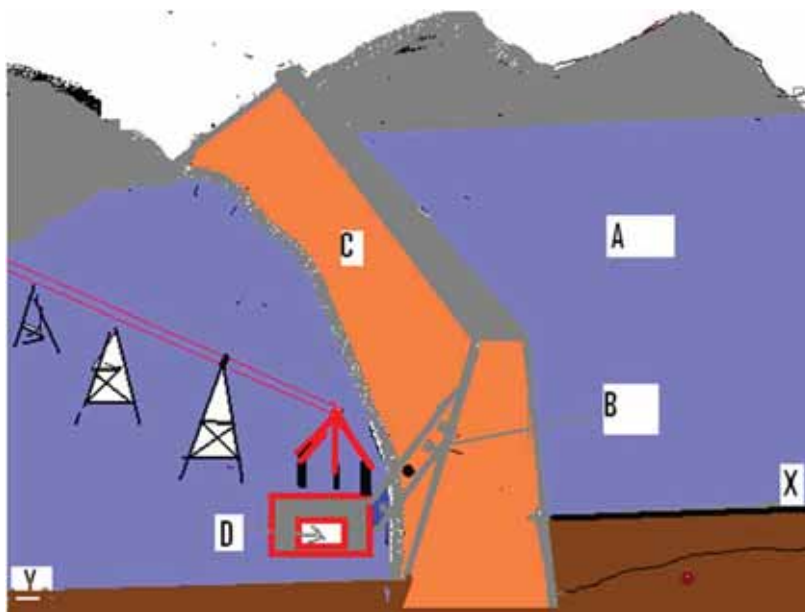
(ii)

6. Evaluate **two** factors that make HEP schemes important to the economy of Uganda. [4 marks]

(i)

(ii)

7. Study the diagram of a hydro-electric power station



(i) Name the features labelled A, B, C and D.

[4 marks]

A is _____

B is _____

C is _____

D is _____

(ii) Explain the importance of the difference between the water levels at X and Y.

[1 mark]

Total [30 Marks]

Self-Assessment Exercise 2

It should take you about 45 minutes to complete this assignment.

1. Discuss two factors that influence the location and development of thermal power stations.

[4 marks]

(a)

(b)

2. Name **one** main thermal power station found in Botswana.

[1 mark]

3. Discuss **two** advantages and **two** disadvantages of burning coal to generate power.

Advantages

[4 marks]

(a)

(b)

Disadvantages

(a)

(b)

4. Discuss the process of generating electricity from coal.
[4 marks]

5. Discuss one role that the following groups can play in the sustainable use of coal as a resource.

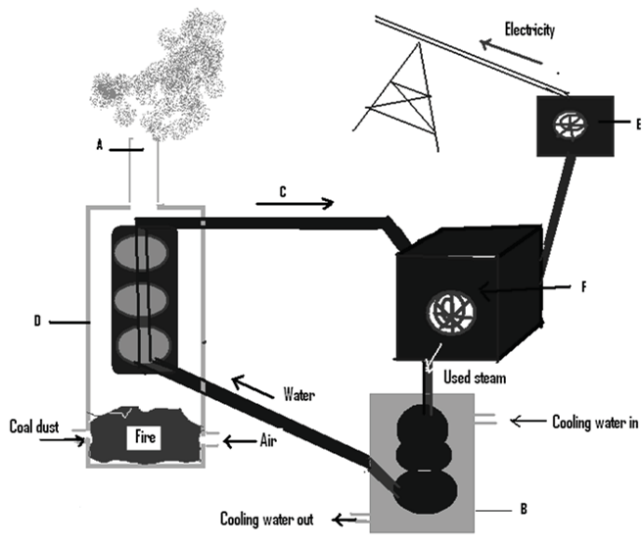
[6 marks]

(a) Government

(b) Conservation Groups

(c) Local Authorities

6. Study the diagram of a Thermal Power Station and name the labelled features A, B, C, D, E, F.
[6 marks]



The process of generating power from coal (Adapted from - [jpg projectmidori.com](http://projectmidori.com)) on 12/03/10

A is

B is

C is

D is

E is

F is

Total Marks 25

If you are finished with this assignment, check for the correct answers at the end of the unit. Redo all those that you failed to do before proceeding to the next topic which is on Solar Power.

Self-Assessment Exercise 3

Now that you have finished Topic 3, answer all the questions in this exercise. Write your answers in the space provided.

1. What is solar power?
[2 marks]

2. What is a photovoltaic system?
[2 marks]

3. Explain **three** uses of solar power.
[3 marks]

(a)

(b)

(c)

4. Discuss at least **four** advantages of using solar power.
[4 marks]

(a)

(b)

(c)

(d)

5. Explain the process of generating power using energy from the sun.

[4 marks]

Total 15 Marks

Unit Assessment

You should do this assessment exercise only if you have completed Self-Assessment Exercise 3. This assessment covers the whole unit. You need an hour to complete this assessment. Do it carefully and then submit your answer to your tutor for marking.

1. What is the electricity that is produced from (a) the force of running water and (b) coal called? [2 marks]

2. Discuss **four** factors that influence the location and development of HEP stations. [8 marks]

(a) _____

(b) _____

(c) _____

(d) _____

3. Describe the process involved in generating electricity using coal. [5 marks]

4. Name any **one** HEP scheme you know and give **two** reasons for the site of HEP.

[5 marks]

(i) _____

(ii) _____

(iii) _____

5. Discuss **two** advantages and **two** disadvantages of solar power . [4 marks]

Advantages

(i) _____

(ii) _____

Disadvantages

(i) _____

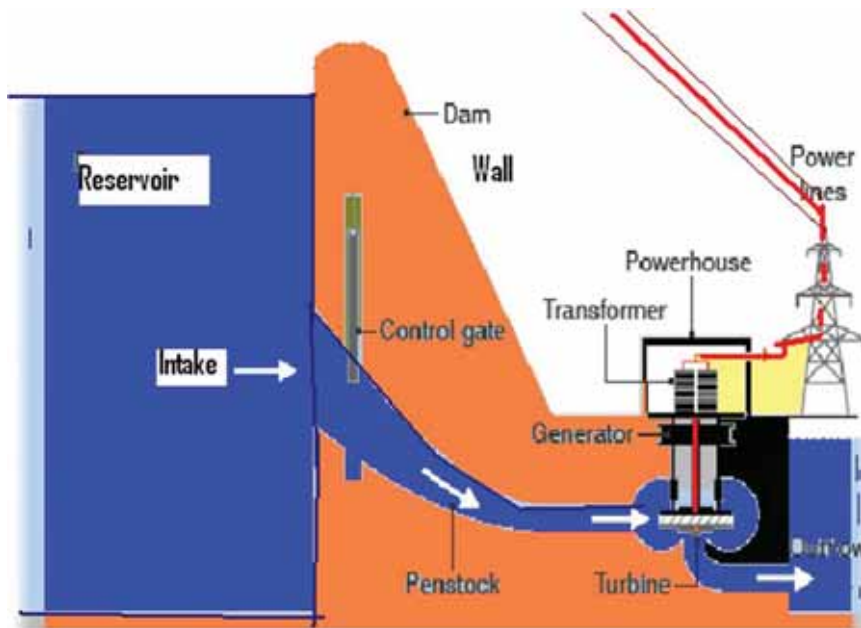
(ii) _____

6. Evaluate **two** factors that make HEP schemes important to the economy of Uganda. [4 marks]

(i) _____

(ii) _____

7. Study the diagram of a hydro-electric power station.



The process of generating power from water (Adapted from - jpg
projectmidori.com) on 12/03/10

(i) Name the features labelled A, B, C and D. [4 marks]

A is _____

B is _____

C is _____

D is _____

(ii) Explain the importance of the difference between the water levels at X and Y. [1 mark]

8. Discuss two factors that influence the location and development of thermal power stations. [4 marks]

(a) _____

(b) _____

9. Discuss one role that the following groups can play in the sustainable use of coal as a resource. [6 marks]

(a) Government

(b) Conservation Groups

(c) Local Authorities

10. Explain **three** uses of solar power. [3 marks]

(a) _____

(b) _____

(c) _____

11. Explain the process of generating power using energy from the sun. [4 marks]

Total Marks 50

If you have completed this unit assessment exercise, you can now proceed to the next unit. Note that if you still have difficulties in answering some of the questions in this unit assessment, you should go through the sections that were difficult for you and try to master them and then proceed to the next unit. You can also discuss these difficult sections with other learners and your tutor.

Answers to Self- Assessment Assignments

Assignment 1

1. Hydro-electric power

2. (a) **Rivers that can supply water throughout the year** – HEP schemes need a constant and large supply of water throughout the year in order to generate electricity without failure. As a result, a large river that flows throughout the year is important for the construction of a dam wall which will make it possible to have a big lake for the supply of water throughout the year. HEP stations, therefore, need to be located on big rivers that flow all year round and where a big dam wall can be constructed to store a lot of water in a reservoir.

(b) **High amounts of rainfall** – Since HEP schemes need a lot of water, it means that they are suitable in areas which have high amounts of rainfall throughout the year. This makes it possible for the river to flow all year round.

(c) **A deep narrow valley with a strong and impermeable rock** – Dams constructed for HEP schemes need to be located in a place where a large lake will form without the water flowing away in another direction. As a result, rivers with deep narrow valleys are good sites for the location and construction of dams to be used for HEP schemes. The strong impermeable rock (hard rock) that prevents water from sinking too fast is also important when the site for a dam is chosen.

(d) **Steep and Upland Gradients** – Fast flowing water is needed to generate energy needed for the production of electricity. As a result, steep and upland gradients are important areas where HEP schemes can be located. Steep upland areas make rivers flow very fast and hence provide the necessary force to make the production of electricity very easy.

3. For the HEP scheme to operate there must be a river which flows throughout the year and a dam wall constructed to create a reservoir. The reservoir is important for storing a lot of water. From the reservoir, a large pipe at the dam wall is used to carry water. The water is made to fall down in this large pipe called a penstock. In the penstock, waterfalls onto a wheel with curved blades called a turbine. The fast moving force of the water falling down makes the turbine spin. The turbine is connected by a shaft to the generator. It is the generator that produces electricity once the turbine is spinning. Once the electricity is produced by the generator, it is transported through power or transmission lines to areas where it is needed in a country. After the water has passed through the turbine, it is discharged into a passage called a tail race, and is returned to the river below the dam. This water is allowed to flow once more in the river. The higher the dam, the greater the force of the falling water, and the greater the amount of electricity produced.

4. (i) The Kariba HEP Scheme in Zambia/Zimbabwe

(ii) The location on the large perennial Zambezi River – We have so far discussed that HEP schemes need to be located on large rivers that flow throughout the year to provide large amounts of water needed for power production.

(iii) The deep narrow Zambezi Valley – The Zambezi River has a narrow valley that has made it possible for the construction of a dam wall. A large lake has as a result been created.

5. **The Advantages of HEP schemes**

(i) Water is a renewable resource. Hence it can be used for a long period of time – Since water is inexhaustible; it means that as long as there is rainfall, it is possible to have HEP schemes. Water is not like a mineral such as coal that can become exhausted. making power production a problem.

(ii) Provide the opportunity for recreation and tourism – Some of the countries with HEP schemes have a lot of tourists and people visiting the sites for recreational purposes. HEP lakes provide the opportunity for recreation especially boating. HEP lakes usually attract wildlife thus make tourists to visit them. Tourists pay some fees to visit these areas and this generates revenue for the country.

The Disadvantages of HEP Schemes

(i) HEP schemes usually result in re-location of settlements since the reservoir covers a large area. Re-location of settlements disturbs the socio-economic development of the people since they have to re-locate their homes, and farmland and other related economic facilities. Re-location is also expensive in that governments usually pay compensation to people who are forced to move their settlements.

(ii) Very large HEP schemes may flood whole villages and force people to leave their homes. That is, if there is a lot of rainfall in a particular year, flooding might occur resulting in high volumes of water in the reservoir, possibly affecting nearby settlements.

6. (i) Development of Industrial Areas – HEP schemes provide electricity to a country. Hence it can promote industrial development. An example is how the Owen Falls Dam on the Nile River in Uganda has contributed a lot to the industrial development of Jinja. Many industries like the copper smelter, asbestos and cement factories depend on electricity generated at the Owen Falls HEP station.

(iii) Irrigation – Reservoirs or dams constructed for HEP purposes are usually important sources for irrigation water supply. e.g. the Kariba Dam supplies water for irrigation purposes in Zambia and Zimbabwe. Irrigation of crops is important for the provision of food and revenue generation in a country.

7. (i) A is a reservoir or a lake.
B is a penstock.
C is a dam wall.
D is a turbine or generator or alternator.
- (ii) To create a fall or head of water.

Assignment 2

1. (a) Large amounts of Coal Deposits – Thermal power stations are located near large amounts of coal deposits. As a result, most thermal power stations are located near coalfields and coal mines. This is because coal is bulky and expensive to transport. Hence, thermal power stations get located near the coalfields and mines to reduce transport costs. Morupule Power Station in Botswana is located near a coal mine called Morupule. As a result, the coal is transported by conveyor belts to the power station.
(b) Flat sites (areas) are required – Flat sites and areas are required for the location of thermal power stations. This is done to enable high chimneys to be constructed in order to release smoke or pollutants high in the atmosphere without obstruction of mountains or upland areas. It is assumed that when chimneys are long, they are able to deposit pollutants in atmospheric layers which are high in altitude, making less of an impact on the environment.
2. Morupule Power Station at Morupule near Palapye.
3. **Advantages of generating power from Coal**
 - (a) There is plenty of coal and many countries have it. Coal reserves in many countries will be available for a longer period of time e.g. Coal reserves in Botswana are estimated at over 100 billion tones.
 - (b) Most countries have large coal reserves in their respective countries; electricity produced from coal becomes very cheap. This has therefore resulted in many countries having many thermal power stations to encourage industrial development.

Disadvantages of generating electricity from coal

- (c) Burning of coal results in the release of nitrogen oxides and large amounts of carbon dioxide. The release of these oxides into the atmosphere can be harmful to the environment since in most cases it is released in large quantities. Too many oxides affect plant and some living organisms.
 - (d) The burning of coal also results in the release of sulphur dioxide into the atmosphere. Sulphur dioxide is linked to acid rain, which is when sulphur dioxide in the atmosphere cools and forms water droplets. If the sulphur dioxide is in large quantities, the water droplets reach saturation point resulting in precipitation. The rain that falls is called acid rain. This type of rainfall is very harmful to people and the environment, as it kills plants for example. .
4. First, coal that comes from the mine need to be crushed into fine powder. The fine powder, which in most cases is referred to as coal dust, is then blown into the furnace at the base of the boiler. At the base of the boiler, it burns in a continuous sheet of flame. The burning coal produces a lot of heat that is used to heat water in the pipes. When the water in the pipe is heated, it turns into steam. The steam produced must be of high degree of purity. The temperature of the steam reaches roughly 700° - 800°C.

The heated steam is forced at high speed onto the turbine. The turbine is like a wheel with many blades. The force of steam on the turbines makes the turbine rotate at high

speeds. The turbine is connected to the generator. The generator rotates and produces electricity. From the generator, the electricity is taken to transformers and through transmission lines the electricity is distributed to areas where it is needed.

5.
 - (a) The Government through the Ministry of Mines, Energy and Water Affairs facilitates policy formulation and implementation on the use of coal resources. That is, government is responsible for making sure that there are laws and legislation governing the use of coal resources.
 - (b) Non-Governmental Organisations e.g. conservation groups should ensure that both the mining and burning of coal are done under recommended environmental standards.
 - (c) Local Authorities e.g. Land Board allocates the land to companies for purposes of establishing either a mine or a thermal power station or for any other use. They also have the responsibility to ensure that the land is used on a sustainable basis without much destruction on it.
6. A is chimney
B is alternator or generator
C is steam
D is furnace
E is transformer
F is cooling tower

Assignment 3

1. Solar power refers to electricity that is produced using energy from the sun.
2. Photovoltaic system is the technology that is used to generate electricity using light energy from the sun.
3.
 - (a) **Domestic Lighting**
Solar power is used mostly in rural areas for domestic purposes. It is used to provide lighting in the house. This is because it is expensive to provide thermal power or hydro-electric power in rural areas because rural settlements are scattered. Solar power is being encouraged in Botswana today e.g. Motshegaletau Village is provided with solar power.
 - (b) **Water Pumping**
Solar power is also used to drive solar water pumps. This is common in irrigation schemes and for livestock watering. There is a water pump that is designed to use photovoltaic power.
 - (c) **Livestock and crop fencing**
Photovoltaic power is also used for the electrification of crop and livestock fences.

Crop fields such as Talana farms in the Tuli Block and Chobe farms in Kasane have electrified fences to prevent wild animals from destroying crops.

(d) Cooking and heating water

In Botswana, solar power is also used for cooking and heating water. Solar panels are usually installed on house roofs especially in towns to produce power. Almost all government houses in rural areas and schools in Botswana have solar panels to generate power mostly for heating water.

4. **(a) Provision of solar power is relatively cheap**

The provision of an electric supply to rural areas or remote locations is difficult and expensive. The extension of the main grid over difficult terrain is seldom economic for small power loads. As a result solar power becomes cheaper since it does not require many grid lines.

(b) No fuel requirements

In remote areas, diesel or kerosene fuel supplies are erratic and often expensive. The recurrent costs of operating and maintaining PV systems are small.

(c) Modular design

A solar array is composed of individual PV modules which can be connected to meet a particular demand.

(d) Easy to maintain

Operation and routine maintenance requirements of photovoltaic cells are simple.

(e) Environmental friendly

There is no pollution through the use of a PV system. When using photovoltaic system, solar panels are exposed to sunlight.

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Unit 10

Research Methods

Introduction

Welcome to Unit 10 of the BGCSE Geography course. In this unit you will learn about methods of carrying out research in Geography. Research as you will find out later, is a well organised method of collecting information used either to build on existing knowledge or to solve problems. You probably used this method of collecting information and solving problems in your junior secondary school subjects like Social Studies. If you have not done this type of project before, you should not worry as this unit will teach you all about it.

Upon completion of this unit you will be able to:



Outcomes

- *define and explain* types of research.
- *identify* a research problem.
- *select* a suitable method of collecting data.
- *present and analyse* data.
- *write* out a research project on your own.



Terminology

[Term]: [Term description]

Research:	A systematic way of collecting data to either solve a problem or to add new knowledge.
Systematic:	Something done in an organised manner.
Basic Research:	A study carried out to get a solution to a problem.
Applied Research:	Research carried out mainly to gain new knowledge.
Data:	Information or evidence collected by a researcher.
Interpret Data:	To explain what the collected information means.
Investigate:	To carry out a systematic enquiry.
Locality:	The area in which you live.
New Knowledge:	Information, which has not been investigated and

	confirmed.
Pool of Knowledge:	It is the known existing knowledge
Questionnaire:	A form with a list of questions to be answered by many people.
Research Ethics:	Rules which should be observed when carrying out research.
Research plan:	Organised steps followed by the researcher when solving a problem.
Research skills:	Competency and ability required to carry out a systematic investigation under certain conditions.
A theory:	An explanation of how certain things behave.
Correlation survey:	Identifies the relationships in the variables.
Descriptive survey:	Describes how things are.
Evaluative survey:	Assesses the impact of the variables.
Experimental hypothesis:	A statement about expected relations among variables.
Hypothesis:	A suggested possible answer to a research problem.
Research problem:	What the investigator sets out to find out.
Survey:	An investigation to find out the distribution patterns.
An Interview:	A questionnaire which is administered verbally.
Primary source:	Original, uninterpreted information.
Quadrant:	A square which is subdivided into smaller square

units.

Questionnaire: A form containing questions which is used for collecting data.

Random sampling: A sampling procedure where every member of the population has a chance to be selected.

Sample: A selected representative part of a population.

Secondary source: A source of data already collected and recorded by someone else.

Transect: A line showing a simple profile of items.

Topic 1: Introduction to Research

Introduction

In this lesson, you will learn what a research project is. Once you know what it is, you shall find out why it is important to learn research skills. Then I shall briefly take you through all the major steps followed when carrying out a research project. This means that you will go through all the major steps without going into the details of each step.

You will learn the details of each step in your next lessons. Also, you will learn how you are expected to behave when carrying out a research project. This is called research ethics. Where possible, I would like you to discuss the issues raised with your study group mates.

Topic Objectives

After completing this topic, you should be able to:

- explain what a research project is
- explain why it is important to learn research skills
- list the major steps taken when carrying out a research project
- draw your own research plan
- recall some of the ethics of carrying out a research project.

Topic Contents List

1.0 What is research?

2.0 Types of research

2.1 Basic Research

2.2 Applied research

3.0 Why do you have to do research projects?

4.0 What do you have to do in order to carry out research?

4.1 Knowing more about your chosen topic

4.2 Deciding on the method of collecting information

4.3 Presenting information

4.4 Drawing conclusions

5.0 Research ethics

5.1 Informed consent

5.2 Honesty

- 5.3 Right to discontinue
- 5.4 Right to confidentiality
- 5.5 Respecting the participants' time
- 5.6 Show courtesy

6.0 Summary

7.0 Assignment 1

Resources

For this topic you will need a recording sheet. For the recording sheet, you can use any clean sheet of paper.



Activities

There are five activities given in this topic. Do all of them as they are meant to help you to understand the topic. Feedback is given immediately after the activity. At the end of the topic there is an assignment for you to do. Do the assignment and check the answers at the end of the unit. If you failed to get the correct answers check and find out where you went wrong. If necessary, do the topic again till you understand it.

1.0 What is Research?

Research is a step-by-step process that tries to answer questions on why and how certain things happen. It is an organised way of getting new knowledge and of solving problems. Figure 1 shows the systematic process of finding an answer to a problem through research.

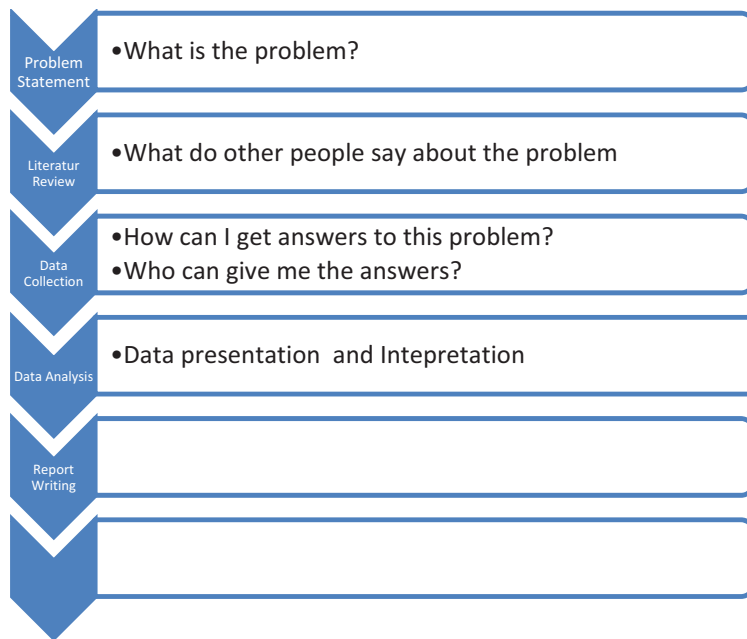


Figure 1: A systematic way of investigating a problem

For you to better understand what research is, carefully study the example of research given below:

Example 1

Kagiso is worried about the problem of uncontrolled tree cutting around his home.



Figure 2 A sample of extensive tree cutting

(Source:http://pleasant_valleyconservancy.org)

He is asking himself such questions as:

1. Who is cutting most of these trees? Is it men, women, boys or girls?
2. Why are they cutting these trees?
3. What type of trees do they cut mainly?
4. What are some of the effects of uncontrolled tree cutting on the local environment?
5. How can we solve the problem of uncontrolled tree cutting?



Activity 1

In the space given below, suggest methods through which Kagiso can get answers to his questions.

Feedback

Most probably you suggested that Kagiso should ask some of the people in the village or go out and see for himself the type of trees that are being cut or that he should read about the effects of cutting trees on the environment. If you mentioned any of these then you are correct. You may discuss this with some people in your village and hear what they have to say.

2.0 Types of research projects

The following are the two main types of research projects.

- the basic research project
- the applied research project.

2.1 Basic research

The purpose of carrying out basic research is to get new information. In this type of project, your main interest is to get new knowledge.

Example 2

A student may set out to investigate the effects of a footpath on the growth of grass. The knowledge the student finds does not need to be used for any purpose.



Figure 3: How a path affects the growth of grass

(Adapted from <http://www.freefoto.com/images>)

The research has been done purely to gain knowledge on how footpaths affect the growth of grass in a particular area. This type of research is known as basic research.



Activity 2

Can you come up with your own example of a research project, which you can do just to get knowledge? Write it down in the space provided.

Feedback

If you mentioned any example, which may result in you getting new information, then you are correct. Some examples may include gangsters in the village, livestock straying in towns etc. If you are in doubt as to whether what you have come up with is an example of basic research, you can ask your tutor to look at it and give you feedback or you may discuss it with another learner or with those you stay with at home.

The important thing to understand is that at times basic research projects are done to add to our pool of knowledge. Sometimes information collected through basic research can be used elsewhere. Study the example, which you gave in Activity 2. Most probably the information, which you got can be used elsewhere.

2.2 Applied research

Applied research is a systematic, step-by-step method of trying to find a solution to a practical real life problem.

Example 3

“At Kanye, a new supermarket was recently opened. Ever since it was opened, there has been traffic congestion and crossing the main road has become dangerous for pedestrians. This is a serious problem which needs an immediate solution.”

You can carry out a research to find out ways of reducing this congestion. Your main reason of carrying out the research would be to find a solution to a problem. Your research in this case is called applied research.



Figure 4: A typical congested street in a city

(Source: <http://blog.trick-bike.com>)



Activity 3

Can you think of a problem in your locality, which needs an immediate solution? Write it briefly in the space provided.

Feedback

If you mentioned any problem, which needs immediate attention in your village, town or city then you are correct. Some of the problems could be diseases, water shortages, security, poor roads and lack of transport among many others.

If you were to set out to systematically find an answer to the problem, then you would be carrying out an applied research project.

You now know the two types of research and some of the reasons for carrying out research. But are the above mentioned reasons the only ones for doing research? Let us examine why research is carried out in some detail.

3.0 Why Do You Have to Do Research?

Well that is a fair question. You need to do research projects because, as you have already noticed, research can help you to get new knowledge. It can also help you solve problems in a systematic way with evidence to support your course of action. In addition, you will learn many skills while doing your projects. Look at some of the skills, which you will learn through doing research projects.

- Problem solving skills
- Observation skills
- Skills for interpreting information
- Skills for analysing information
- Decision making skills based on available information

You already know about getting new knowledge and solving problems. When doing research, you will also develop your reasoning skills. You will be able to put things in groups (classification) and to look closely at the different aspects of things (analysis). When carrying out a research, you will also learn how to observe and record accurately what you see. In the process you will gain many practical

geography fieldwork skills.

4.0 What You Have to Do in Order to Carry Out a Research Project

For you to carry out a research project, you need to first identify a research problem. In the case of Kagiso the research problem was extensive tree cutting in the village. He wanted to find out why people were cutting so many trees in the village. In Activity 2 you thought of your research project, which may be different from Kagiso's or my examples. A research problem is what you want to find out. This is perhaps the most difficult part of a research project. Here you have to decide exactly what it is that you want to find out.



Activity 4

Now think of any topic, which you would like to investigate and write it down. Also write down the questions your investigation intends to answer.

Feedback

There is no single correct answer. Any topic based on the problem, which is interesting to you, should be correct. The questions, which you ask, should lead to the solutions to your problem.

By now you should have an idea of what a research topic is. We shall deal with research topic identification in more detail in the next Topic. Remember, we said that this is a brief walk through the process of research.

4.1 Knowing more about your chosen topic

When you have identified a topic then you find out as much about it as possible. You can do this by reading the work done by others in this field or discussing with others. This will help you to know what others have written or said about your topic. This is known as literature review.

4.2 Deciding on the method of collecting information

Once you have read and discussed about your chosen topic, you now need to decide what methods you will use to collect information. First you will have to decide who or what is going to be your source of information and what method you will use to collect that information.



Figure 5: Carrying out an interview

(Source: <http://www.projects-abroad.org>)

You may decide to:

- ask people (interview, as in Figure 5)
- send questions to people (questionnaire)
- make your own observations
- do field work
- read from books (literature review)

All these are methods of collecting information. Do not worry if you are not familiar with them. We shall deal with them in more detail in Topic 2.

4.3 Presenting information

Once you have collected your information, you re-organise it such that it is easy to interpret and to explain the patterns that you observe. We call this **presenting** and **interpreting** data. Study the example given below:

Example 4

Kagiso records in his field notebook “the trees cut are *mosethla, mosethla, mosetlha, mosetlha mophane, mokala, mokala, mophane, moretlhwa, mophane moretlhwa, morula, morula, mosu, mophane, mophane mosetlha, mosethla, mosetlha, mosetlha.*”

Can you tell which tree has been cut most frequently? Probably not! Accordingly, you can easily tell when the data is well presented or not.

He then re-organises as shown in Table 1.

Table1: Frequency of cutting down different trees in Kagiso’s village in June 1998

Name of tree cut	Frequency of cutting
Moretlwa	2
Mophane	5
Morula	2
Mokala	2
Mosethla	8
Mosu	1
Total number of trees cut	20

A pattern has clearly come out. Can you spot the pattern? Which tree has been cut most frequently? You probably easily got it right. Just by looking at the table you can see that the *mosethla* tree has been the target of most tree cutting in Kagiso’s village.

Thus, when you are presenting your information you reorganise your data and explain the patterns that come out.

4.4 Drawing conclusions

Once you have presented and interpreted your data you can now draw your conclusions.



Activity 5

Study the pattern, which came out in Kagiso’s presentation in Table 1 above. What conclusion do you think he drew from the data? Explain your answer.

Feedback

Most probably Kagiso concluded that the most frequently cut tree is the *mosethla* tree followed by the *mopane* tree. The *mosethla* tree has the highest frequency (8) followed by the *mopane* tree (5). The

mosu was least cut (1).

5.0 Research Ethics

Carrying out some research, particularly on social topics, involves dealing with people of different age, beliefs and backgrounds. Therefore, the way you handle yourself around them is important for the success of the research.

When carrying out research, there are certain rules which you have to keep in mind. These are usually referred to as **research ethics**. These are the rules that show acceptable behaviour when you are carrying out a research. Given below is a list of some of them. Read through them and familiarise yourself with them.

5.1 Informed consent

This is the most basic principle of research ethics. It means that people who take part in your research must know why you are carrying out that research. They must also agree to take part in the research. It means that it is wrong for you to involve people in your research against their will. Remember; to always explain what you are doing and why you are carrying out that research. Make them understand that they are free to accept or reject participation.

5.2 Honesty

When carrying out your research, you must be very honest to the people who are taking part in the project. You must not use deception. When reporting your findings, report as accurately as possible. Again, you must be honest.

5.3 Right to discontinue

If people participating in your research feel that they no longer want to continue for example, answering your questions, they are free to withdraw.

5.4 Right to confidentiality

Whatever people tell you during your research must be kept private. Do not go about telling others what other people have said during your research. Use the information given only for the purpose for which it was collected. Do not ask questions which are meant to interfere with people's privacy. Respect the privacy of individuals.

5.5 Respecting the participants' time

Do not waste peoples' time by asking useless questions or coming late to meet them. Ask only those questions, which have a direct bearing to your research topic. Above all, if you make an appointment, be on time.

5.6 Show courtesy

Before you start the conversation or interview be polite and greet your audience and before you leave, thank the people who have taken part in your research. Remember also to acknowledge their

contribution when you finally write a report.

6.0 Summary

In this lesson you have learnt that research is an organised way of collecting information either to solve a problem or to get new information. There are two types of research, basic and applied research. When carrying out a research, you need to:

- first identify a problem area
- find out more about the problem to be investigated
- decide on the method of collecting data
- present your information and then
- interpret the data and draw conclusions.

We also said that when carrying out research you need to observe ethics such as getting the consent of your respondents, honesty, right to confidentiality, respecting your participants' time and being courteous to them. In the next lesson you will learn how to formulate a research topic in more detail.

Now that you have gone through the steps for carrying out a research project, you may want to read the whole topic one more time. If you feel that you have understood the entire topic, try to answer the questions given in assignment 1.



Assignment

Assignment 1

Instructions

- (a) Answer all the questions in the spaces provided.
- (b) You may spend about 30 minutes on this exercise.

1. What is a research project?

[2 marks]

2. Name and explain **two** types of research projects which you know.

[4 marks]

3. Write out a research problem, which you would like to investigate in your area. [4 marks]

4. List the steps you would follow when carrying out a research project. [6 marks]

5. Why do you think it's important to carry out research projects?
[4 marks]

6. Mention at least **five** research ethics, which you consider to be important. [5 marks]

Topic 2: Research Design

Introduction

In the previous topic, you learnt about a research project. Do you still remember what we said a research project was? If you have forgotten, just check back to the previous topic. You also learnt the major steps taken when carrying out a research project. Can you still remember them? In this topic you will learn how to identify a research problem, how to write a hypothesis and also how to select a suitable research design for solving the research problem.

Topic Objectives

After completing this topic, you should be able to:

- identify a geography research problem
- write out a hypothesis for an identified problem
- select a suitable research design for solving the research problem.

Topic Contents List

1.0 Formulating a research problem

- 1.1 The title of the research project
- 1.2 Types of research studies in Geography

2.0 A hypothesis

- 2.1 Formulating a hypothesis
- 2.2 Characteristics of a well formulated hypothesis
- 2.3 Why a hypothesis
- 2.4 Types of hypotheses

3.0 The research design

- 3.1 Experimental research design
- 3.2 Survey research design

4.0 Summary

5.0 Assignment 2

Learning approach

The learning method used in this topic is a hands-on practical approach where you are expected to learn through participating. It is for this reason that a lot of activities have been deliberately included. You are expected to do all the activities as they are designed to give you a practical experience in problem identification. This practical experience will help you to understand the topic and prepare you for Section A of paper 1 which assesses your ability to identify a problem and select a research

design. As in the previous topic, feedback is given immediately after the activity. At the end of the topic there is an assignment for you to do. The answers are given at the end of the unit.

1.0 Formulating a Research Problem

A research problem is what you want to study. Before you start on a research project you have to decide what it is that you want to find out. Do you want to find out how land is used in your area? In this case your research problem would be land use in your village, town or city.



Figure 6: Formulating a research problem

Now think of a research problem that you can study.

It is not always easy to find a research problem. However, consider the following questions as they may help you to find a suitable research problem.

- (a) Are you interested in the topic you want to investigate?

Before you select a research problem first decide what you are interested in. Are you interested in population movements? If you are not interested, well then, do not carry out a research study on the topic because if you do you will most probably find it boring and difficult. Look for a topic that is interesting to you. On the other hand if you are interested in the topic, you can study population movements in your village in the last five years for example. As a result, this becomes your research problem. Try activity 1 given below:



Activity 2

Think of a research problem that interests you. Write it down in the space below.

Any problem that interests you is quite acceptable. It can be a problem related to transport, education, health or any other issue of interest. It is important that you write it down as clearly as possible.

(b) Can your topic be investigated?

Sometimes, even if a research problem seems interesting, it cannot be easily investigated. To get a better understanding of research problems which cannot be investigated carefully study the examples below.

Example 1

“A study of Kanye”

What makes this topic difficult to investigate is that it is too broad. It does not say what exactly it is that we want to investigate. For example, do we want to investigate settlement patterns in Kanye or the types of houses? It is too broad and is not clear. Your research problem must be clear and focused. It must clearly specify what it is that you want to study. For example, “The distribution of shops in the Mafhikana Ward in Kanye” This is much clearer. We know exactly what we want to find out; how different types of shops are distributed in the Mafhikana Ward in Kanye.

Let me give you another example to further clarify my point.

Example 2

“Population movements in Botswana”

The topic sounds quite interesting but this research problem cannot be easily done because Botswana is too broad. You will need a lot of time and money to carry out this type of investigation. What this implies is that when you select a research problem you must take into account the time you have and the funds that would be needed. Perhaps, a more suitable research problem would be “Population movements in the Jakalasi ward in the past five years”. Notice that I have reduced the geographical area covered and I have also specified the time that I would like to study. Remember, your research problem should fit into the time you have. Let’s look at the third example.

Example 3

“Drug Trafficking in Botswana”

This topic is too broad and is unlikely to be done within a short period of time. Secondly, it would be unsafe for you to start investigating drug trafficking. Leave out risky types of investigations like this one.

(c) Is your research problem a geographical problem?

Your research projects should relate to geographical issues. In other words, your research problem must relate to spatial distributions, the characteristics of places or the relationship between people and places.



Activity 2

Now carefully study the research problems given below. State whether they are geographical topics or not. Explain each of your answers.

Research problem	Is it a geographical topic (Yes/No)	Explanation
(a) Traffic density along the Khama Crescent between 8 am and 9 am.		
(b) Impact of tourists in the Kazungula entry point		
(c) The history of Botswana.		
(d) The impact of the new housing scheme on the crime rate in my village		
(e) The cost of land decreases from the city centre		

Feedback

Most probably you got all of them right. “Traffic density in the Khama Crescent” is a geographic topic that relates to distribution patterns of human and vehicle traffic at the stated time. The “Impact of tourists” relates to how human beings affect the environment and is therefore a good geographic issue to study. The third one is more of a historical research problem than a geographic research problem.

Let us now summarise what we have learnt so far. When selecting a research problem, make sure that your research problem:

- is interesting and challenging
- can be investigated within the time

available

- is well focused and clear
- is researchable
- relates to a geographical issue.

1.1 The title of a research project

Once you have identified your research problem you need to change it to a suitable title. You can present your title either as a statement or a question. For example: “The distribution of shoe manufacturing industries in Mochudi.” Or “What factors determine the distribution of shoe manufacturing industries in Mochudi?” Note that your title must not be too long and it must relate to what you are studying.

1.2 Types of research studies in geography

In geography there are many different types of research studies. Here are some of the different types of study which have been successfully carried out by other students.

(a) A study of conflicts in your area

The place where you live, regardless of where it is, can provide you with a very rich environment for carrying out a research project. Observe carefully and see if there are issues whereby different groups have different views relating to those issues. For example, are there any land use conflicts?

In your locality, you may study such topics as:

- the effect of tourism on the local environment
- the impact of the new housing scheme
- the effects of the new by-pass on congestion in the city
- uncontrolled tree cutting in the village.

These are just a few examples; there are many other conflict-based topics that you can think of.

(b) A study that tests a theory

You may carry out a study, which attempts to find out if a theory is applicable in your area. A theory is an explanation of how certain things behave under certain conditions. For example, you may have read that land use decreases with the distance from the market. Then you can set out to find out if this theory applies to cattle rearing in your locality. Does the distance from the market in your own area affect sorghum production for example?

(c) A study that compares geographical characteristics of places or issues

This is a popular type of study among geography students. Here you are required to compare places or activities such as shop types along a street or two shopping centres at different parts of a village, town or city.

(d) A study that analyses distribution patterns

This type of study is also popular and can be done within a short period of time. There are many examples including the distribution of leisure centres, schools, hospitals, telephone booths, soils, diseases and vegetation patterns.

(e) A study that examines change through time

This is a study, which investigates changes, which have occurred over a long period of time. In this type of study you need to have information on earlier trends so as to be able to compare what the situation was like before the introduction of the new element. Some examples could be changes in the vegetation and ecosystem around your village, changes in the population characteristics of your village, land in the village, and shop types in the mall. The important thing to note here is that you compare what the situation was like and what it is currently.

(f) A study that examines behaviour of people

Here the study attempts to find out why people choose to do certain things in a particular way. For example, why do certain people prefer to stay in certain wards? Such studies can examine such issues as residential preferences, shopping preferences, recreation, and household movements among many others.

Here is a summary of what we have been discussing. When carrying out your geography project you can:

- study local conflicts
- test a theory
- compare geographical areas and issues
- analyse distribution patterns
- examine change through time
- study people's behaviour.

2.0 A hypothesis

Once you have identified your research problem, the next step is to formulate a hypothesis. A hypothesis is a suggested possible solution to the problem, which you intend to study.

2.1 Formulating a hypothesis

To formulate a hypothesis you need to first discuss your research problem with others so as to get their views on the problem. You may read what others have written about your research problem from the library. For example, if your research problem was on heads of households in your village, you could read and discuss different households in Botswana. Out of this discussion and through reading you may find that women head most of the households. As a result of this general observation, you may also suggest that women head most of the households in your village. Your suggested answer could probably be "most heads of families in the Mokwati village are women." This is a suggestion, which has not been verified, and hence is a hypothesis. It is a possible answer to your research question. Once you have come up with a possible answer, which is known as a hypothesis, you now try to test whether it is correct or not. If it is correct, you adopt it and if it is not correct you reject it. In a research project, you may have sub hypotheses, which help you to find out if your major hypothesis can be adopted or rejected. The sub hypotheses are tentative answers to your problem. Now do the activity given below.



Activity 3

Boitumelo has identified her research problem as “Factors that determine the rate of production in the Batsamai shoe manufacturing industry in Kanye”. What possible hypothesis would you formulate for her research problem?

Feedback

There are many possible correct answers to this problem. A possible hypothesis could be formulated as one of the following statements.

- A high demand for shoes increases production in the factory
- Employee satisfaction increases production in the factory
- A shortage of raw materials reduces shoe production in the Batsamai factory.

Any similar hypothesis you may have formulated is acceptable.

2.2 Characteristics of a well formulated hypothesis

The hypotheses given above are just examples. You should note, however, that a good hypothesis must have the following attributes or features.

- **It should not contradict existing knowledge.** Your hypothesis must always be in agreement with the generally accepted ideas. In other words, it must agree with what other people say. For example, there would be no point in formulating a hypothesis, which says there is no relationship between wages and residential areas because obviously you can't stay in a place whose rent you can't afford. It will be a waste of time to try and test such a hypothesis.
- **It must predict the relationship between variables.** By the way, a variable is a characteristic that can assume a range of values. For example, in the hypothesis “temperature decreases with height (altitude)”, the variables are temperature and height (altitude). This means that the hypothesis will test the relationship between temperature and height. If a relationship is established, it means any change in altitude will affect temperature.
- **It should be testable.** A testable hypothesis is one that can be verified. This means that information can be gathered which can support or reject the hypothesis. If a hypothesis is true then, whenever such a study or experiment is carried out using the same method under similar conditions similar results should occur.

Example 4

Study the following hypotheses and determine whether they are testable or not.

- Akanyang tries to start his car in the morning and it fails to start. Akanyang suggests a hypothesis that **the car failed to start early in the morning as punishment for his sins**. Is this hypothesis testable?

This type of hypothesis cannot be verified. It is not testable.

On the other hand is the following hypothesis testable?

- Akanyang’s car fails to start in the morning. He suggests a hypothesis: **the car failed to start because the battery is dead.** He can actually test the battery and see if it is working or not. If he finds that the battery is not dead, he can reject the hypothesis and if he finds that the battery is indeed dead he can adopt the hypothesis as correct.

Therefore Akanyang’s second hypothesis is testable.

For a hypothesis to be testable, it must relate variables that are capable of being measured. It is not possible in Akanyang’s first hypothesis to practically relate his sins with the power of the battery to start a car!

Do Activity 4 to get practice on testable and untestable hypotheses.



Activity 4

Which of the following hypotheses in the table is testable? Explain your answer.

Hypothesis	Can it be tested?	Explanation
1. There is a relationship between poverty and crime.		
2. An increase in the number of industries result in a decrease in the number of unemployed people.		
3. There is a relationship between democracy and development.		
4. There is a relationship between employment and mode of transport.		
5. There is a relationship between type of housing owned and level of education attained.		
6. There is a relationship between shopping behaviour and the level of education.		

--	--	--

Feedback

I hope you noticed that all the above hypotheses are testable but you would probably find a lot of difficulties with measuring poverty, democracy and development. These ideas (concepts) cannot be measured directly; they can only be measured through indicators. For example, you may measure poverty by the number of meals people have per day! The number of meals in this case is an indicator of poverty or you may use wages and salaries of the bread earners as indicators of poverty. At this stage I advise you not to make hypotheses, which are difficult to measure. Stick to those, which are easy to test.

2.3 Why a hypothesis?

The following paragraphs explain the importance of formulating a hypothesis as a first step in undertaking a research.

- The hypothesis is important in that it helps you to select the important variables and test them. For you to be able to make a hypothesis on shoe production, you must have knowledge of the industrial processes, which determine the production of shoes. You need to select the important variables and test them. In the example on shoes given above, the variables selected were shoe production, employee satisfaction, demand and availability of raw materials.
- A hypothesis will also help you by indicating the procedure to be followed and the type of information (data) to be collected. We shall deal with this in more detail later in the next lesson.
- A hypothesis will help you to arrive at an answer to your solution because when carrying out research, you cannot test a question but you can test a hypothesis. This will become clear to you as we proceed.
- When you are carrying out your research do not try to prove that your hypothesis is correct. You must either accept it or reject it on the strength of the evidence you have gathered from the research.

As a reminder, remember, we said that a hypothesis:

- is a suggested possible solution to a problem being investigated
- should not contradict existing knowledge
- predicts the relationship between variables
- should be testable
- indicates the procedure to be followed and the data to be collected
- can also help in directing the interpretation of data collected.

2.4 Types of hypotheses

The type of hypothesis, which we have discussed so far, is called the **experimental or research hypothesis**. These are statements about the relationships one expects to find as a result of the research. It may be a statement about the expected differences or relationship between the variables in the study. These hypotheses are developed from either observation or reading.

Another type of hypothesis is known as a **null hypothesis**. It is called a null hypothesis because it says that there is no difference or no effect or no relationship between variables. A null hypothesis states the opposite of what the researcher expects to find. If proved correct, it is rejected and the experimental hypothesis, which was formulated with it, is accepted instead.

Example 4

“There is a significant difference between temperatures in the windward and leeward slopes.”

“There is no significant difference between temperatures on the windward and leeward slopes.”

The first hypothesis is an **experimental hypothesis**. It is the same as the examples which you have been doing above which suggest what you hope to find out.

The second hypothesis: “There is **no** significant difference between temperatures on the windward and leeward slopes” is an example of a null hypothesis. After carrying out the study this hypothesis may be rejected and the alternative experimental hypothesis adopted which, in this case it would be “there is a significant difference between temperatures in the windward and leeward slopes”.

Sometimes a null hypothesis is written as (H₀).

A null hypothesis enables researchers to compare their findings with chance expectations through statistical tests. If the tests show that the difference or similarity most probably did not occur by chance, then the null hypothesis is rejected in favour of the experimental hypothesis. Only a null hypothesis can be tested through statistical procedures.

3.0 The Research Design

Once you have formulated your hypothesis, you now proceed to decide what procedures you need to follow in order to effectively test your hypothesis. This description of the procedures to be followed when testing a hypothesis is usually referred to as a **research design**. At this stage, you will probably need to know only two research designs: the experimental research design and the survey research design for you to effectively carry out geography research projects.

3.1 Experimental research design

In geography, you may need to carry out simple experiments under controlled conditions as illustrated in Figure 8. For example, you may want to compare the porosity of (how fast water goes through the) soils in different parts of your field. You may collect samples and take them to your home and find out how fast water passes through each of the soil samples from your field or you could ask permission to use the laboratory in the secondary school close to your home. This exercise can be better done through an experiment and observation.

Name -----

Age-----

Sex-----

Marital status_-----

Qualifications-----

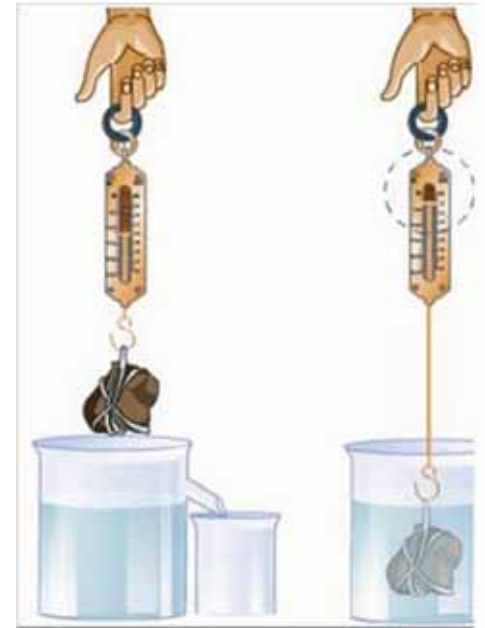


Figure 8: Carrying out an experiment

(Source

[:http://image.tutorvista.com/content/gravitation\)](http://image.tutorvista.com/content/gravitation)

It is important to understand that the research design, which you select, is determined by the hypothesis, which you are trying to test. Thus, if your hypothesis suggests conducting an experiment then you have to carry out an experiment in order for you to answer the question. We will discuss more about carrying out experiments in geography in the next lesson.

3.2 Survey research design

A very popular research design, which you need to know about, is the survey research design. This research design seeks answers to current topical issues such as population distribution structures, behaviours and effects of newly introduced issues by asking structured questions written on a form known as a questionnaire (see Figure 9).

Figure 9: A simple questionnaire

The survey research design is applied to samples of populations in order to discover the incidences, distribution and interrelationships among variables. For example, you may want to find out the population composition in your village. In this case, you would not need to check on the whole village population. You would select only a few and use the information to make generalisations about the whole population. Note here, I have already emphasised that the design is determined by the research problem and the subsequent hypothesis. In this case, can you carry out an experiment to find out the population structure of your village? No! However, you can use the survey research method to make a generalisation.

Here are some of the main types of survey research designs:

- the descriptive survey
- the evaluative survey
- the comparative survey and
- the correlation survey.

(a) The descriptive survey

The descriptive survey design collects information in order to help describe the issues as they are at the time. This type of survey can be carried out to describe for example, population composition, shopping trends and vegetation transects, housing patterns among many others. The important thing to note here is that figures are collected and used to describe issues as they are. There is very little or no control of the issues under study. You will learn more about a descriptive survey in the next lesson.

(b) An evaluative survey

It describes how well an activity has been done. In some cases it seeks to measure the effectiveness of newly introduced elements into an organism or social or economic structure. The evaluative survey tries to show the changes brought about by the introduction of the new element. For instance, a student may try to find out how successful a cleanliness campaign has been. S/he may try to find out changes in people's attitudes towards waste disposal after the cleanliness campaign. "Are people still carelessly throwing away litter?" "Have they changed their attitude towards personal hygiene?" The information collected can be used for improving the implementation of future cleanliness campaigns.

(c) A comparative survey

In a comparative survey, the researcher compares information collected from different geographical locations with similar conditions or data collected from the same place at different times. For example, a student may carry out a comparative survey of traffic congestion during the lunch hour on

the Mandela Highway and the Western bypass in Gaborone. After collecting information, s/he can compare the traffic density on both roads.

(d) A correlation survey

A correlation survey attempts to find relationships, which can be used to predict trends in particular situations such as in production lines in industries and population trends.

Example 5

Tuelo carries out a survey of shoe production at Dithaku Shoe Factory by recording the number of shoes produced over a period of ten years. She observes a constant annual increase of about 10%. She uses this information to predict the annual shoe production at Dithaku Shoe Factory for the next two years.

Now, do the activity given below which asks you to decide on the research design you would use to test a given hypothesis.



Activity 5

Fill in the research design, which you consider as suitable for testing the given hypothesis.

<i>Hypotheses</i>	<i>Research Design</i>
1. Sedimentary rocks break up into silt.	
2. The Khama Crescent has more congestion during the peak hours than Nyerere.	
3. There is a relationship between shopping behaviour and type of employment among shoppers.	
4. The distribution of shops declines with distance from the city centre.	
5. Alluvial soils are more porous than clay soils.	

Feedback

You probably remembered that the experimental design is suitable mainly for those hypotheses, which can be solved under controlled conditions. It also allows for the identification of casual relationships. In some cases a control experiment is also used. The survey is suitable mainly for those studies, which do not need controlled conditions. If you followed these arguments, you should have gotten the following answers.

1. *experimental design*
2. *survey*

3. *survey*
4. *survey*
5. *experimental design*

4.0 Summary

Now let us go over some of the main points that you have learnt in this Topic.

- You learnt that a research problem is what you set out to study. Remember we said that your research problem must be researchable and must be clearly defined. It must also be a geographical issue.
- Once you have identified your research problem, formulate a hypothesis if possible. Remember, we said a hypothesis is a possible, suggested answer to the research problem. Its use is to guide you in selecting a research design. It can also be used when analysing data and in drawing conclusions. It is also the mechanism used for testing whether our suggestion is correct or not. There are two types of hypotheses: the experimental and null hypotheses. Do you still remember the difference between the two? If you have forgotten, read Section 2.0 again.
- Once you have formulated your hypothesis, think of a suitable research design. Remember, a research design is the procedure, which you will follow in order for you to test your hypothesis.



Assignment

5.0 Assignment 2

Instructions

- (a) Answer all the questions in the spaces provided.
- (b) You may spend about 30 minutes on this exercise.

Section A: How much do you remember? [16 marks]

1. What is a research problem? [2 marks]

2. Give your own example of what you consider to be a good research problem. [3 marks]

3. Mention any **three** characteristics of a good research problem. [3 marks]

4. Mention any **three** areas of research in geography. [3 marks]

5. What is a hypothesis? [2 marks]

6. Write out **one** example of a null hypothesis. [1 mark]

7. Mention **two** types of research designs. [2 marks]

Section B: How much can you do? [5 marks]

Think of a problem in your locality. Write it as a research problem. From the research problem, formulate a hypothesis and a sub hypothesis.

Total [20 Marks]

When you have finished check your answers at the end of the unit

Topic 3 Data Collection

Introduction

By now you ought to know how to formulate a well-defined topic for study. You are almost ready to collect data relating to your topic. What you need now is to identify different methods of collecting data and decide on your sources of data. In this topic you will learn how to use different methods of data collection and how to carry out sampling procedures in a geographical research.

Topic Objectives

At the end of this topic you should be able to:

- design and prepare a simple questionnaire, an interview schedule and an observation sheet
- select and use suitable sampling procedures in carrying out your fieldwork.

Topic Contents List

1.0 Methods of collecting data

- 1.1 Questionnaires
- 1.2 How to construct a questionnaire
- 1.3 Caution when constructing questionnaire
- 1.4 The interview
- 1.5 Conducting an interview
- 1.6 Advantages and disadvantages of an interview
- 1.7 The observation sheet

2.0 Sampling

- 2.1 Methods of choosing a sample

Resources

In this topic you will need a lined sheet of paper and a pencil to practise drawing observation charts. If you cannot find these you should not worry as you can still do the topic using the space provided.

Activities

There are activities in this topic. Do all of them as they are meant to help you to understand the lesson. As in the previous lesson, feedback is given in *italics* immediately after the activity. Once again at the end of the topic there is an exercise for you to do. The answers are given at the end of the unit.

1.0 Methods of Collecting Data

Collecting data simply means collecting information, which you will use for testing your hypothesis.

If you collect data on different soils in your village by actually going out and collecting and comparing different soil samples, you are collecting information directly from its source and this is called **primary data** and your source is called **primary source** of data. If you collect data from what others have written, you are collecting **secondary data**. Thus, getting data from books, official statistics, letters and other written documents gives you secondary data. In geographical research projects, you are encouraged to use both methods of data collection.

In order for you to collect data you need instruments to collect and to record your data just as you would need a ruler to measure the length of your sheet of paper! There are three main instruments used for collecting data when doing fieldwork in Geography and these are: a questionnaire, an interview and an observation sheet. Each of these instruments is discussed in the next part of this lesson.

1.1 Questionnaires

The word questionnaire means a form, which is used for collecting information from a person who is giving the information (the respondent). The form filled in at the hospital for example, is a type of a questionnaire. It is made up of a set of questions, which are all logically related to the central problem, which you are investigating. Some of the questions are asked such that they are only a few alternative ways of answering them, and others leave room for a variety of answers. These are referred to as structured or open-ended items respectively.

Example 1

1. A structured question

“Are you employed?” Yes/No (Tick the correct response)

2. An unstructured question

“Give suggestions for the improvement of the education system in your district.”

1.2 How to construct a questionnaire

There is no rigid format for constructing questionnaires. The important thing is to make it such that it collects data, which is required by your study. There are six question formats, which should serve as models for you when constructing your questionnaire: filling in blanks, multiple choice, comment on, list, rank, and Likert scales.

- (a) Filling in blanks

This format asks a question and leaves a blank space for the response. The stem should be a complete sentence rather than a phrase.

Example 2

Has tourism had a good effect on Kasane? _____

Note the respondent is expected to answer either yes or no.

- (b) Multiple-choice

These are questions, which are similar to the fill in the blank type, except that the respondent is given

a list of answers from which to choose.

Example 3

How often do you come shopping in Mahalapye?

- Occasionally _____
- Weekly _____
- Monthly _____
- Annually _____

In this case the respondent is required to either tick or encircle the suitable response from the given list. This type of question is easier to administer and to analyse but if you use it make sure that the choices cover the required variety of responses.

(c) Comment on filling in blanks

This type of question is similar to the one that leaves a blank space. It tries to get a lot of information on a particular issue and therefore leaves space for comments.

Example 4

To what extent has Kasane gained from tourism?

While a lot of information can be gathered using this type of question, it is often very difficult to analyse. Use it mainly when carrying out an in-depth study.

(d) List

Asking a respondent to list things is a good way of finding out views in an unbiased manner. The respondent thinks of answers without being given a list from which to choose.

Example 5

List three major reasons why you buy your goods in this particular shop.

(e) Rank ordering

In this type of question you ask the respondent to put a list of things in their order of importance. It seeks to know the opinion of the respondent.

Example 6

Rank in order of importance, the following reasons for buying your goods from this particular shop:

- | | <u>Rank</u> |
|--|-------------|
| • Goods are cheap | — |
| • It is near my home | — |
| • The staff are friendly | — |
| • There is a large variety of products | — |

(f) Likert scales

The Likert Scale is one of the most useful question forms. The scale is named after Rensis Likert who developed it in 1932. In this question, the respondent is presented with a sentence and asked to show

how much s/he agrees with the statement on a five point scale of strongly agree, agree, undecided, disagree and strongly disagree.

Example 7

For each of the following statements tick the box which indicates the extent, to which you agree or disagree.

Statement	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
Increase in tourism is beneficial to Chobe					
Tourists increase pollution in game reserves					
Tourism brings foreign currency to countries					

1.3 Caution when constructing questionnaires

When constructing your questionnaire, take note of the following.

1. Start with simpler easier items, which will not antagonise your respondents.
2. Phrase your questions clearly and courteously.
3. Do not make questions, which demand too much intelligence and knowledge.
4. Your questionnaire should not be too long.
5. The items should not try to find out about other people’s secrets.
6. A brief, persuasive statement stating the purpose, and importance of the research exercise should accompany your questions.
7. Remember to thank your respondent for his/her contribution.

1.4 The interview

There are two main types of interviews – the **structured interview** and the **unstructured interview**. A structured interview or schedule is a questionnaire, which is administered by the researcher verbally. S/he asks questions, which have already been prepared and records the responses of the respondent who answers orally.

An unstructured interview is whereby the interview takes the form of a conversation without prior

preparation. It is open-ended allowing the respondent to explain in greater detail than would be the case with a questionnaire. This type of interview is difficult to conduct and the data is difficult to classify and quantify. You are well advised to use the structured interview



Figure 10: Conducting an interview

(Source:<http://farm4.static.flickr.com>)

1.5 Conducting an interview

Talking to somebody is a very easy task yet conducting an interview requires skill. An interview is a social interaction, see Figure 10 above and therefore the interviewer has to create an atmosphere of friendship with the informant. As an interviewer, you must begin by making an appointment at a date and time convenient to the respondent so that s/he can give you honest and open answers. Sometimes speaking to an informant before the actual interview may help create an atmosphere of friendship.

While carrying out the interview, avoid being judgmental, giving clues and showing expressions of approval or disapproval. The interview itself must not be longer than at the most, thirty minutes. A long interview is likely to tire the person being interviewed and create tension. It would be best to hold an interview with one interviewee at any one time.

1.6 Advantages and disadvantages of an interview

Although interviews are used in research to obtain vital information, they have some advantages and disadvantages compared to other methods of collecting data.

(a) Advantages

- You can use an interview with people who cannot read or write.
- It provides immediate answers.

- It is flexible and allows you to make changes where necessary.
 - An interview gives you a chance to observe the respondent.
- (b) Disadvantages
- The respondent may not feel comfortable to give certain answers in your presence.
 - The respondent may try to please you by giving you misleading answers that she/he thinks are the answers you are expecting.



Activity 1

You want to conduct a survey on the impact of tourism on the environment in and around Chobe village. Design a questionnaire, which you would administer verbally for collecting data from both tourists and the local people in and around Chobe.

There is a variety of ways in which you can formulate the questionnaire. Yours could be similar to one of mine given below. Yours does not need to be exactly the same as the example given below but the general idea should be the same.

Feedback

Your questionnaire will probably look like the sample given below.

Questionnaire Sample

We are conducting a survey on the impact of tourism on the environment around Chobe. I would greatly appreciate it if you would assist me by answering a few questions.

1. Sex male/ female

2. What is your age? _____

3. Why are you in Chobe? _____

I am: a local
a foreigner
a tourist
other (specify) _____

4. How long have you been in Chobe?
less than one week
1-2 weeks
3-4 weeks
more than four weeks

5. Tourism has had financial gains in Chobe. Do you agree? yes/no

6. Tourism has increased littering. Do you agree? yes/no

7. Comment on the effects of tourism on wildlife in Chobe.

Thank you for your time.

Figure 11 Sample of a questionnaire

This questionnaire is just an example. What is important is that your questionnaire must retrieve the information, which you require.

1.7 The observation sheet

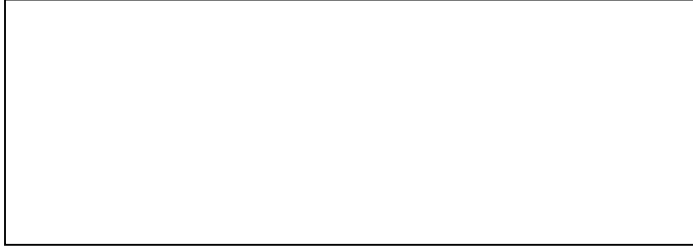
When you are going to collect data through observation you can construct and use an observation sheet. The example given below shows an observation sheet used by a student for recording traffic responses to a newly constructed zebra crossing for pedestrians in a road point, which is very prone to accidents. You can make your own observation sheet similar to the example given below.

An observation sheet

Place of observation: _____ Time: _____

Date of observation: _____

Sketch Map



An observation sheet must show the trait that is being observed and time when the observation was made. Whenever the observed trait appears, quickly record it in the observation sheet. Recording must be done while the trait is still being observed.

Tallying is a fast method of recording, which can be used when observing, using the observation sheet.



Activity 2

There is a lot of traffic congestion along the Khama Crescent during the morning rush between 8:00 and 8:30 am. You want to investigate the traffic density and compare it to the lunch rush and off peak periods. Prepare an observation sheet, which you could possibly use for collecting data for comparing the three observation periods.



Feedback

If you recalled the explanation given in Section 1.6 above, you should have found this activity straightforward. The following is how I handled the activity; see if it is similar to yours.

Most probably your observation sheet looks like the one given below:

An observation sheet

Place of observation: *Khama Crescent* Time: *8:00 am – 8:30 am.*
Date of observation: *8 June, 2001*

Sketch Map

Vehicle observed	Morning Rush	Lunch Rush	Ev
Buses			
Trucks			
Taxis			
Private sedans			

Figure 12: Sample of an observation sheet

2.0 Sampling

When collecting data it is sometimes difficult to investigate every item with the relevant characteristic in the target population. In such cases social researchers examine only a limited number of items with similar characteristics to the target population. The group of items selected for investigations are known as a **sample**. The process of selecting this group to be studied is called **sampling**.

A sample becomes necessary when the target population is too large. For example, it would be very difficult for a student to carry out a research project including all the people in the village. Instead of investigating everybody, the student would most probably select a sample. The sample size is often determined by the availability of resources such as money and time in which to complete the project. In most cases the funds are inadequate and this restricts the size of the sample. However, if the resources are readily available the sample may be bigger. This is desirable because a large sample gives more accurate results than a smaller sample. You are advised to select samples, which can be done within the time and other resources available to you.

2.1 Methods of choosing a sample

There are two main methods of sampling used in geography. These are **probability** and **non-probability** sampling. Probability samples include among many others, simple random sampling, systematic sampling and stratified sampling. Non-probability samples include convenience sampling, quota sampling and purposive sampling.

The choice of a particular sampling method depends on the type of data needed, the structure of the population from which the sample is to be selected and the objectives to be met. The resources available also determine a sample and the precision wanted.

Let us examine each of these methods of sampling.

(a) Simple random sampling

In this method each unit in the target population has a chance of being selected. By affording all units an equal chance, bias is eliminated. For instance when carrying out a household survey a student may select the sample by first writing out all the house numbers in the ward on pieces of paper and then putting all the pieces of paper in a hat and then randomly picking the required number of households. For random sampling to be effective there has to be a complete list of the population from which the unit will be randomly selected.

Sometimes instead of using random points you may use randomly selected lines such as streets, avenues or transects. Here, what is randomly selected is the line. For example, you may decide to investigate the type of housing along a particular randomly selected street. Sometimes you may choose to randomly select small squares called quadrants instead of lines or transects. A quadrant is just a square, which is subdivided into small units, which can be used to measure the population of the characteristic under study.

(b) Systematic sampling

In this method, the units are selected in a systematic manner in a clearly set pattern from a population list. The starting point however, is randomly selected. For instance, if a sample of 100 is required from a population of 500, every fifth element can be selected while any number between 1 and 5 is selected randomly. This method can be applied to point, line and quadrant sampling.

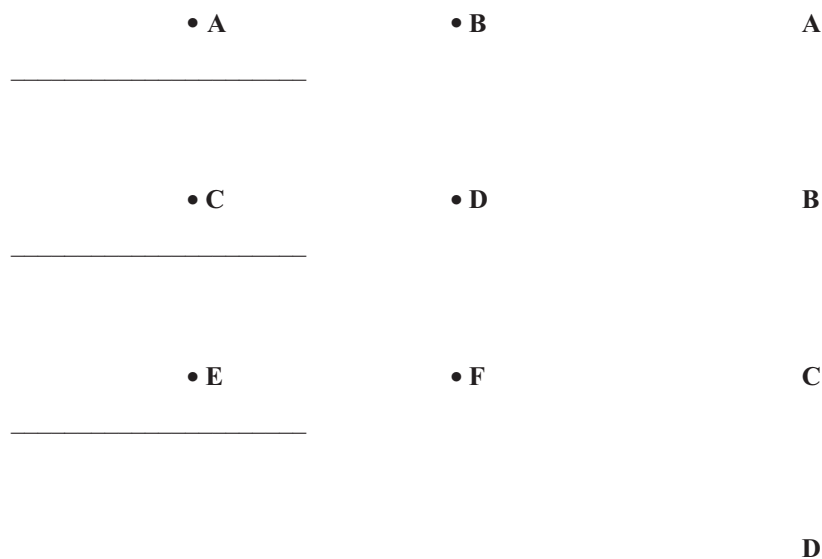


Figure 13: Systematic points

(c) Stratified sampling

With this method, the population is classified into groups possessing similar characteristics. A population for instance, can be classified according to sex, age groups, ethnic groups and racial groups. You can use the method with points, lines or with quadrants when doing physical geography studies.

(d) Non-probability sampling

Some social scientists maintain that researchers often resort to the use of non-probability samples because they are cheaper to carry out and less complicated than others. These have the disadvantage of being non-representative. The most widely used non-probability sampling method is convenience sampling. This involves selecting the nearest items to serve as subjects of investigation. This process is carried out till the required number of units has been attained. The method is applicable to points, lines and quadrants.

3.0 Summary

In this lesson you learnt about the primary and secondary sources of data. The primary sources being those which are the original sources of data and the secondary being those, which have been compiled by others. You also learnt how to construct a questionnaire, interview schedule and an observation sheet. A questionnaire is a form, which is used when collecting data. Its items can be in the Likert Scale, comment, rank, list, multiple-choice or fill in blank type of questions. You also learnt about sampling procedures. Sampling was defined as choosing representative elements for a population with similar characteristics. The methods discussed were random point, line and quadrant sampling, the stratified point, line and quadrant sampling. You also learnt about convenience sampling where you choose the most convenient sample.

You can now complete Assignment 3 and thereafter check your answers with those provided at the end of the unit. If some of your answers are incorrect review the relevant section before moving onto the next topic.



4.0 Assignment 3

Instructions

This particular assignment is meant to help you consolidate your understanding of data collection. You did the practical application in the examples.

Answer all the questions in this exercise. You may take 30 minutes to do this exercise.

1. Mention two types of data, which can be collected in a research study. [2 marks]

(i) _____

(ii) _____

2. What is a questionnaire? [1 mark]

3. Explain the differences between a questionnaire and an interview. [2 marks]

4. Mention any four types of questioning methods, which you can use when constructing a questionnaire. [4 marks]

(a) _____

(b) _____

(c) _____

(d) _____

5. Mention any four disadvantages of using an interview when collecting data. [4 marks]

(a) _____

(b) _____

(c) _____

(d) _____

6. What is sampling?

[1 mark]

7. Mention any three methods of random sampling, which you can use in your fieldwork.
[3 marks]

(a) _____

(b) _____

(c) _____

(d) _____

Total = [20 marks]

Check the correct answers for the exercise at the end of this unit.

Topic 4: Data Presentation

Introduction

In the previous topic you learnt how to collect data. Can you still remember the sources of data? We said these were primary and secondary sources of data. You also learnt how to construct instruments, which you can use, for collecting valid data and these included the questionnaire, the interview and an observation sheet. In this lesson you will learn how to present the data you have collected. This is a step in which all the data collected is now presented such that it can be easily understood. There are many methods of presenting data. Some of the most common ones used by students in geography include a sketch map, diagrams, flow charts, tables, graphs, histograms, pyramids, and scatter-grams. In this lesson we will discuss mainly the common ones used when presenting social, economic and physical aspects of geography.

Topic Objectives

At the end of this topic, you will be expected to be able to:

- present information using maps, diagrams, flow charts, tables, graphs, histograms, pyramids and scatter-grams
- interpret data presented
- draw conclusions based on the data presented.

Topic Contents List

1.0 The Sketch map

2.0 Diagrams

3.0 Presenting statistical data

3.1 Classification and tables

3.2 The do's and don'ts of tabulating data

4.0 Graphs

4.1 Bar charts

4.2 Line graphs

4.3 Circular bar graphs

4.4 Pyramids

4.5 Pie charts

4.6 Triangular graphs

4.7 Maps and photographs

4.8 Flow line maps

4.9 Scattergrams

5.0 Analysing data

5.1 Descriptive tabular analysis of data

5.2 Steps in analysing tabular data

5.3 Observation analysis

5.4 Document analysis

6.0 Summary

7.0 Assignment 4

Resources

In this topic it is important that you read some of the suggested references, as they will certainly help you to understand the lesson better. The references have been included at the end of the topic. You will also need a map of your local area, a tape measure and an observation chart.

Activities

As in the previous topics, there are some activities for you to do. You have to do them for practice. At the end of this topic there is an exercise meant to test your understanding of the whole topic. If you find that you cannot do the exercise it means that most probably you did not understand the topic. You will then need to review the topic until you are confident enough to do the exercise.

1.0 The Sketch Map

In geography fieldwork, one of the basic methods of presenting data is through the use of a sketch map. The sketch map is a roughly drawn map that you can draw to locate the area under study. You can also use it to show land use, type of vegetation and settlement distribution. A sketch map can also show spatial relationship, that is, the positions of things in relation to each other as shown in figure 10 below:

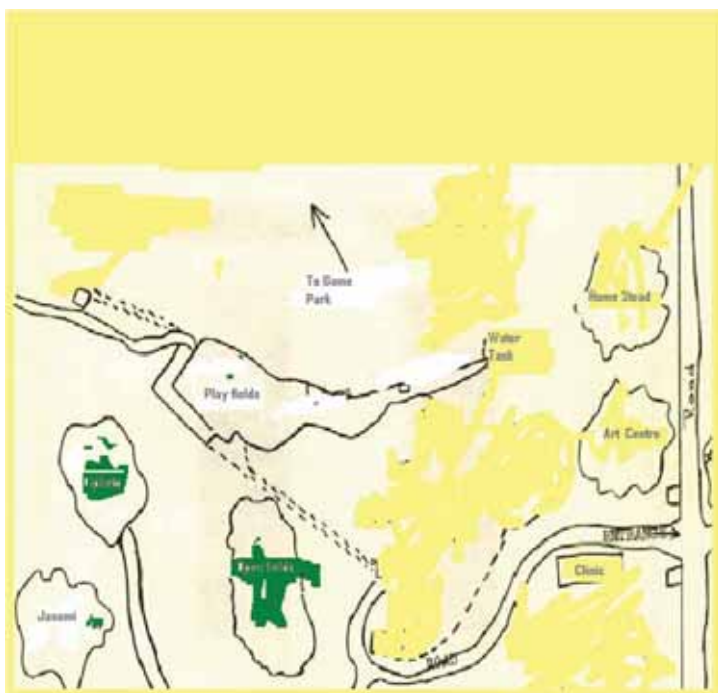


Figure 14: A typical sketch map

When drawing a sketch map try and take the following into account:

- The shape of the map must be a fair representation of the location under study
- Use conventional symbols used in atlases and other types of maps
- Include a key in your sketch map
- Use shading for showing different aspects of your map.



Activity 1

Draw a sketch map of your locality showing the land use patterns.



Feedback

As long as your sketch map is fairly accurate, has a frame, a title, direction north, a key, and you have used conventional symbols, then your map is probably correct. You can show it your tutor at the study centre for comments.

2.0 Diagrams

You can present information in the form of diagrams. Diagrams are drawings that are labelled and help to explain things. Maps, plans, cross sections, flow charts, graphs and pie charts are all diagrams. We have already looked at a sketch map and you have already learned about topographic maps. In

this section let us concentrate a bit on cross-sections. We have already learned about a transect when dealing with sampling procedures. A transect is a form of cross-section. A cross section is what a thing would look like if it were sliced in half.

When you cut a slice of bread in the morning what you see after removing the end face is a cross section! A cross sectional diagram will show you the shape of an object, as in the example below.

Example 1

The cross-section of a volcano is cone shaped.



Figure 15: A typical cross-section of a volcano

(Adapted from <http://thumbs.dreamtime.com/thumb>)

A cross-section can also show different parts of a feature as shown in the diagram above. Sometimes a section can show land features and types of vegetation along a transect as shown in the diagram below:

Cistus villosus
Eumano arabica
Hel. obt.

Path

Path

Asphodelus
microcarpa

Hyoscyamus h'



Figure 16: A vegetation transect

Diagrams are most useful and appropriate when presenting settlement patterns.

Diagrams are also used to present human-made objects that are of geographical interest. Examples are the blast furnace in which iron ore is smelted and the steel furnaces where steel is made.

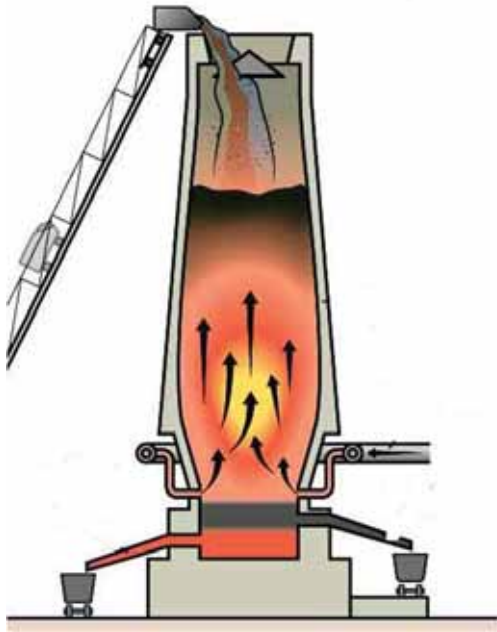


Figure 17: A blast furnace

(Adapted from solar navigator.com)

The above diagram presents iron smelting. If you use a diagram like the one on iron smelting you must always discuss and explain what it is showing.

Flow diagrams are especially used to present data on the processing of raw materials or the manufacture of an industrial product. Cross-sectional diagrams may be used at each stage or simply a rectangle with the process of each step written in them may be used.

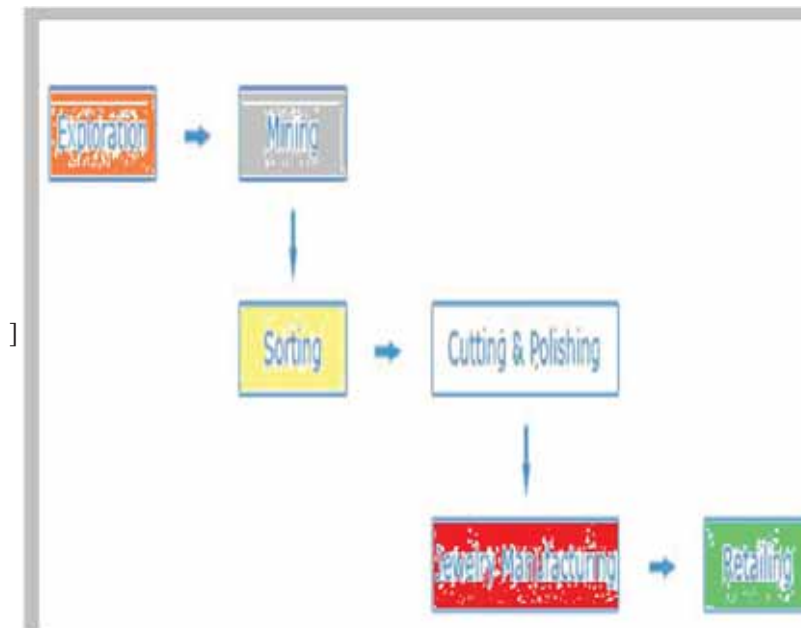


Figure 18: A typical process flow chart

These diagrams, as in figure 18, give you a step-by-step explanation of the process. The following are some important facts to consider when drawing diagrams:

- The shape must be a fair representation of the real thing
- Diagrams must be large and neat
- Labelling must be clear and kept in a horizontal line
- There must always be a title
- Where necessary, shading can help you to show differences
- Diagrams must be accompanied by a discussion.

3.0 Presenting Statistical Data

Statistics means the data collected in figures (quantitative data). Statistics is usually presented in tables, graphs, bar charts, pie charts or scatter grams.

3.1 Classification and tables

The first step after collecting your data is to arrange it such that it forms meaningful patterns (**classification**) and then present it as a table. Study the example given below:

Example 2

Let us suppose that a student doing research interviews twenty patients at Athlone Hospital in Lobatse to find out the most common disease treated in ward 105. She/he records the following information:

“Tuberculosis, tuberculosis, dysentery, tuberculosis, malaria, malaria, malaria, malaria, malaria, cancer, cancer, diarrhoea, malaria, malaria, dysentery, kidneys, malaria, malaria, cancer, cancer”

You obviously notice that it is very difficult to grasp and interpret the information. It is also very difficult to pick out a pattern or a relationship from this raw data. It would also be very difficult to remember this type of data. But, if we bring all the items with common characteristics together the data becomes easier to grasp, interpret and understand. Look at the same information given in the table after items with common characteristics have been brought together.

Types of Diseases	Number of patients
Tuberculosis	3
Malaria	9
Dysentery	2
Cancer	2
Diarrhoea	1
Kidneys	1
Total	20

Table 2: Common Diseases in Ward 105 at Athlone Hospital

The bringing together of items with common characteristics is known as classification. There are four main methods of classification. These are:

1. **Time based** classification as in: per minute, per hour, per day, per week, etc.
2. **Geographical** based classification as in: ward, district, province, country, etc.
3. **Qualitative based** classification as in: sex, ethnic groups, race, nationality, etc.
4. **Quantitative based** classification as in: temperature in degrees Celsius, height, length, etc.

After the information has been collected and classified, arrange it such that the patterns, connections, and relations can be clearly seen at a glance. Arranging information in the form of a table is called tabulation. Tabulation helps to make the information easier to process visually and mentally.

In your Geography course, you are expected to use simple tabulation as data presentation. This

consists mainly of entering in the variables and the number of times they appear (frequency). In this case the diseases are the variables and have been entered in the column entitled “types of diseases”. The number of patients has been entered in the frequency column.

3.2 The do’s and don’ts of tabulating data

In placing data into tables there are precautions that have to be taken. These are:

- Classify the collected material according to common characteristics
- Make a rough draft taking into account the layout of rows and columns
- Name all the columns and rows
- State all units of measurement
- Explain all symbols used
- Underline all totals and important results
- Be neat.

4.0 Graphs

Graphs are specially drawn diagrams that have a vertical line called the y-axis and a horizontal line called the x –axis.



X and Y axis

Graphs can either be in the form of a bar as in a **bar chart** or a line as in a **line graph**. At times they use **points** like in the case of a **scattergram** or pictures as in a **pictogram**. Let us examine a few samples of these graphs.

4.1 Bar charts

This is a graph, which presents data in the form of bars. It is sometimes referred to as a **histogram**. These can be seen visually. Differences and similarities also stand out allowing for easy comparisons.

This is one of the most effective methods of presenting numerical data. It makes use of an x and a y-axis on which there is a scale and labelling of the measurements that we are interested in. Study the example given below:

Example 3

The table below shows land with different crops at Farm 45 in the Barolong Farms recorded by a geography research student.

Types of crops	Land under cultivation (hectare) (ha)
Maize	25
Sorghum	15
Millet	10
Beans	5
Peas	5
Total	45

Table 3: Land under cultivation at Farm 45

To present this information on a bar chart first draw your x and y-axis. On the x-axis evenly space vertical bars of the same width. Then mark out a proportionate height to the crop acreage of each of the crops. A suitable scale should be used to represent each unit. For example, 1cm represents 5 hectares. Thus, the height of the column for maize using this scale would be 5cm. Look at the bar chart drawn using the information collected from Farm 45.

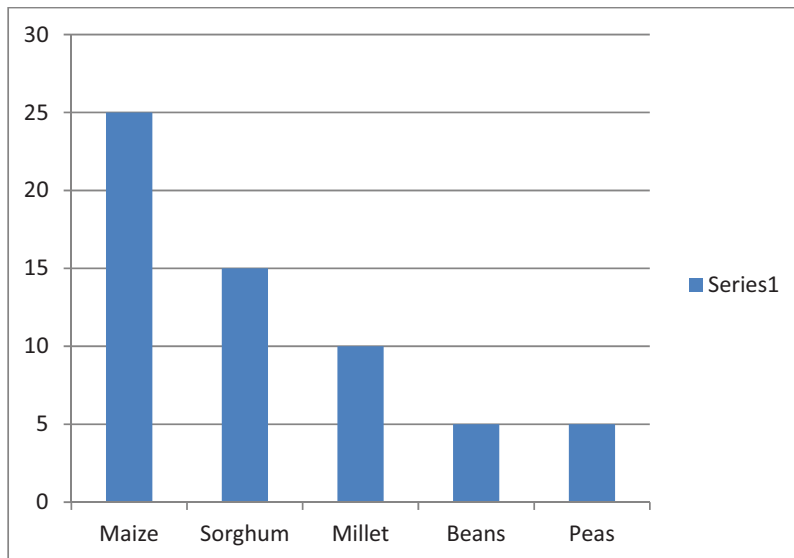


Figure19: Bar chart showing land use at Farm 45

Make sure that your bar chart is well labelled, shaded and has a key.

The advantage of the bar chart is that you can clearly see the distribution of the variables. For example, maize clearly covers the largest acreage in Farm 45. Each bar allows you to immediately see the quantity and the item it represents.

4.2 Line graphs

The line graphs are drawn on a squared paper to a certain scale. It also needs the x and y-axis. On the horizontal axis you record the independent variable and on the vertical axis the dependent variable. The independent variable is the variable that you manipulate in an experiment and the dependent variable is the observed result. For example, when comparing time and temperature, time is more constant because it varies in constant increments. The dependent variable is the one that changes as in our case, temperature. To clearly understand how to present your data using a line graph carefully study the example given below:

Example 4

Kagiso records temperature at Lobatse weather station over a period of seven hours using an observation sheet. Part of his observation sheet is shown after seven hours and it looks like the one given below:

Time (hours)	Temperature ($^{\circ}$ C)
8.00	15

9.00	12
10.00	10
11.00	11
12.00	16
13.00	20
14.00	25

Table 4: An observation sheet for temperature recordings from 8:00 am to 2:00 pm at Lobatse.

To draw a line graph using figures from the above table follow these steps.

1. Draw a horizontal and vertical line axis on squared paper. Label the horizontal y-axis and the vertical x-axis.
2. Choose a scale that will fit the size of your paper.
3. Show the time scale on the horizontal axis and the temperature figures on the vertical scale. Start the vertical scale from zero. Plot each reading on the graph and join the points with a ruled line.



Activity 2

Use the figures and the instructions above to draw a line graph showing temperature over a period of seven hours at Lobatse. Use the gridded space below.

Feedback

If you have followed the three steps mentioned above, you should have gotten the graph right. Your graph probably looks like the one I have plotted below.

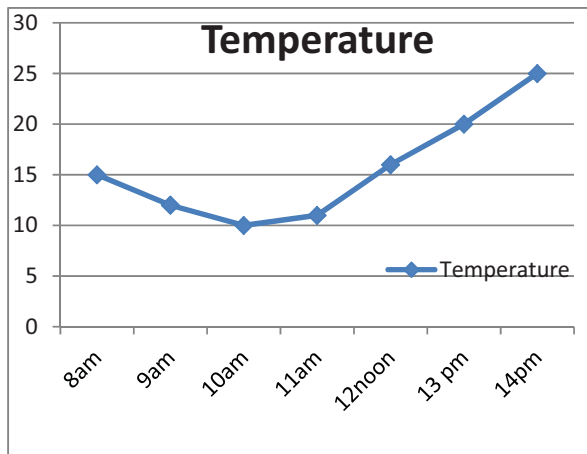


Figure 20: A line graph showing Temperature recorded at Lobatse

A line graph can easily be used to present developmental trends. It can therefore be used in presenting such aspects as increase or decrease in temperatures, production, sales of goods, population, hospital admission and enrolment patterns in many institutions. The line graph is also very important when showing growth patterns in living organisms.

Sometimes line graphs are shown together with the bar chart. This is particularly common with temperature and rainfall where temperature is shown as a line graph while rainfall is shown as a bar graph as shown in the diagram given below

4.3 Circular bar graph (The wind rose)

A circular bar graph is just like bar graph except that it shows the occurrence of a phenomenon from different directions. Its most popular use is in presenting wind direction in a wind rose. The wind rose is a graph, which shows how often the wind blows in a particular direction and can be shown for a week, month or year. Here is an example of a circular bar graph.

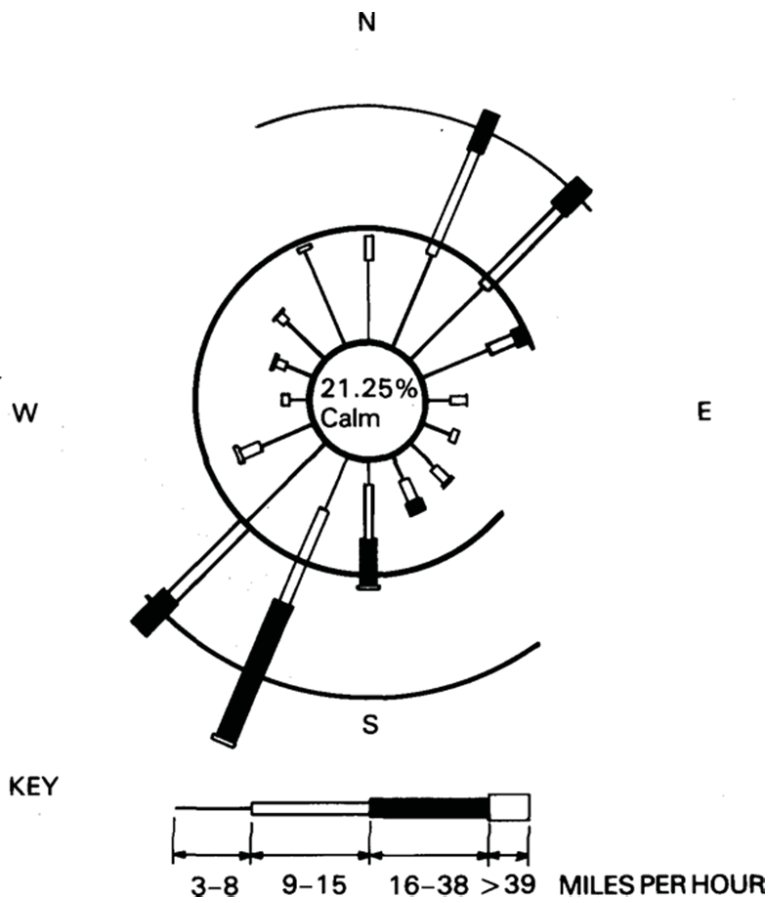


Figure 21: A Wind rose (Adapted from <http://www.fao.org/dosep>)

For traffic density, a similar presentation is used whereby the thickness of the line represents the density of the traffic. However, the representation principle remains the same.

4.4 Population Pyramids

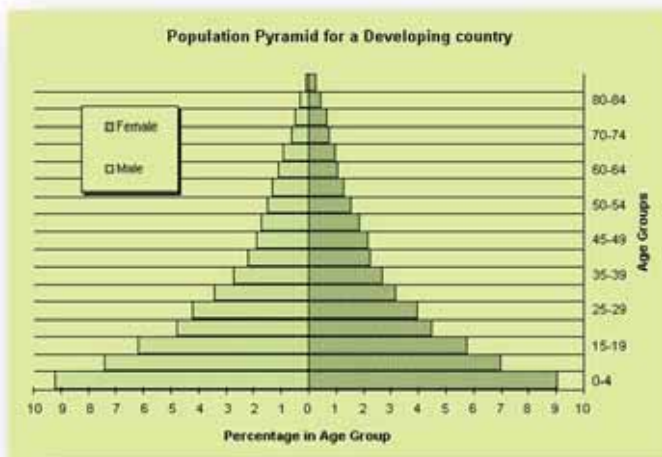


Figure 22: A typical

population pyramid

The pyramid is mainly used when presenting population statistics. It is formed by two horizontal bar graphs that are presented side by side. The age-sex graphs when presented side by side often look like a pyramid and hence the name **population pyramids**. An example is given below:

The population pyramids are used to present the population structure. The population pyramids present the population as the total number of males according to their ages in one graph and a total number of females according to their ages in the other graph. The graphs are put side by side to allow for comparisons of the two groups.

4.5 Pie charts

This is another commonly used method of graphic presentation. Its purpose is to show the component parts of the total. Proportionate sectors of a circle are used to represent data. We calculate the angle of each sector at the centre of the circle by working out the proportion it bears to the whole. See the table given below.

Crops	Hectares	Calculation of Angle at centre	Degrees
Maize	25	$25 \times 360/60$	150
Sorghum	15	$15 \times 360/60$	90
Millet	10	$10 \times 360/60$	60
Beans	5	$5 \times 360/60$	30
Peas	5	$5 \times 360/60$	30
Total			360

Table 5 Calculating the angle at the centre

After calculating the angle at the centre, use a pair of compasses to draw a circle using a suitable radius, which will make your circle, fit into your page. Then use your protector to mark out the angles at the centre. Finally, mark out the sectors as shown below in figure 23.

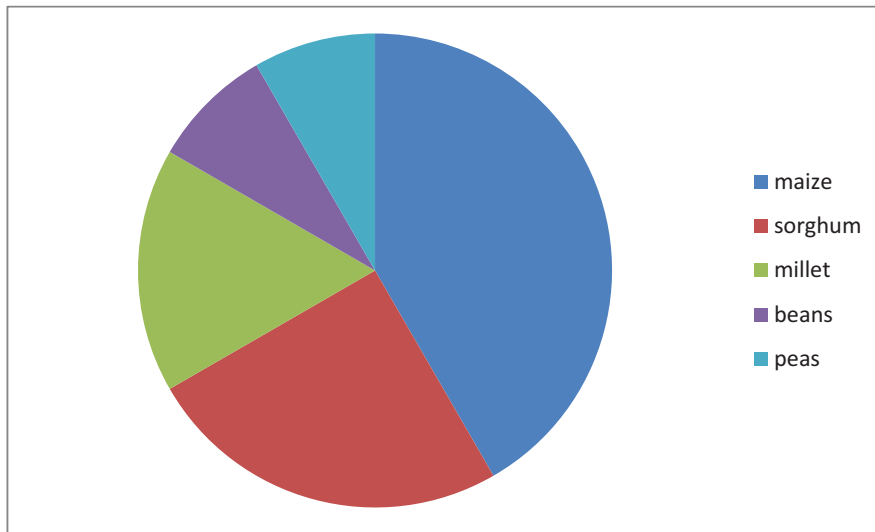


Figure 23: A pie chart showing land under crop cultivation in Farm 45 at Barolong

The chart presents information such that it can be easily seen as a whole. The different sectors can be clearly seen in relation to each other. Comparison is therefore easy.

4.6 Triangular graphs

These are graphs that are used to show data that can be divided into three parts. This usually includes such data as soil (sand, silt and clay), employment (primary, secondary and tertiary) and population (young, adult and elderly). The diagram below shows a triangular graph of soil texture. The data must be in the form of percentage and the percentage must total 100%.

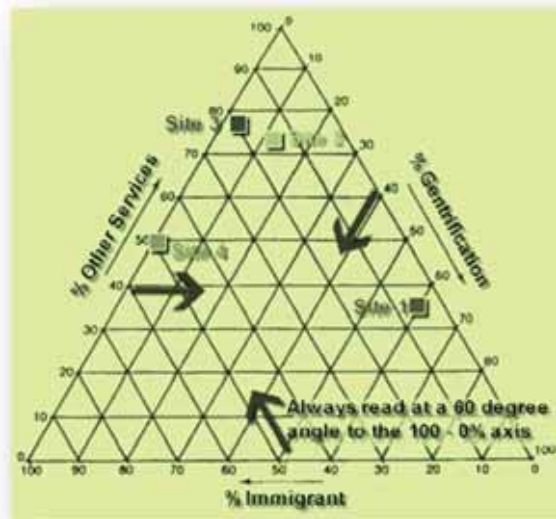


Figure 24: A typical triangular graph

The main advantages of triangular graphs are that:

- a large number of data can be shown on one graph
- groupings are easily recognisable
- classification can be shown
- dominant characteristics can be shown.

4.7 Maps and photographs

Maps and photographs can also be used to present data on the geographical areas from which the information was collected. For showing data different shading or colouring can be done. You will deal with maps in more detail in Unit 2.

4.8 Flow-line maps

Flow-line maps show the volume of movement between places. An arrow indicates direction. Varying the thickness of the line shows the volume of moving objects.

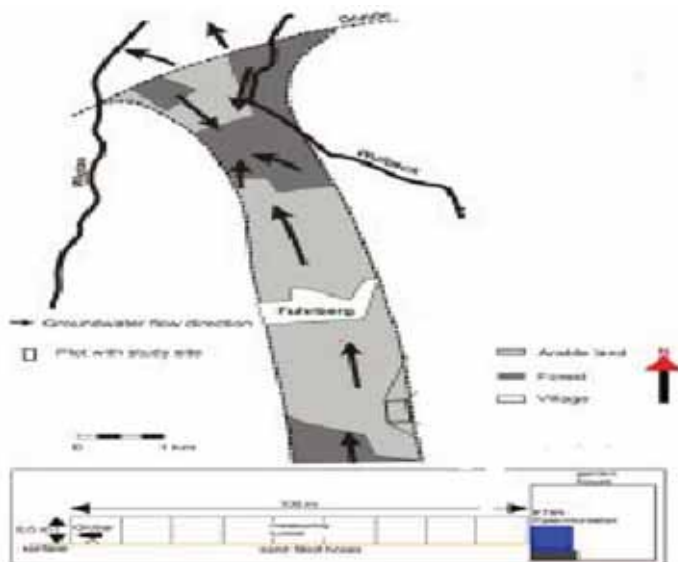


Figure 25: Flow-line map of traffic

The map must have a key. The range of thickness must be carefully selected and the background information must be kept as simple as possible.

4.9 Scatter-grams

For correlation studies you may present your information using scatter-grams. These are graphs, which show how variables correlate. To correlate means to change in relation to another variable. Correlations show relationships. They just identify relationships but not causes.

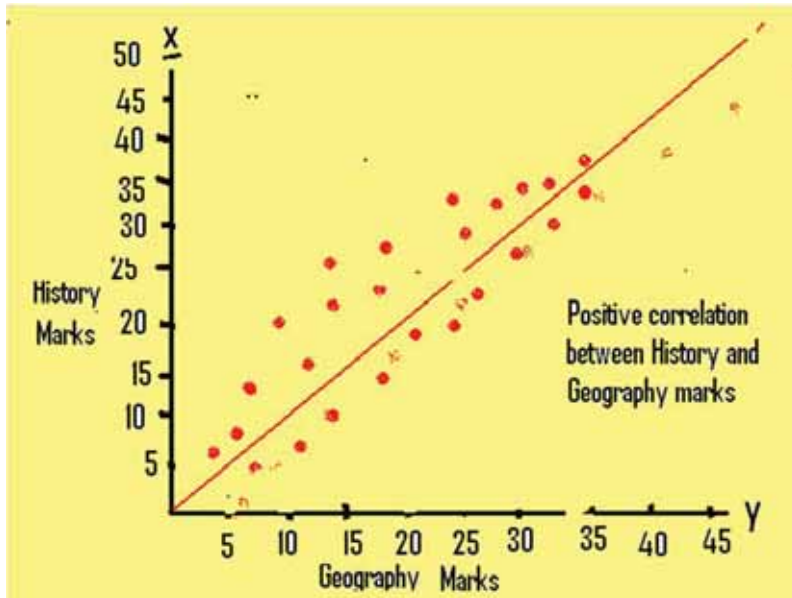


Figure 26: Diagram of a scatter-gram

It is not always easy to calculate correlations. However if you have access to a computer you can use it to calculate correlations.

5.0 Analysing data

Analysing data means giving meaning to the data presented. After presenting your data you need to now explain what your data is showing. Data analysis depends on the type of data collected. We need therefore to briefly discuss types of data analysis to enable you to be able to interpret your data meaningfully.

There are many types of data analysis but for the purposes of our Geography course we shall only discuss (a) Descriptive tabular analysis (b) Documentary content analysis (c) Observation.

5.1 Descriptive tabular analysis of data

This means examining tables, graphs, and charts for relationships and patterns. To be able to meaningfully analyse tabular data, you must know at least the basic elementary concepts of statistics such as averages, the mean mode and median and simple percentages. These are important in making comparisons and analysing data.

Mean

This is the common average and is calculated by adding all the items and dividing by the number of items.

Example 4

The number of shirts produced in Clothe Yourself Factory from January to October 2000 was:

Month	J	F	M	A	M	J	J	A	S	O
Sales	80	60	50	50	70	40	50	90	70	40

The total number of shirts produced was 600. To calculate the mean, divide 600 by 10, which is the number of items. The mean is 60. You can then say the average number of shirts produced per months was **60**.

(b) Median

When items are arranged in the order of their size starting with the smallest or the largest, the value of the item in the middle is called the median.

Example 5

A geography student records the ages of people shopping at Score supermarket as:

15year, 12 years, 16 years, 19 years and 12 years. S/he arranges these in order starting with the smallest one.

12, 12, **15**, 16, 19

The middle item is **15**. Therefore, the median age is 15. This is important if the extremes are unknown. It will at least show you the central tendency.

(c) Mode

The mode of a discrete (single data) distribution is the most frequent or popular item on the list.

Example 6

A student carrying out a survey at a roadside makes the following recordings:

Mode of transport	Trucks	Sedans	Buses	Lories	Motor cycles
Number	25	13	3	50	1

The **mode** was **50** since the most frequent users of the road were the lorries. The student can now say which of the vehicles uses the road most. The student has used the mode to make a descriptive analysis of road users.

(d) Percentages

Simple percentages can be used for making comparisons. A percentage simply means a score out of a total of 100. Most mathematics texts will show you how to calculate simple percentages.

5.2 Steps in analysing tabular data

It is sometimes difficult for beginners to analyse tabular data. However, the following steps (Adapted from Abdellar and Levine, 1963 pp. 379 – 381) may act as a general guide to help you.

1. Start by examining the aims of your project. Examine each aim individually and where possible, change them to questions.
2. Identify and list all data presented (in graphs, tables, maps, etc.) under each of your aims.
3. Take each graph, table or chart under each aim and carefully check and record the following features:
 - the meaning of the title
 - method used for data collection
 - sample investigated
 - the variable being measured
 - variations in totals, averages and percentages
 - relations in variables
 - any patterns
 - frequency of occurrence
 - describe clearly your observations from the given data.

5.3 Observation analysis

You can analyse data by carefully describing your observations. This would be most useful when describing locations, for example, using maps and sketch maps. You can also describe information given in pictures, photographs and diagrams through observation. This method can be usefully used together with tabular analysis to give a broader and richer analysis.

5.4 Document analysis

You can also analyse information from books, official records and government reports. The analysis can be used also in conjunction with the other methods of analysis. It is important to note that detailed vivid descriptions can enrich your project and enhance the findings arrived at using other methods.

6.0 Summary

In this lesson you learnt how to present and analyse data. You learnt how to present data using sketch maps, graphs, flow charts and pictures. Remember, for our course it is important that you present your data in many different ways. It is also advisable that you interpret each presentation. Do not just present data without interpreting it. Data analysis, we said was a way of giving meaning and identifying patterns in our data. The main methods, which you need to use in your geography research work, are descriptive statistics, document analysis and observation analysis. Again, use all the methods to enrich your interpretation.



Assignment

7.0 Assignment 4

Instructions

- (a) Answer all the questions in this exercise
- (b) Time allocated is about 40 minutes.

1. What is a sketch map? [1 mark]

2. Name any three characteristics of a sketch map. [3 marks]

(i)

(ii)

(iii)

3. Draw a sketch map of your village. Show the major features such as hills, river, roads and settlements.

(a) a cross section

(b) a transect

(c) a pictorial flow chart

5. Draw a flow chart showing the production of any product that is produced in your area. You may need to discuss this with your study group mates.



6. Using the information from the hospital sheet given below, draw a bar graph showing the type of diseases common at Nyangabwe Hospital for the month of June.

[9 marks]

Tuberculosis	30
Malaria	10
Dysentery	40
Cancer	5
Diarrhoea	55
Kidneys	5

7. Explain the following terms used in descriptive statistics.[3 marks]

(a) Mean

(b) Mode

(c) Median

Check for sample responses as the end of the unit. I have deliberately left out the allocation of marks because what is important here is for you to understand and apply the skills that you have learnt.

Unit summary



Summary

In this unit you learned the following main points.

Data analysis, we said was a way of giving meaning and identifying patterns in our data. The main methods, which you need to use in your geography research work, are descriptive statistics, document analysis and observation analysis.

Research is an organised way of collecting information either to solve a problem or to get new information. There are two types of research, basic and applied research. When carrying out a research, you need to:

- first identify a problem area
- find out more about the problem to be investigated
- decide on the method of collecting data
- present your information and then
- interpret the data and draw conclusions.

When carrying out research you need to observe ethics such as getting the consent of your respondents, honesty, right to confidentiality, respecting your participants' time and being courteous to them.

A research problem is what you set out to study. Remember we said that your research problem must be researchable and must be clearly defined. It must also be a geographical issue.

Once you have identified your research problem, formulate a hypothesis (a possible, suggested answer to the research problem). There are two types of hypotheses, the experimental and null hypotheses. Do you still remember the difference between the two?

Once you have formulated your hypothesis, think of a suitable research design. Remember, a research design is the procedure, which you will follow in order for you to test your hypothesis.

Types of data sources can be classified under primary and secondary sources. The primary sources being those which are the original sources of data and the secondary being those, which have been compiled by others.

Common methods of data collection include questionnaire interview and observation.

Sampling is defined as choosing representative elements for a population with similar characteristics. The methods discussed were random point, line and quadrant sampling, the stratified point, line and quadrant sampling. You also learnt about convenience sampling where you choose the most convenient sample.

Data collected can be presented using sketch maps, graphs, flow charts and pictures. Remember, for our course it is important that you present your data in many different ways. It is also advisable that you interpret each presentation. Do not just present data without interpreting it.

Data analysis, we said was a way of giving meaning and identifying patterns in our data. The main

methods, which you need to use in your geography research work, are descriptive statistics, document analysis and observation analysis. Again, use all the methods to enrich your interpretation.

The assessment that follows below will help you to apply what we have discussed in this unit. No answers are provided. You are expected to benefit from the discussion of assessment with your group mates and your tutor.

Before you move on, let's try this short activity:

Imagine that there is a problem of littering around a shopping complex or mall. You wish to carry out an investigation into this problem. Based on what you have learned:

- (i) Formulate a research topic for your investigation
- (ii) Give two aims of your research.
- (iii) Suggest two hypothesis for your topic.
- (iii) Give any two problems, which you might encounter in carrying out your research

Discuss your answers with your peers and with your instructor or tutor.

Assessment



Assessment

1. Identify a problem in your community and write a topic that reflects that problem.
2. Why do you think the problem is worth investigating?
3. What do other people say about the problem?
4. How do you intend to go about collecting information relating to the problem?
5. After collecting your data, how do you intend to analyse it?
6. Explain how you will present your findings.
7. Identify a problem in your village. Carry out a research project on the identified issue. Make recommendations on how the problem can be solved. Discuss your project with your study group mates and you tutor.

Answers to Assignments

Answers to Assignment 1

1. Research project is an organised way of collecting, presenting, analysing data and drawing conclusions based on the data collected.
2. Applied and the basic research projects.
3. Any researchable topic related to location, spatial distribution or any geographic topic.
4. I would:
 - (a) identify a problem area and formulate a research topic.
 - (b) select a research design.
 - (c) decide on the method of collecting data.
 - (d) present and analyse the data.
 - (e) draw conclusions.
5. One can:
 - (a) gain new knowledge.
 - (b) develop skills of investigation.
 - (c) develop interpretation skills.
 - (d) develop skills for decision making.
6.
 - (a) Informed consent
 - (b) Right to withdraw
 - (c) Honesty

Answers to Assignment 2

1. A research problem is the area, which the investigator sets out to study.
2. Any example that is researchable, focused, can be done within a limited time and does not need too many resources.
3. Some of the characteristics of a good hypothesis are that it must express a relationship between two variables, it must be testable and it must also point to the method of collecting and analysing data.
4. A study:
 - (a) of the conflicts in the locality.
 - (b) that tests theory.
 - (c) that compares geographical characteristics of places or issues.

- (d) that analyses distribution patterns.
- (e) that examines change through time.

(Any **three** of these would be correct.)

5. A hypothesis is a suggested answer to a research question.
6. Any hypothesis, which states that there is no relationship between variables, should be taken as correct.
7. The experimental and survey research designs.
8. Any problem that has been clearly stated, hypothesis suggested and method given in line with what you have learnt should be acceptable.

Answers to Assignment 3

1. Primary and secondary data.
2. A questionnaire is a form consisting of questions, which is used for collecting data.
3. A questionnaire is usually structured while an interview is not tightly structured to allow for clarification and more questions to be asked by the person carrying out the interview. A questionnaire is usually posted while the interview is verbal and is carried out face to face with the respondent. The responses in a questionnaire are often written on the form. In an interview, a tape recorder can be used to record the responses or notes can be simply taken using a pen and a notebook.
4. They include any of the following; filling in blanks, multiple choice, rank ordering, comments, listing, and the Likert Scale items.
5. The advantage of using an interview is that:
 - it can be used with people who cannot read or write .
 - immediate answers are given.
 - allows for changes.
 - the respondent can be observed.
 - clarification can be sought.
6. The process of selecting a representative sample.
7. Random point sampling, random line sampling and random quadrant line sampling.

Answers to Assignment 4

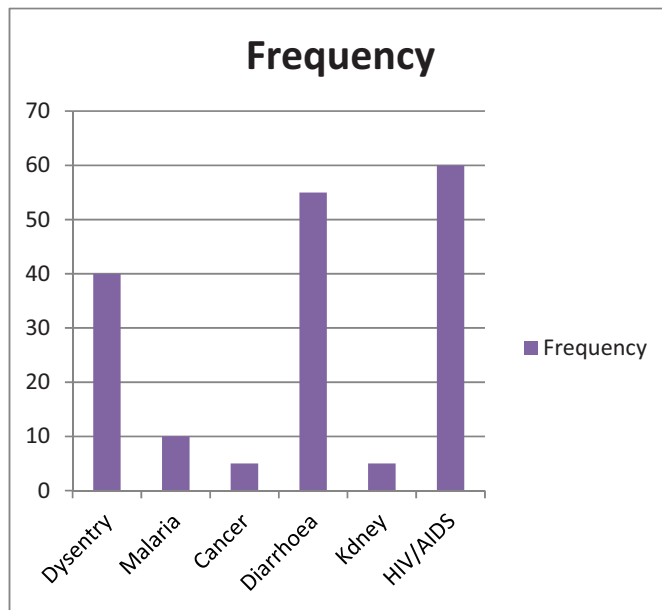
1. A sketch map is a roughly drawn map that is used to locate the area under study.
2. It should have any of the following: a frame, a title, a key, the north direction, and conventional symbol.
3. (a) A cross-section is what a feature would look like if it were sliced across. It is sometimes

known as a profile.

- (b) A transect is a line drawn across any geographical feature.
- (c) A pictorial flow chart is a diagram that shows the stages of a process in the form of pictures.

4. Your sketch map should have a key and the direction north. Refer to Map reading in Unit 2 of the course.

5. Your bar chart should look like this one.



6. Any flow chart showing a process in the manufacture of any product is acceptable. However, if you are not comfortable with what you have drawn check with your study tutor.

- 7
- (a) The mean is the average calculated by adding all the items and dividing by the number of items.
 - (b) The median is value of an item, which is in the middle of a set of values when they are arranged in their ascending or descending order.
 - (c) The mode is the most frequent item on the list

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Unit 11

Agriculture: Arable and Pastoral Farming

Introduction

Welcome to Unit 11 of your Geography course. The unit is about Agriculture. As you have already learnt in your JC or BGCSE Agriculture courses, Agriculture is an important sector of Botswana's economy. It is the backbone of the rural economy in Botswana and many other African countries. It also plays an important role in the lives of people in urban areas.

Just take a moment and think about where the food we eat everyday comes from. Imagine what people in the rural areas and cattle posts do every day. How about those in farms? Why do or should you have a vegetable garden in your backyard? From all these questions and many more, you would realise that there is no single person who does not get affected by Agriculture in one way or another.

You may also be wondering why we discuss Agriculture while you are studying Geography. Well, think about it! In the course introduction you learnt that Geography helps you to know how human beings and their environment interact. Doesn't Agriculture do the same? Hence it is important to study Agriculture even in subjects like Geography.

As we have mentioned before, this unit is about Agriculture. In it, you will learn about arable and pastoral farming as practiced in Botswana, Southern Africa and some other parts of Africa. The unit consists of eight (8) topics as outlined below.

Topic 1 will introduce you to arable farming but focusing on Botswana. The next two topics will discuss Botswana's arable farming at subsistence and commercial levels respectively. Our case studies under commercial farming (Topic 3) include Tuli Block (Talana Farm) and Pandamatenga farms. Note here that we do not use a case study for subsistence arable farming as it is practiced country wide. Topics 4 and 5 then take us to the wider region, where we shall study plantation agriculture, particularly, sugar in Natal (South Africa) and cotton in the Gezira (Sudan).

In Topics 6 and 7, we address another branch of Agriculture; namely pastoral farming. You may call it pastoralism or animal husbandry or livestock farming. Pastoral farming involves the rearing of animals and in this unit we will concentrate on the rearing of cattle in Botswana. Our last topic, Topic 8, will then discuss future prospects of arable farming in Botswana and evaluate the impact of government assistance schemes such as: Arable Land Development Programme (ALDEP) and Financial Assistance Policy (FAP) in promoting arable farming. The topic will also discuss the impact of agriculture on the environment.



Outcomes

Upon completion of this unit you should be able to:

- *discuss* arable and pastoral farming systems as practiced in Botswana
- *locate* on a map of Botswana, areas of both arable and pastoral farming
- *discuss* commercial arable farming as practiced in other parts of Africa
- *evaluate* the impact of government’s effort in trying to boost agricultural production through financial assistance schemes
- *discuss* how to practice environmentally friendly agriculture

Teaching and Learning Approach

As you may have noticed in the course introduction, a learner-centred approach is used in teaching this course. This particular unit will incorporate that approach as well. In fact it will emphasise more on your own ability to work out things for yourself and consolidate the knowledge you acquire. To that end there will be case studies, hands on activities, reflection questions, rhetorical questions, group discussions, pair work and other activities employed in order to assist you to learn and understand better. There are also a lot of illustrations that you are required to interpret and even use to answer questions. All these are meant to present the content in a more user-friendly way.

You will notice that content in this unit is predominantly theoretical. Whenever possible, reference is made to your prior learning as a way to assist you to reflect and consolidate knowledge. However, there are topics that contain content which is rather new to you. In such cases, you would note that I have adopted the transmission style of teaching with little reference made to your prior knowledge (except where you are required to reflect on what I have already discussed in the previous sections of the topic).



Terminology

Arable farming:	The growing of crops
Bagasse:	Fibrous waste that result from crushing of sugarcane to extract juice for making sugar
Commercial arable farming:	Growing of crops for sale/cash/market
Communal land:	Land owned by the community
Deforestation:	Permanent clearance of trees or woodland
Dredging:	Removal of silt
Ginnery:	A factory in which machines are used for separating links from the seed

Green revolution:	Introduction of new varieties of seeds and fertilisers which have resulted in remarkable increase in food production
Molasses:	The thick brown syrup which remains after sugar crystals are removed
Ratoon crop:	Cane which grows from the remains of the harvested one
Reforestation:	Replanting of trees in areas which have been cleared of trees or woodland
Sedentary farming:	Settled subsistence farming or a farming system in which the same crop fields are frequently reused over many years
Subsistence arable farming:	Growing of crops for home consumption or growing of crops to meet the family needs
Transhumance:	Seasonal movements of farmers with their animals

Activities

Each topic has some activities in which you may be required to write down answers in spaces provided or to pause and think of an answer. Feedback (answers) is given immediately below each activity. Each topic ends with an exercise, which will help you evaluate yourself on your understanding of the whole topic. These exercises are found at the end of the unit under the Assignment section. They are listed one under the other. Do these exercises to the best of your ability. Answers to these exercises are given at the end of the unit (immediately below the exercises). Do all these exercises and activities since they are an important part of your learning.

At the end of the unit, you will find a tutor-marked assignment (called Assessment) for you to do. It is required that you work on this assessment and submit it to your tutor for marking. Although this assessment does not contribute to your final grade, it is important for you to do it as it will assist your tutor to assess how you are progressing with your course.

Glossary

The meaning of certain words or concepts which you may find difficult to understand is given in a glossary (named as Terminology) above. If you come across a word which is not in the glossary, I am advising you to use a dictionary. If you do not have a personal dictionary, please check for a copy at your study centre, mobile centre or your local library.

Resources

This unit is meant to be self-contained. That is, it is written in a way that it will see you through to your final examinations. However, a list of reference materials is given at the end of the unit. You are encouraged to read some of these resource materials to further your knowledge on the

content covered in this unit. Most of these materials will be readily available at your study centre or in your local library. There may be specific resources required in a particular topic. In such cases, they will be noted in the relevant topic introductions.

Time

Content in this unit has been arranged such that it would take you about 2 hours to complete each topic. As this unit has eight topics, it means that you would require roughly sixteen (16) hours to complete the unit. This does not mean you must rush over the topics. Time spent on each topic will depend on how fast you learn. Make sure that you have fully understood each topic before you proceed to the next one.

You will also need to spare some time to work on assignment and assessment items mentioned earlier. Each assignment should take you about 45 minutes while the assessment should take you about 1 hour 30 minutes. Even though you will not be supervised as you do these activities, try to pace yourself so that you get used to answering questions within a stipulated time. Remember your final examinations will be written within a stipulated time. So, practice!

Topic 1: Arable Farming Systems in Botswana

Introduction

As you have already seen in the unit introduction, this unit is about Agriculture. Furthermore, the unit introduction also mentioned two branches of Agriculture; arable and pastoral. In this topic we shall focus on arable farming. We will discuss the two systems of arable farming, that is, subsistence and commercial arable farming. We will then locate on the map of Botswana, areas where both farming systems are practiced. We will also look at the characteristic features of each farming system and conclude by discussing factors influencing arable farming, again focusing on Botswana.

Topic Objectives

At the end of this topic you should be able to:

- define subsistence and commercial farming
- locate on a map of Botswana, areas of both subsistence and commercial farming
- differentiate between the two arable farming systems
- discuss factors influencing arable farming in Botswana.

To facilitate easy teaching and learning, content in this topic has been arranged as outlined below. I have sequenced the sections and sub-sections such that we move from the broad to specific topics. We conclude the topic by reflecting on what you have learnt by way of a summary, and then test your understanding through a self-assessment exercise.

Contents List

- 1.0 Definition of arable farming systems in Botswana**
- 2.0 Characteristics of arable farming systems in Botswana**
 - 2.1 Subsistence farming
 - 2.2 Commercial farming

3.0 Factors influencing arable farming in Botswana

3.1 Physical factors

3.2 Human factors

4.0 Summary

5.0 Exercise 1

1.0 Definition of Farming Systems in Botswana

In the unit introduction, you learnt that arable farming is a form or branch of agriculture. It refers to the growing of crops. Arable farming can take place at both subsistence and commercial levels. This means that there are two systems of arable farming. These are subsistence arable farming and commercial arable farming.

Before we discuss what subsistence and commercial arable farming systems are, find the definition of the words **subsistence** and **commercial** in your dictionary. Remember in the resources section, we emphasised the need to either acquire a personal dictionary or access one at your study centre or local library!

Now that you have found the meanings of the two words, let us try to define the two farming systems.

(a) Subsistence arable farming

This is the growing of crops for home consumption or the growing of crops to meet the family needs. There are distinct types of subsistence arable farming and you shall learn these later when we discuss subsistence farming in detail. Subsistence arable farming is mainly practised by rural households. In Botswana, it is confined to the eastern and northern parts of the country on communal land. By communal land, we refer to land owned by the community.

(b) Commercial arable farming

It refers to the growing of crops for sale or profit. It is practised on freehold and leased lands which are found in the eastern and northern parts of Botswana. We shall discuss commercial arable farming in detail in Topic 3.

Study the following map (Figure 1), which shows land use and ownership in Botswana. From this map you will learn where arable farming takes place in Botswana.



Figure 1: Land tenure and land use in Botswana

Source: May D. (1998): **Geography of Botswana**

Subsistence arable farming takes place on communal land and commercial arable farming takes place on freehold farming areas (use the map key to identify these areas). According to Figure 1 above, you will also realise that communal land covers the majority of arable farming land in Botswana.

I hope you are able to see the difference between these two farming systems. If not, go back and read the section above. But to further our discussion on the differences between the two systems, let us look at some characteristics of both subsistence and commercial farming in Botswana.

2.0 Characteristic of Farming Systems in Botswana

From the definitions of commercial and subsistence farming systems, you were able to draw some differences between the two farming systems. Let us look at the characteristics of the two systems in detail.

2.1 Subsistence arable farming

Subsistence arable farming in Botswana has the following characteristics:

- The fields are of small size and located near or around the village.
- The fields are either fenced with wire or thorn bushes to prevent crops from being damaged by animals.
- The fields are cultivated year after year. This is known as sedentary or settled subsistence farming.

- Monoculture (growing the same crop in the same piece of land year after year) is mostly practiced but crop rotation may be practised to improve soil fertility and reduce the spread of diseases.
- Farmers use simple farm implements such as hoes, spades, knives, axes etc.
- Farmers depend on family labour.
- Crops produced are mainly for home consumption and the surplus is sold locally.

2.2 Commercial farming

Commercial arable farming has the following characteristics:

- Commercial arable farming may either be **intensive** or **extensive**. **Extensive farming** involves the use of large machinery (mechanised) and a small labour on very large- sized farms. Yields per unit area are lower than optimum.
- **Intensive farming usually involves a large use of labour and capital to relatively small-sized farms**. This type of farming produces high yields per unit area. The two case studies (Pandamatenga farms and Tuli Block-Talana farms) we are going to study later in this topic are good examples of intensive and extensive arable farming in Botswana.
- **Commercial arable farming** requires **large capital investments**. I am sure you are familiar with the term ‘capital’. It refers to money and machinery. Since farms are mechanised, large sums of money are required to buy tractors, harrows, ploughs, planters, cultivators, and harvesting machines. Farm labour must be paid and farm machinery must be well maintained.
- **Commercial farms** use **modern methods** of farming e.g. row planting and crop rotation. This is done to reduce the risk of diseases and soil exhaustion.
Chemical fertilisers, insecticides, pesticides, fungicides are all used to prevent crop damage and increase the yields.

Now that we have discussed characteristics of arable farming, does this help you see the difference?

3.0 Factors Influencing Arable Farming in Botswana

Arable farming is influenced by a number of factors. We shall sub-divide these into physical and human factors. These are as follows:

3.1 Physical factors

These are mainly environmental factors which the farmer has to influence if she or he is to engage in arable agriculture. You have studied some of the factors in Unit 2: Map reading, Unit 3: Weather Studies and Unit 4: Climate. I am going to describe some of them, including some that might be new to you.

(a) Relief

If I may remind you, relief means the shape of the land surface; how flat, hilly, mountainous, swampy etc. the land is.

The ideal relief for most types of arable farming are the flat plains or gentle slopes. Botswana's relief can be described as flat to gently undulating (hilly). It is very difficult to cultivate steep slopes or mountainous areas. Can you think of any major problem that can result from the cultivation of steep slopes? If you have thought of **soil erosion**, then you are absolutely correct.

(b) Climate

Climate, as you already know, has a great influence on any type of plant or crop grown. I am sure you have heard people complaining of crop failure due to climatic conditions. The main climatic factors influencing arable farming are rainfall and temperature. The intensity (amount) and distribution of these factors must always be considered as they determine crop yields.

In order to decide if Botswana's climatic conditions are suitable for agriculture, let us study Figure 2 which shows the distribution of rainfall.

The map (Figure 2), tells us that there are two areas of higher rainfall. Use the key to identify the two areas. These are the northern parts (Chobe/Okavango area) and the south-eastern part around Gaborone and Lobatse. The rest of the country has low rainfall. This means that the country has inadequate rainfall. There is also a great variation of rainfall amount from year to year. The country also experiences both drought and flood periods.

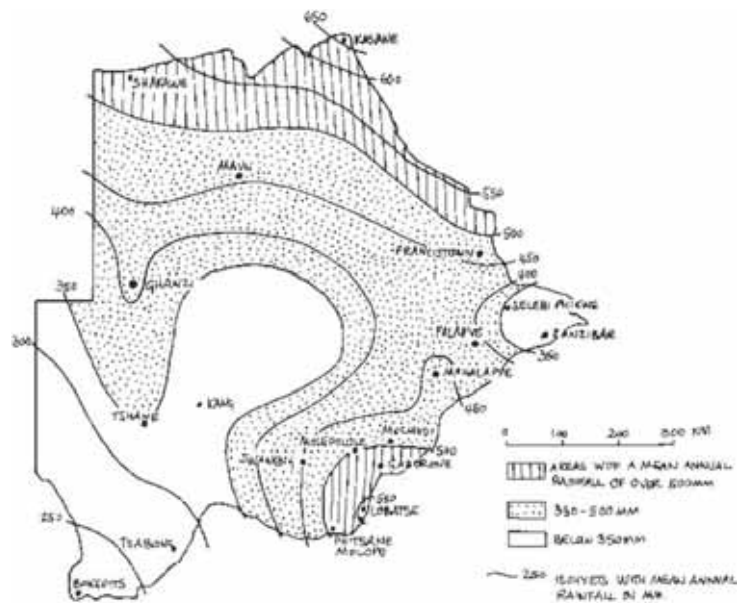


Figure 2: Distribution of rainfall

Source : May, D. (1998) : Geography of Botswana; page 24

The temperature maps, figures 3 (a) and (b) show that there are large differences in temperatures in the country. In Figure 3 (a), you would notice that most areas in Botswana are of high temperatures, that is, over 25°C in summer (January). The other map for winter (July) shows low temperatures over most parts of the country. Therefore, from both maps, we can conclude that the country does not have suitable temperatures for crop production.

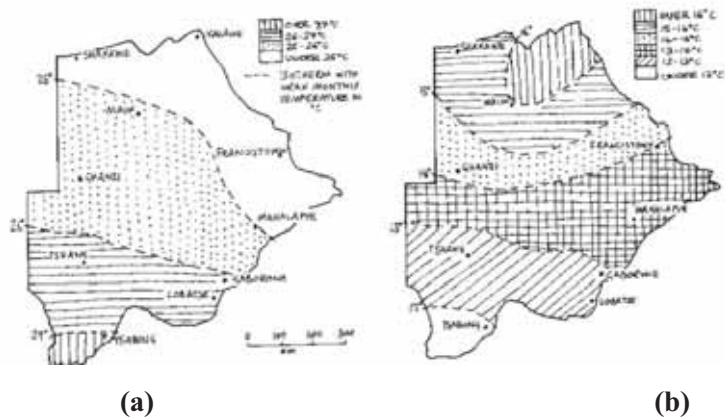


Figure 3: Temperature variation in Botswana

Source: May D. (1998): Geography of Botswana

(c) Soils

Soils are varied in their physical and chemical properties and because of this, their suitability for different crops also vary. Study figure 4, which shows soil types in Botswana.

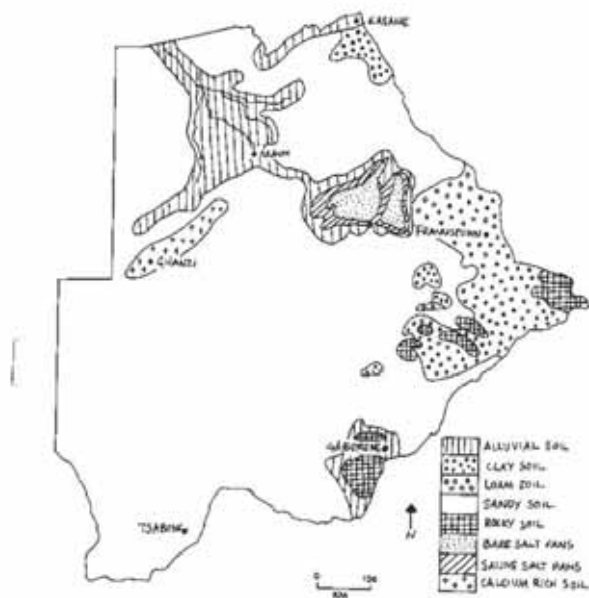


Figure 4: Soil types in Botswana

Source: May D. (1998): Geography of Botswana

Figure 1 shows that arable farming is confined to the eastern parts of the country. From figures 1 and 4, find out the types of soil in areas of arable farming.

When studying the map of soil types, you must have realised that the dominant type of soil is sandy soil. The entire western, central and southern parts of the country are covered by sandy soils that lack plant nutrients and have a poor water holding capacity, that is, it cannot hold water for a long time. Arable farming is more confined to the eastern part of the country because of fertile loam soils. Other parts of the country have fertile soils that are either too wet or saline for the growth of certain crops.

(d) Biotic factors

Crop cultivation may be hampered by the presence of biotic agents such as weeds, parasitic plants, diseases, insect pests, and wild animals. All these cause great damage or destroy crops.

Give examples of biotic agents which affect arable farmers in your area. Do you know any preventative measures to some of these biotic agents? Your response may be a little different, but in Botswana, all types of biotic agents affect arable farming and contribute a lot to low crop yields. Preventative measures include the use of fungicides and insecticides.

3.2 Human factors

Farming is also strongly influenced by a number of human factors. Below we discuss such factors. As you read through the discussion, try to relate the information with what pertains in your locality.

(a) Capital (money and machinery)

Try to think of what farmers would need money for. As you might have rightly said, farmers need money to purchase farm equipments or machinery, seeds, fertilisers, insecticides, pesticides, fencing material and also to pay farm labour and to transport the produce. In commercial agriculture large sums of money are required. Farms which require more capital are said to be capital intensive than those which require less money.

(b) Markets

Earlier in this topic, we defined commercial arable farming as the growing of crops for sale. For selling of crops to take place, there should be a market. But what is a market?

A market is a place or consumers (people) who are able to buy products. People and industries serve as a market for agricultural products. What the farmer decides to produce is greatly influenced by the distance from the market. To make you reflect on the market issue, do the following activity.



Activity 1

There are two farms with varying distances from the market. One farm grows flowers and vegetables while the other farm grows cereals. Which one of the two farms should be located near the market? Give a reason for this.

Feedback

You may have chosen whichever type of crop and given valid reasons for your choice. However, the answer I have chosen is the flowers and vegetable farm, which is also known as market gardening. It should be located near the market because the products are perishable, meaning they can easily get spoiled/rotten over a short period of time. They also don't require large areas of land. Farms which need to be located near the market are referred to as market-oriented. On the other hand, cereals do not get spoiled quickly and can be transported to far away markets safely. As such they do not need to be grown near the market as does the perishables.

(c) Labour

Labour requirements depend on the type of farm or the farming system. Which type of farming system requires paid labour? Your answer should be 'commercial farming'. Some commercial farms are more mechanised, meaning they use more machines and therefore require less manual labour.

Other commercial farms require more manual labour, in other words, they are **labour intensive**. Some farms require labour during certain seasons e.g. during harvesting time. This type of labour is referred to as **seasonal labour**. On the other hand, subsistence farming depends more on family labour or any form of traditional cooperation which will enhance (improve) productivity, for example molaletsa (where a farmer invites others to assist with say weeding and provides them with meals and even some traditional brew).

(d) Land ownership

If there is any farming in your area, ask farmers about land ownership. You will learn that subsistence farming takes place on communal land, that is, land owned by the community. In this land tenure, land is allocated to members of the community by the land board. Commercial farming takes place on freehold or leased land. Under freehold tenure, an individual or a group of people own land, securing their own capital and making profit.

Figure 1 shows land tenure (ownership). Study the map again and try to locate the following freehold areas on which commercial arable farming is practised.

- Tuli Block
- Gaborone Block

- Lobatse Block

Under leasehold tenure, the farmer pays rent to the landlord or land owner. The rent is usually paid in the form of cash or labour. Pandamatenga and Molopo farms are good examples of commercial farming practiced under lease hold tenure. We will discuss more about Pandamatenga farms in Topic 3.

(e) Government policy

A policy is a plan of action or a statement of ideas. Botswana government has its own policy on agriculture. This policy shows the extent and strength of government's interference or control over agriculture. Some countries have policies which compel (force) farmers to produce certain type of crops only, but in Botswana, government interference is minimal, meaning that farmers are free to grow whatever crops they like. Government policy nevertheless, has a great influence on decisions made by farmers.



Activity 2

Study the land tenure map again (figure 1) and suggest **four** reasons for confining arable farming to the eastern and northern parts of the country. Write your answers in the space below.

Feedback

In order to answer this question, you must know the type of land that is ideal for arable farming. In other words, you must know factors influencing arable farming. Since we have discussed these factors, I am sure you have suggested the following:

- *fertile soils*
- *adequate or higher rainfall*
- *mild temperatures*
- *flat plains or gentle slopes*

From Activity 2 and our discussion on factors influencing arable farming, you have learnt that

Botswana is not an ideal country for arable farming. Only five per cent (5%) of the land is suitable for crop production. The rest of the country has low rainfall, high summer temperatures, and infertile soils.

4.0 Summary

In this topic you have learnt that arable farming is the growing of crops. It is practised in Botswana at both subsistence and commercial level. At subsistence level, farmers grow enough crops for the family. The surplus is either stored for future use or sold locally. Commercial farmers produce crops for sale.

We have also discussed both physical and human factors influencing arable farming in Botswana. The physical factors include relief, climate, soils, and biotic factors. Human factors include capital, market, labour, land ownership, and government policy. From the land use map, you have learnt that only a small portion of this country is suitable for arable farming. Arable farming is mainly confined to the eastern and northern parts of the country, which have fertile soils and higher rainfall.

Now that we have introduced the two types of arable farming, Topic 2 will focus on subsistence arable farming in Botswana. But before you move on, do Exercise 1 under the Assignment section to check your understanding of the topic. As stated in the unit introduction, work on the questions without referring to the study unit so that you can reliably gauge your level of understanding. Then check your answers against the suggested answers given at the end of the unit.

Topic 2: Subsistence Arable Farming in Botswana

In Topic 1, you were introduced to the arable farming systems as practised in Botswana. You also located on a map of Botswana areas of subsistence arable farming. In Topic 2, we shall focus on subsistence arable farming. We shall discuss activities involved in this farming system, problems experienced by subsistence arable farmers and their possible solutions. This will then be followed by a discussion of commercial arable farming in Topic 3.

Topic Objectives

By the end of the topic you should be able to:

- list inputs and outputs of subsistence arable farming
- discuss processes and activities involved in subsistence arable farming
- discuss problems experienced by subsistence arable farmers in Botswana
- discuss possible solutions to problems faced by subsistence arable farmers in Botswana

Topic Contents List

- 1.0 Subsistence arable farming in Botswana**
- 2.0 Processes and activities involved in subsistence farming**
- 3.0 Crops produced by subsistence farmers**
- 4.0 Problems faced by subsistence arable farmers in Botswana**
 - 4.1 Environmental factors
 - 4.2 Economic factors
- 5.0 Solutions to problems facing subsistence arable farming**
- 6.0 Molapo cultivation**
- 7.0 Summary**

1.0 Subsistence Arable Farming in Botswana

You already know the definitions of subsistence arable farming and where it is practised in Botswana. What percentage of the population do you think practises this farming system? From your JC Agriculture, you must have remembered that the correct answer is '75%'. This percentage mainly comprises of the rural households. I am sure you have seen small fields in or around villages in Botswana.

If you come from the rural part of Botswana, you would surely have been to the fields or passed by a field one day. But even if you come from urban areas, there are fields along major roads connecting even cities and towns to the villages. Most of these fields are used for subsistence arable farming.

In Botswana the type of subsistence arable farming practised is known as sedentary or settled subsistence arable farming. In this farming system, the crop fields are frequently reused. The community cultivates the same crop fields every year. After this topic, try to find out how long farmers in your community have been cultivating their fields. You will definitely learn that some crop fields have been cultivated over a period of 30 years. Again, in this type of farming, methods of tillage are more advanced and crop rotation is practised. Some farmers, however, still use primitive (backward) methods of farming. e.g. hand broadcasting and simple implements (tools) like hoes and axes.

2.0 Processes and Activities in Subsistence Arable Farming

The following account on Mpho's family from Phalane village will help you understand all processes and activities involved in subsistence arable farming. As you read this account, note down all activities involved and the order in which they are performed, the inputs (things required for production) and outputs (things produced).

Mpho's family lives in a village called Phalane. When the rainy season starts in September, her parents go to the lands, where they cultivate a small piece of land. Their crop field is about 4 hectares in size. There are many crop fields around the village. This land is owned by the community and is called communal land.

Many preparations are made before ploughing. Mpho's mother repairs huts, selects seeds, mends storage barns and Mpho's father repairs the fence, destumps the fields, ploughs and collects donkeys and oxen from the cattle post. Last year, Mpho's family had obtained fencing equipment, 6 donkeys for draught power and a plough from Arable Land Development Programme (ALDEP).

During the first rains in November/December, the family starts ploughing. They grow crops like maize, sorghum, melons, beans, pumpkins and sweet reeds. Although Mpho's family cultivates the same piece of land every year, they practice crop rotation. In December, during the school vacation, children join their parents at the lands. Family labour is used but sometimes they ask for assistance from neighbours. For example, last year, Mpho's mother called 'Letsema', a traditional cooperation system, in which neighbours helped with the harvesting.

Mpho's family uses hoes for weeding and knives for harvesting. Improved fencing has lessened the problem of pests. However, birds and other small pests are still a problem. Birds are scared by scare-crows and noise making. Most farmers around this village have been advised to use insecticides/pesticides. Carts drawn by either donkeys or oxen are used for transporting harvested crops from the fields to the village. These crops are then stored for family use, but the surplus is sold locally or in the nearest town.

After ploughing, Mpho's father takes all the oxen back to the cattle post. Only few donkeys remain so that they could transport the produce back to the village. Mpho's family did not get a good harvest this year. The rain had come late and was inadequate (not enough). Some plants died before ripening due to high temperatures. Pests and diseases also contributed to low yields. Although the yields are low, enough food has been produced to feed the family. In other words, there is no surplus. If there were any surplus, they were going to sell that in the village and the neighbouring town.

From Mpho's account, you have learnt all activities involved in this farming system. The activities are listed below in order of occurrence. These are:

- preparations before ploughing
- ploughing
- weeding
- harvesting
- transportation
- storage

Did you come up with the same list as mine? If not please ensure you read the case study again and identify such activities. Remember we said that subsistence arable farming requires inputs and these should be turned into outputs. The following activity will help you understand these ideas better.



Activity 1

While reading Mpho's account, you should have noted down the farm inputs and outputs. In the spaces below, list 5 inputs and 5 outputs of this farm.

Inputs

- 1.
- 2.
- 3.
- 4.
- 5.

Outputs

Feedback

Since you have learnt that 'inputs' are all things necessary for production and 'outputs' are things produced, then I expect you to have listed the following:

Inputs

ploughs

seeds

labour

hoes

draught power

knives and axes

Outputs

maize

sorghum

beans

pumpkins

melons

peas

We have just listed the inputs and outputs of subsistence arable farming. Next, we shall study those outputs (crops produced), and find out where they are grown and conditions necessary for the production of these crops. We shall not discuss inputs of subsistence farming, as all you need is to name them as we have already done in the activity above.

3.0 Crops Produced by Subsistence Farmers (outputs)

You have already listed some outputs (crops produced or yields) from Mpho's farm. Let us now discuss all subsistence arable outputs (crops produced), conditions required for their growth and areas where they are produced in Botswana.

(a) Sorghum

Sorghum is the staple food grown all over the country. Unlike other crops, sorghum can withstand long dry conditions with rainfall as low as 300 mm spread throughout the growing season. Sorghum yields are largely influenced by rainfall.

(b) Maize

It is also widely grown by subsistence farmers. Maize cannot withstand drought conditions like sorghum. It usually requires rainfall amount of about 500mm or more.

(c) Millet

Only grown by few farmers in the eastern part, but more important in the north-eastern parts of the country where rainfall is higher. Millet can grow under the same conditions as sorghum.

(d) Beans and cowpeas (pulses)

These are grown all over the country. They can also grow under the same conditions as sorghum. Leaves are harvested while tender, and then cooked and dried to provide relish. But they can be allowed to grow into seeds called pulses.

(e) Squashes, melons, and pumpkins

These are also widespread in Botswana. They are inter-planted with other crops. The leaves of pumpkins and squash are also cooked for relish. Some squash melons are sliced, dried and stored. The hard shells of dry squash are also used as food and water containers.

(f) Sweet reeds

These are also widespread, but require rainfall of over 500 mm. The production of sweet reeds is very low because they are best consumed while still fresh.

I am sure you have eaten or seen at least one of these crops either in the rural areas or even in urban areas. Every Autumn, you see people selling crops like melon, maize, and sweet reed in towns and cities. These are outputs from farms and fields out there. Remember we said subsistence farmers may sell their extra produce.

Do you think it is easy to produce these crops? Pause and think of any problems these subsistence farmers are likely to face. As you think of the possible problems, keep the definition of subsistence farming in mind.

Well, let us expand on your ideas by discussing some of these problems together.

4.0 Problems Faced by Subsistence Arable Farmers in Botswana

In the previous section, we discussed outputs of subsistence arable farming. Next, we shall look at problems faced by subsistence farmers in Botswana. Can you think of any problems that a subsistence arable farmer would encounter?

Read the list of problems below and some of these might be common in your local area. These problems are subdivided into environmental and economic factors.

4.1 Environmental factors

These are factors relating to the physical surroundings like the following:

- Rainfall is very low, unevenly distributed and unreliable
- High summer temperatures which result in a high rate of evaporation
- Soils covering large parts of the country are mostly poor and infertile
- Severe drought sometimes occur, resulting in low yields or no yield at all
- Pests and diseases damage crops and also lead to low yields.

4.2 Economic factors

These are factors relating to lack of inputs on the part of the farmer.

- Lack of draught power.
- Labour shortage.
- Lack of capital.
- Lack of skill/knowledge.

If you do not understand how the above factors could be problems, may I then refer you back to our discussion on factors influencing arable farming. All the above factors have led to low yields or output.

Now we know problems experienced by subsistence farmers. Let us try to discuss possible solutions to these problems. Study the cartoon (**Figure1**), which shows several experts trying to advise a peasant (poor subsistence) farmer on how to solve her problems.



Figure 1: The Agricultural experts and the peasant farmer.

After studying the above cartoon, you would realise that subsistence farmers encounter several problems. You would also notice that the experts may also have wrong perceptions about farmers. For example, they may think farmers do not produce because they are lazy; only to find that the poor farmers do work hard but still fail to produce as they should due to lack of expertise.

Look at the picture again. Assess some of the comments made by both the farmer and the experts. Do experts give comments that are helpful to the farmer? Make a list of problems you identify as well as their possible solutions as mentioned in the picture. The next time you visit your study centre, discuss these ideas with colleagues to see if you have similar or different views on these issues.

Below is a discussion of what some of these problems are and their possible solutions.

5.0 Solutions to Problems Facing Subsistence Arable Farming in Botswana

In order to encourage arable farmers to produce, government has made some effort to help them. Government has carried out research, provided money and extension services to farmers. They should therefore take advantage of the following approaches to solve the problems mentioned above.

- Practising better (modern methods of farming) for example, crop rotation, row planting and ploughing across the slope.
- Seeking for advice from Agricultural Extension Offices or Agricultural demonstrators.
- Using improved seeds (hybrid seeds) and securing drought power and farm equipment through government programmes that are offered from time to time.

Most of what we have discussed so far applies to subsistence farming in the eastern and south-eastern parts of the country. Let us now briefly discuss Molapo cultivation and find out how it differs from what you have learnt so far.

6.0 Molapo Cultivation

This is a form of subsistence agriculture that is practiced in the north (Okavango and Boteti areas). The word ‘molapo’, as most of you know, means stream or a small river. This should give you an idea of where cultivation takes place. As the word suggests, it takes place on land bordering rivers. These lands are made fertile by sediments deposited during floods. Some of the lands used are river beds or swamps. As you would expect, the type of soil found here is clay or loam soils. These are fertile and retain moisture.

Traditional methods similar to those used in the rest of the country are practiced. Other characteristics of subsistence farming that you have read also apply here. An exception is that more draught power is used since soils are heavy. Crops grown are sorghum, maize, watermelons and pumpkins. Even though the fields are slightly smaller, that is, 1 to 3 hectares, the yields are fairly high.

Molapo farming could also have its own problems. Try to think of major problems that could be experienced during heavy rains. Well, the two major problems are **flooding and water logging** (standing water). To address these problems, farmers build bunds to stop the rising flood water. The government is also working on a design of bunds with water-intake and drainage facilities in the area.

7.0 Summary

On the map of Botswana you have located areas of subsistence agriculture, for example, Okavango/Boteti areas and the eastern parts of the country. At subsistence level, we have discussed all activities involved, the outputs and inputs, problems experienced by farmers and their possible solutions. An account on Mpho's family has given you a clear picture of all activities, inputs and outputs involved in this farming system. Molapo cultivation is another form of subsistence agriculture, which takes place in the north (Okavango/ Boteti areas). These lands are fertile but difficult to cultivate due to the problem of water logging.

We have come to the end of this topic and Exercise 2 (under Assignment section at the end of the Unit) will help you to evaluate your understanding of the whole topic. Complete the exercise first and then compare your answers with those provided. If you got some questions wrong, review the relevant sections before going on to do the next topic.

So far, we have concentrated on subsistence arable farming. But what about those arable farmers who want to produce to sell? This is termed commercial arable farming and it is what we will now focus on in the next topic.

Topic 3: Commercial arable farming in Botswana

In the previous topic, we have discussed arable farming at subsistence level. We also looked at factors influencing arable farming in Botswana in Topic 1. In this topic we are going to study commercial arable farming (the growing of crops for cash/sale) in Botswana. Our case studies are the Tuli Block farms, particularly Talana Farm and Pandamatenga Farms. For both case studies, we will describe and discuss activities involved, the inputs and outputs, problems and their possible solutions.

Learning Objectives

At the end of the topic you should be able to:

- locate on a map of Botswana areas of commercial arable farming. •list inputs and outputs of commercial arable farming
- discuss processes and activities involved in commercial arable farming
- discuss problems experienced by commercial arable farmers in Botswana
- discuss possible solutions to problems faced by commercial arable farmers in Botswana.

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4.0 Summary

1.0 Commercial Arable farming Areas in Botswana

In Topic 1, you learnt that commercial arable farming is the growing of crops for sale/cash/profit. In Botswana, only 5% of the commercial farmers practice arable farming and the rest are pastoral farmers. From our discussions on factors influencing arable farming, most physical conditions e.g. the harsh climatic conditions, do not favour arable farming. In Topic 1, we have also mentioned that commercial farming takes place mostly on freehold and leased land. Try to locate commercial arable farming areas on the map (**Figure 1**) below.

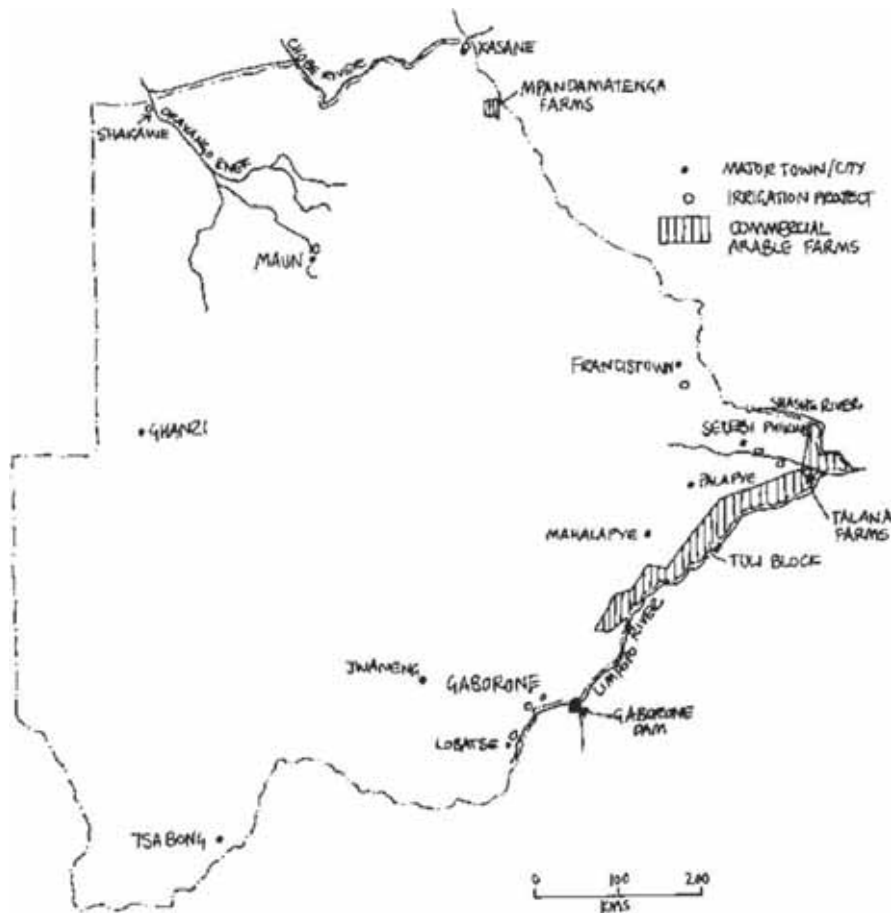


Figure 1: Commercial arable farming areas in Botswana

Source: Silitshena, R. and Mcleod, G. (1998): *Botswana: A Physical, Social and Economic Geography*

From our discussion in Topic 1, and from the figure above, you should have remembered that commercial arable farming takes place on the eastern part of Botswana and the Pandamatenga area.

The two case studies on commercial arable farming in Botswana (Pandamatenga and Talana farms) that we will discuss in this topic will help you understand the characteristics of cash crop farming more clearly. Talana farm in the Tuli Block area is an example of an **irrigated intensive** cash crop farm. Farms like Talana include:

- Mogobane farms
- Chobe farms
- Lobatse block
- Gaborone block

On the other hand, Pandamatenga farms are an example of **dryland farming** which is practiced **extensively**. This type of farming is also practiced at Barolong farms in the Southern District.

In order to understand the difference between the two commercial farms, it is very important to know the meaning of the words in bold.

- **irrigation** means ‘artificially watered’ or watering of crops by artificial means.
- **dryland** is when crops grown depend on rainfall. Irrigation is not practiced.
- **intensive farming**: The size of the farm is small but yields per unit area are high. This results from intensive use of labour, machinery, fertilisers and pesticides.
- **extensive farming**: The farm size is large but production (yields) per unit area is low. It uses large machinery and grows one or two crops only.

We have introduced commercial farming in general. Now we are going to look at our two case studies in detail. Let us begin with an example of intensive commercial farming.

2.0 Talana Farm (Tuli Block)

Again study the map (**Figure 1**) above and try to describe the location of the farm. You are absolutely correct to say that Talana farm is located at the confluence of the Limpopo river and its tributary called Motloutse river. The farm is in the Tuli Block area (eastern part of the country). The sketch map (**Figure 2**) shows the location of the farm.

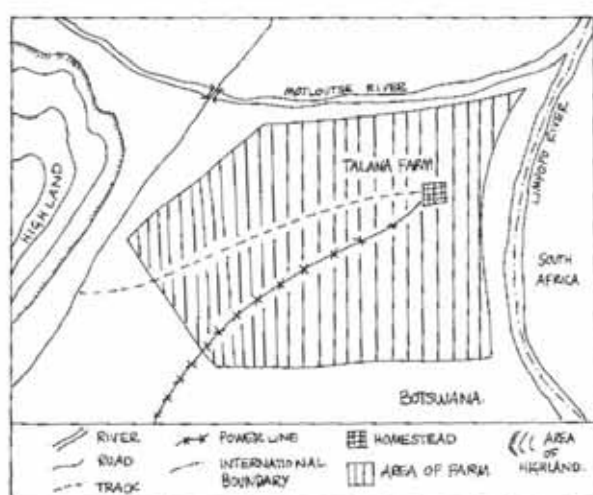


Figure 2: Location of Talana farm

Source: Silitshena, R. and Mcleod, G. (1998): Botswana: A Physical, Social and Economic Geography

Talana farm covers an area of about 1,800 hectares with approximately 500 hectares under cultivation. It is a subsidiary of Botswana Development Corporation limited (BDC).

Now that we know where the farm is located, let us look at reasons for this location.

Look at Figures 1 and 2 again. As you do that, try to remember what we said earlier about factors influencing arable farming. What do you think is the benefit of having the farm located at the

confluence of the two rivers? What can you conclude about it being located in the eastern part of Botswana?

Well, I hope you noted very good reasons for such a strategic location of the farm. Let us now discuss some of the reasons together. As we do that, check whether these are some of the reasons you mentioned.

2.1 Factors influencing the location of Talana Farm

(a) Fertile soils

The Tuli Block area has fertile dark brown loamy soils that are suitable for crop production. The land is also fairly flat, therefore, soils are well drained and easy to cultivate.

(b) Availability of water

The two sources of water for irrigation are rivers and boreholes. Water is pumped from Limpopo and Motloutse rivers, especially during the rainy season. Each river has a sand point from which water can be drawn. There are 15 boreholes. Boreholes sunk on the banks of the two rivers are a reliable supply of water for irrigation throughout the year.

(c) Climate

The major crops grown are suitable for semi arid conditions of this area. High summer temperatures lead to loss of moisture through evaporation.

2.2 Farm inputs

Inputs, as we have said earlier, are all those things that are necessary for the production of crops. These can be divided into natural inputs (those provided by nature) and human inputs (provided by people). Study the list below of both natural and human inputs.

(a) Natural inputs are:

- land/soils on which crops are produced
- water from the boreholes and the two rivers
- climate (moderate temperatures and sunshine for plant growth and ripening).

(b) Human inputs

- labour: since farming is undertaken intensively, a lot of labour is required, especially for weeding and harvesting. Both skilled and unskilled labour is employed. The farm employs about 100 permanent workers, the rest is seasonal casual labour.
- machinery: small machinery is used for planting.
- capital (finance) : a lot of money is spent on farm equipments, labour and maintenance.
- seeds: specially selected seeds are bought from South Africa and used for planting.
- fertilizers: chemical fertilisers are used since soil fertility has been declining.
- pesticides/insecticides/fungicides: these are used on pests and diseases which destroy crops. An electric fence keeps away large and small animals.

- packaging material: This includes boxes and bags for packing farm products.
- irrigation equipment: all the necessary irrigation equipment is bought from South Africa. A lot of money is also spent on repairing or replacing some parts.
- transport: trucks are used to transport farm products to the market. The farm is accessible by tarred road from Bobonong and only 15 km of good gravel road from the tarred road.
- infrastructure: the farm has good roads, electricity and telephone services and a small airstrip of about 800m long. There are also houses for management and farm workers and a community hall equipped with all the necessary amenities (social needs).

I hope you realise that all these factors contribute positively to the good produce at Talana farm (and indeed it is one of the successful farms in Botswana). As we have said in the introductory part of this topic, Talana farm practises intensive farming. We have also mentioned that there are lots of boreholes around the farm. It is through these boreholes and water from the two rivers that irrigation is possible at Talana farm.

Now, let us look in detail how irrigation is done at Talana farm.

2.3 Irrigation at Talana farm

Farming at Talana is undertaken intensively. The farm is also 100% irrigated. There are no supplementary rainfall crops. Now that we know the kinds of inputs available our next step is to find out how they irrigate crops. You might find that you are familiar with one of the methods used at Talana farm. The following methods of irrigation are used at Talana farm.

(a) Drip irrigation

Drip irrigation is mainly used for vegetables and trees. In this method, water is allowed to drip at a rate of 2 litres per hour from suspended plastic pipes which are set 60 cm apart. This method enables water to sink or be absorbed slowly into the soil.

(b) Sprinkler method

This method is mainly used for maize irrigation. A number of large scale farmers in this area use this method. In this method, an iron pipe is laid in some rows of the cultivated area. The pipes have sprinklers at intervals of 5 metres. As sprinklers rotate, they are able to water a large area. The disadvantage of this method is that there is loss of water through evaporation.

(c) Centre pivot

This is used to irrigate potatoes and other vegetables such as onions and tomatoes. A centre pivot is a long structure on which pipes with sprinklers are attached at intervals. The sprinklers are on wheels that move on their own in a circle.

These are the most common methods of irrigation at Talana. Do you know of any other methods of irrigation? Well below are other methods of irrigation used elsewhere in Botswana.

2.4 Other irrigation methods used in Botswana

(a) Micro-jet

This consists of a small nozzle mounted on a plastic or metal stand which is 20-50cm long. The jet is connected by plastic feeder pipes which run along the pipes. Water under great pressure comes out in a jet and hits a plastic plate, causing it to spray outwards.

(b) Flood irrigation

This is the oldest method in which water flows through irrigation channels (gutters) leading to areas to be irrigated.

(c) Hose and watering cans

Water is fetched from a standpipe in the garden with watering cans or a plastic hose pipe with a sprinkler is connected to a stand pipe. This method is used by small farmers e.g. market gardeners around urban areas.



Activity 1

From our description of various irrigation methods used at Talana and the rest of the country, study the following pictures and identify the methods of irrigation shown in the picture.

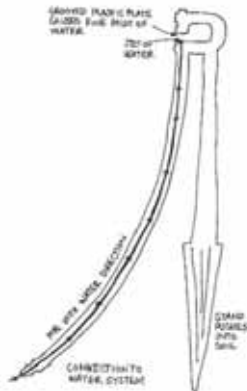
Picture 1



Picture 2



Picture 3



Picture 1 _____

Picture 2 _____

Picture 3 _____

Feedback

If you have read the descriptions of various irrigation methods, then you should know that Picture 1 is Sprinkler irrigation, Picture 2 is the central pivot, and Picture 3 is the microjet.

I have already mentioned that Talana is one of the successful farms in Botswana. You also know that farming is a process of converting inputs into outputs. So, if the farm is successful, then there must be a lot of output from it. Thus, the next section will show what the inputs we have just discussed above are turned into.

2.5 Crops produced (outputs) at Talana Farm

Crops produced are actually the outputs of a farm. Outputs are all those things which are produced in a business or organisation.

Crops grown at Talana farm are maize, sorghum, cotton and potatoes, which are grown on a large scale. A larger piece of land is used therefore, the yields for these crops is high. Crops grown on a small scale or a small piece of land are beetroots, butternuts, onions and tomatoes. Other crops grown are sunflower and tobacco, pumpkins, and gemsquash.



Activity 2

Study figure 3, which is a more detailed map of Talana farm and answer the following

questions. Write your answers in the space provided.

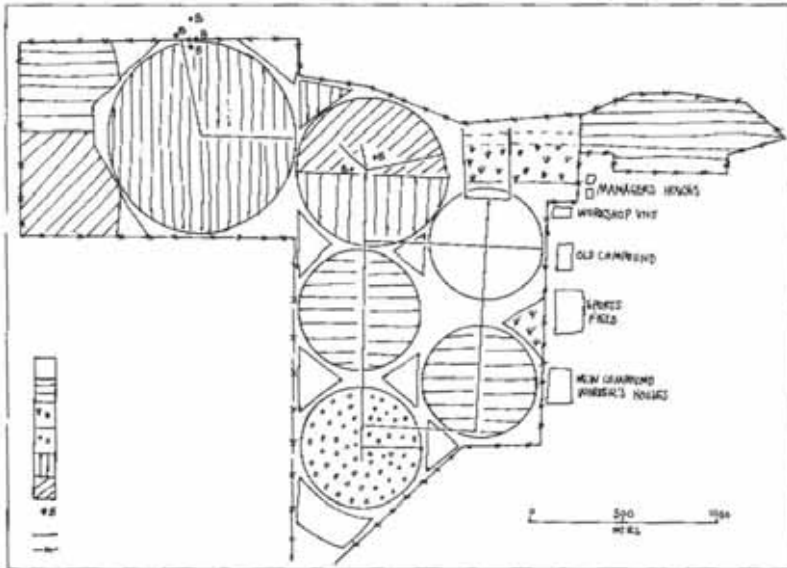


Figure 3: Irrigation system at Talana Farm

Source: Silitshena, R. and Mcleod, G. (1998): *Botswana: A Physical, Social and Economic Geography*; page 116

1. Which crop covers the largest area?

2. List any **two** green manure crops.

3. All crops in this farm are grown under irrigation. State **two** advantages of irrigation.

4. Name the type of fence used and state its purpose.

Feedback

1. *The map shows that **cotton** covers the largest area. Cotton is planted in summer and harvested in winter.*
2. *The green manure crops at Talana farm are beans and peas. As the name suggests, the crops are ploughed into the soil as manure.*
3. *All crops are grown under irrigation to ensure adequate supply of water throughout the growing season.*
4. *Crops can also be grown throughout the year. The farm has an electrified fence to keep wild animals away.*

We have discussed the outputs of Talana farm and we can conclude that both large scale and small scale crop production are practiced at this farm. Large scale farming products are maize, sorghum, cotton and potatoes, while beetroots, butternuts, onions and tomatoes are produced on a small scale.

Let us now find out what happens to Talana Farm's produce.

2.6 Marketing of crops from Talana Farm

Some of the farm produce are sold locally. Maize, sorghum and soya beans are sold to Botswana Agricultural Marketing Board (BAMB). Vegetables are sold to the local supermarkets and hawkers businesses. If you enquire around about the suppliers of vegetables in your area, you may learn that most of them are from the Tuli Block farms (particularly Talana farm). Cotton is sold to the South African markets.

2.7 Problems experienced at Talana Farm

We have already mentioned some problems in the past. While you are reading these problems, try to think of their solutions as well. Problems experienced on the farm are as follows.

(a) Pests and diseases

Diseases such as pink cobrot and maize smut are caused by fungi. Pests like aphids cause virus to be transferred onto crops, while birds and wild animals either destroy or cause a great damage to crops.

(b) High irrigation costs

Irrigation inputs are expensive to purchase and to maintain. The borehole engine is costly and fuel (diesel) is needed to run the engine. Some pipes are bought from South Africa, and when they get worn out or break, they have to be replaced.

(c) High evaporation rate

Much water is lost through evaporation, especially in summer when temperatures are high.

(d) High cost of land clearing

Clearing of land is expensive as machines are used.

(e) Low market prices

BAMB prices are very low and as a result the farm does not make much profit, especially with crops like maize and sorghum.

(f) Competition for the local market with outside producers

Talana Farm faces a tough competition with South African producers whose products are comparatively cheaper. Agricultural produce entering Botswana from a member of Southern African Customs Union (SACU) are duty free.

(g) Distant markets

Talana farm is far from the markets, thus resulting in high transport costs.

From the above discussions, I hope you notice that although Talana is a successful farm there are problems encountered. As a commercial farm, its management has to come up with strategies to counter the problems. Where possible, government also comes in to assist. For example, in case of competition, government periodically closes borders for vegetables to ensure that local producers are supported. Government also improves infrastructure like roads to ensure easy access to the markets.

I hope you still remember that in the introductory part of this topic, we said commercial farming can be intensive or extensive. We also defined these terms. We then said Talana is an example of an intensive commercial farm. Now, let us move on to discuss a farm that practices extensive commercial farming.

3.0 Pandamatenga Farms

Our next case study is on the Pandamatenga Farms which are situated in the Chobe District. Do you still remember where this area is? In case you have forgotten, look at Figure 1 and locate Pandamatenga farms. The farms are on the central and southern plains, west of the Nata-Kazungula road. The map (Figure 4) shows the present location of Pandamatenga farms.

Pandamatenga farms are an example of dryland extensive commercial farming in Botswana. Another example of this type of farming is at Barolong farms in the Southern District. This is referred to as dryland farming because crops grown depend on rainfall; no irrigation is practiced.

Pandamatenga farms were allocated in 1983 as a government effort to pursue its policy of food self-sufficiency in grain production. At the beginning of this project, 50 farms were leased out to 34 applicants for a period of 15 years. Study the map (**figure 4**) where you will note that all farms are numbered up to 50. All fifty (50) farms cover a total area of 25,074 hectares, but an additional 21,122 hectares were cleared for farmland. As you can see on the map, the farms stretch over 2 plains, that is, the central plain and the southern plain.

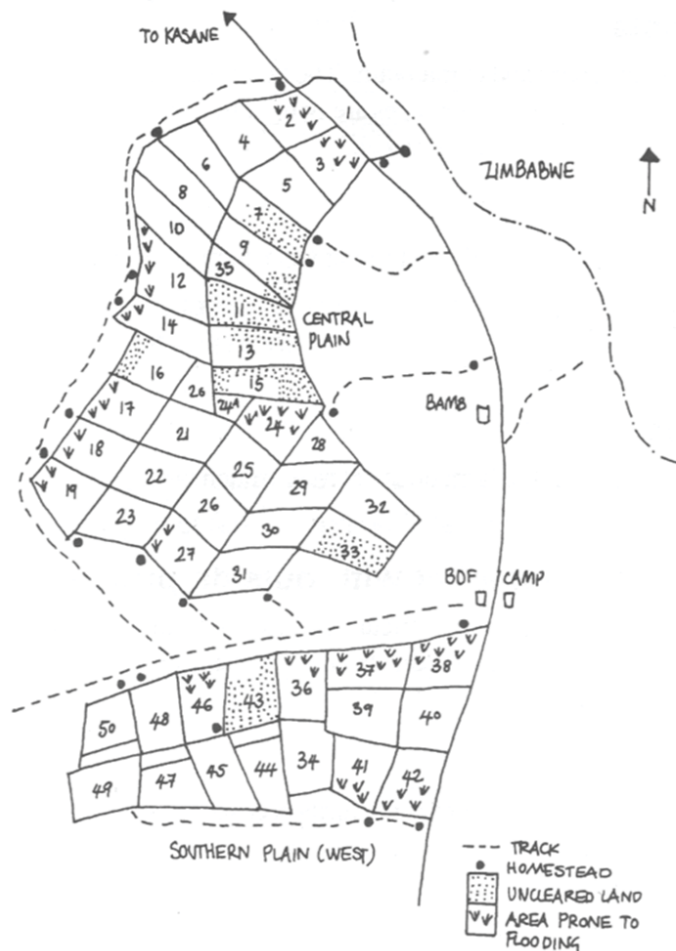


Figure 4: Pandamatenga Commercial farms

Source: Pandamatenga Commercial Farms Rehabilitation Study, Final Report – June 1998

Like you saw in the case of Talana farm, there must be some reasons why Pandamatenga farms are located where they are. Let us discuss some of those factors.

3.1 Factors influencing the location of Pandamatenga farms

Our discussion of the location of Talana farm as well as the problems they encounter should have given you an idea of what people look for when they locate their farms. Do you remember some of the reasons? Do you think the same reasons would apply every time and everywhere?

Well, let us discuss what influenced the location of Pandamatenga farms. As you go through these factors, try to compare them with what we discussed under Talana farm.

(a) Soils

Soils are predominantly black clays. These soils are very fertile but very difficult to work on during wet seasons. They also become very hard in the dry season.

(b) Climate

Pandamatenga experiences hot and moist summers and mild dry winters (that is, semi-arid climate). The amount of rainfall recorded since crop production started ranged from 340 mm to 983 mm. This makes the area well suited for drought resistant crops.

(c) Land

There is plenty of space for expansion when the need arises. The farms are on the plains which are fairly flat; this makes it easy to use machines. Only southern plains are currently cultivated because the whole area is not in use.

Looking at these factors, you should have by now realised that each farm location have some particular factors to consider. For example, at Talana farm, availability of water was an important consideration to make. Why do you think so? Of course, Talana farm rely on irrigation while Pandamatenga relies on rainfall. (Remember it is dryland farming). The other thing is that we may talk of the same factor but under different circumstances. For example, land was considered for both cases, but at Talana they mostly looked at its suitability while at Pandamatenga they considered both suitability and availability. Remember the definitions of intensive and extensive farming we discussed earlier?

Just like in the case of Talana farm, let us now look at the inputs required at Pandamatenga.

3.2 Farm inputs

You have already learnt that inputs are all those things needed to produce whatever is planned. We have already described the inputs at Talana farm, and since most of them are the same for Pandamatenga farms, we will just list them. They include:

- land
- climate
- capital (finance)
- fungicides/insecticides
- machinery
- seeds
- labour
- fertilizers

From this list, I hope you realise that both intensive and extensive commercial farming require similar inputs. The only difference could be the extent to which each is required. For example, extensive farming will require more land than intensive farming.

When deciding where to locate a farm, there is always consideration of what to produce. Or better still the type of produce determines where to locate the farm. Look at Figure 1 and note the location of the two areas. Also, look at the factors considered in locating the two farms. Would you think the two farms would produce the same crops?

Well, let us see what is produced at Pandamatenga.

3.3 Crop production (outputs)

Pandamatenga has been identified as a suitable area for rainfed arable farming or dryland farming. As we have discussed before, this is because of the fertile soils and higher average rainfall than in most parts of the country.

At the start of the project, the main crop grown was sorghum, which during the first couple of years had satisfied the policy of food self-sufficiency. Few years later, farmers developed interest in other crops like maize, cotton and sunflower.

In 1996/97 there was a shift of crops cultivated, to a mixture of cotton, sunflower and sorghum. Can you think of any reasons for these changes in crop varieties? Some changes were based on the result of research trials which were conducted by the Department of Research in the Ministry of Agriculture. Other changes were due to price considerations.

Sorghum and cotton are planted between early November and late January. Sunflower is planted later in February as it can withstand low winter temperatures.

From this discussion, I hope you realise that there are some similarities and differences in terms of crops produced. For example, Talana produces some vegetables while Pandamatenga produces predominately field crops.

As an example of one of the farms located in Pandamatenga, let us briefly discuss Masedi farms.

3.4 Masedi farms at Pandamatenga

This is a Debswana funded project established in 1998. The project was established with the aim of developing a sustainable farming model for the local farmers and also in view of vision 2016's aim of attaining food security for Botswana. A total amount of P10 million is used to run this project for a period of 8 years. The project also runs an outreach Programme which assists local subsistence farmers to progress to a commercial scale. It is hoped that these farmers will in future serve as role models for other farmers in Botswana. At its establishment, a total land of 2,400 hectares was put under sorghum and maize cultivation. Three years later the farm harvested about 3000 tonnes of sorghum, out of which 2 500 tonnes is contracted to government institutions. However, this is not enough to meet the country's demand of 13 000 tonnes per annum. The country still imports sorghum from South Africa. Besides sorghum, the farm also produces cotton and sunflower.

Masedi farms partly owe its success to an Australian, Mr. Ian Keene a highly experienced farmer from a similar type of environment. The use of fertilisers, nutrients and hybrid seeds, minimum tillage and maximum pest control also contributed to its success.

The success of Masedi farms has had a great impact and has led to some developments in this area. This includes the establishment of processing industries and the development of infrastructure. Young Batswana are also sent to Australia for specialised training on dryland farming.

Like I said earlier, this discussion on Masedi farms was meant to give you just a brief description of one of the Pandamtega farms where government has a stake. We will now go back to the general discussion of Pandamatenga farms by looking at marketing (selling) of their farm produce.

3.5 Marketing of crops from Pandamatenga

The main market for sorghum and maize produced at Pandamatenga farms is Botswana Agricultural Marketing Board (BAMB). BAMB was established for the purchase of food grains and other crops like groundnuts, beans and sunflower. BAMB also supplies agricultural inputs such as fertilisers, seeds, stock feeds and jute bags. It has several depots or centers and one of them is at Pandamatenga.

BAMB prices are usually low and fixed and as a result farming has been unprofitable. The BAMB pricing policy has greatly contributed to the failure of crop farming in this area. For example, BAMB price for sunflower is P392 per tonne whereas in South Africa the same amount sells for twice this price. If you were a farmer in this area, would you sell your sunflower in Botswana or South Africa? Obviously you would sell in South Africa, and that is what most farmers have resorted to. The sorghum price of P391 per tonne has remained in force since 1992 to date, and for this reason, farmers have allocated more land to crops of higher prices such as sunflower and cotton as opposed to sorghum.

The presence of Masedi farms has had a great impact and resulted in some developments in the area. BAMB has responded by putting up silos for storage (see figure5).

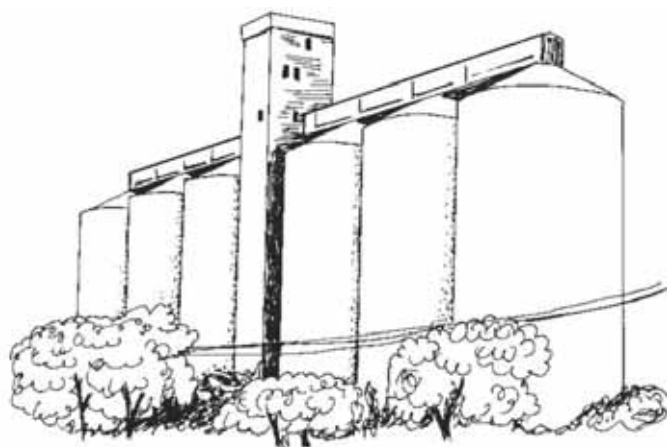


Figure 5: Silos similar to those at Pandamatenga

Farming by nature is a risky business. What do you think Pandamatenga farmers face as problems? As you think about these, keep on re-visiting the figure showing the location of the farms as well as considering factors considered in locating farms.

3.6 Problems experienced by farmers at Pandamatenga

I am sure you already know some of the problems from the sub-topics we have already discussed. Can you think of any problems posed by the physical environment i.e. climate and soils? Now let us discuss these problems.

(a) Drainage problems

We have already described the clayed soils of Pandamatenga as poorly drained. This is because they can hold water for a long time (waterlogging). The area has a flat terrain which does not

provide a suitable slope for runoff. Both poor infiltration and runoff have resulted in flooding. Cases of severe flooding have been reported in the central plains and on farms along the roads. The government is also expected to put up a drainage system to control flooding in the area.

(b) Crop damage by pests

Pandamatenga farms are located in an area of a high number and a variety of wildlife species. Crops grown attract both small and large animals. The compensation scheme provided by the Department of Wildlife and National Parks (DWNP) is not sufficient (enough) to cover the losses. In an attempt to reduce losses or protect the farms, both farmers and the DWNP shoot animals every year, especially large ones. Do you think this is the best solution to this problem? Obviously it is not a good solution. Since the establishment of Masedi farms there has been no crop damage by wild animals as the government has put up an electric fence around Pandamatenga farms. Pesticides are also used to control other pests. However, there are still other pests like birds which damage crops.

(c) Poor infrastructure (roads, electricity and telecommunications)

The existing earth roads within the farms are poor and impassable during rainy season. Farms are also not connected to the telephone services, which only extend as far as the village. Botswana Power Corporation is also considering power connection to the farms, which will cost each farmer P 257 000. If farmers are operating at a loss, do you think they will be able to meet the costs of these services? The answer is obviously 'no'. Think of the best solution to this problem and we will discuss it later.

(d) Poor management and planning

Farmers lack knowledge and expertise in the operation and management of their farms. Lack of skills to undertake farming in such physical conditions has resulted in many farmers failing to cope with the challenges presented by nature, e.g. flooding. Due to lack of information, there is also low adoption of improved technology.

(e) Low market prices

We have already discussed the problem of marketing crops from Pandamatenga. Try to recall what we said about BAMB prices. We have discussed that they are low and discouraging or demotivating. This has resulted in farmers shifting to more production of cotton and sunflower which can be sold at a higher price in South Africa. With these changes, do you think the government will achieve the aim of self sufficiency in grain production?

(f) Problems of securing financial assistance

The majority of the pioneer (first) farmers were foreclosed by the National Development Bank (NDB). This means that farmers could not secure loans from the bank since they have failed to settle their debts. On the other hand, few old farmers still in operation have also run into some financial difficulties as their loans have fallen into arrears. It is hoped that the Masedi project will rescue these farmers if they adopt their approach. NDB will also assist farmers to acquire the new type of equipment suitable for farming in this area.



Activity 3

Match the following problems with their possible solutions by using arrows. You are given an example of **problem 5** which matches **solution C**.

Problems	Possible Solution
1. Lack of financial support	A Must have an electrified game fence and a grid fence for cattle.
2. Poor drainage	B Bund-roads must be constructed. Government must financially assist to connect telephone and electricity to the farms.
3. Poor management	C BAMB must review its planning pricing policy, such that they will motivate farmers to produce more.
4. Poor infrastructure	D Construction of drainage systems e.g. digging drainage channels.
5. Low market prices	E The ministry of agriculture must provide research and extension services.
6. Crop damage by wildlife	F The government and other lending institutions e.g. NDB must provide financial assistance e.g. providing credit schemes.

Feedback

I am sure you have matched them as follows:

1. F
2. D
3. E
4. B
6. A

4.0 Summary

In this topic you have learnt a lot about commercial arable farming which aims at producing food and none-food crops (like cotton) for sale. In Botswana, this takes place on freehold/leased land. Through our case studies: Pandamatenga farms and Talana farm (Tuli Block), we discussed some of the important characteristics of commercial crop farming. For example, intensive cash crop farming and extensive cash crop farming.

Talana farm which is located at the confluence of Motloutse and Limpopo river is an example of an intensive irrigated cash crop farm. The farm is owned by BDC. Crops grown here include Soya beans, green manure crops, maize, cotton and sorghum. Water is obtained from the boreholes and two rivers (Motloutse and Limpopo). Methods of irrigation used include sprinkler, drip and center pivot. Most products from Talana are sold to Botswana Agricultural Marketing Board (BAMB). Others are sold to the local supermarkets. Problems experienced at Talana include pests and diseases, high irrigation costs, high evaporation rate, high costs of land clearing, low market prices, and competition for the local market with foreign (South Africa) producers.

The next case study (Pandamatenga farms) which we learnt about is an example of extensive dryland farming. Pandamatenga farms are situated in the Chobe District. Reasons for the farm location included fertile soils, favourable climatic conditions and plenty of space for expansion. The main crops grown are sorghum, maize and cotton. They are sold to Botswana Agricultural Marketing Board (BAMB). Farmers in this area experience problems such as poor drainage, crop damage by pests, poor infrastructure, poor management and low market prices. All these problems have led to farmers running into some financial difficulties. However, the government and some companies such as Debswana have been assisting farmers in these areas. The more recent developments in this area include the establishment of Masedi farms, a Debswana funded project aimed at providing an ideal model for sustainable farming in this environment.

This topic has focussed on commercial farming in Botswana. In the next two topics we will discuss commercial farming in other parts of Africa. We will start with Topic 4 which will discuss plantation farming in Natal.

Now, check your understanding of the topic by doing Exercise 3 in the Assignment section of the unit.

Topic 4: Plantation agriculture: Sugar in Natal (South Africa)

Introduction

In Topics 1 and 3 you have learnt about commercial arable farming, which refers to the growing of crops for sale/profit/cash. In this topic you will learn about plantation agriculture. At the end of the topic you should be able to distinguish between the type of commercial farming system discussed in Topic 3 and plantation agriculture. We will discuss plantation agriculture under the following aspects: site, location, inputs and outputs, cultivation, harvesting, processing, marketing, benefits, problems and possible solutions. Our case study will cover sugar cane in Natal (South Africa).

Topic Objectives

At the end of this topic you should be able to:

- define plantation agriculture
- describe characteristics of plantation agriculture
- locate on a sketch map sugar cane plantations in Natal

- describe the cultivation and harvesting of sugar cane
- explain various stages in sugar processing
- describe the transportation and marketing of South African sugar
- state the advantages (benefits) and disadvantages of sugarcane plantations to South Africa's economy.

Topic Contents List

1.0 Introduction to plantation agriculture

- 1.1 What is plantation agriculture?
- 1.2 Characteristics of plantation agriculture

2.0 Sugar plantations in Natal (South Africa)

- 2.1 Historical background of sugar cane growing in Natal
- 2.2 Ownership of sugar cane farms

3.0 Distribution of sugar cane farms

4.0 Physical and climatic conditions necessary for sugar cane growing

- 4.1 Cultivation of sugar cane
- 4.2 Harvesting of sugar cane

5.0 Transportation of sugar cane to the mills

- 5.1 Stages in the processing of sugar
- 5.2 Uses of sugar
- 5.3 Marketing of sugar

6.0 Problems experienced by sugar cane plantations

- 6.1 Advantages of sugar plantations to the economy of South Africa 56
- 6.2 Disadvantages of sugar plantations to the economy of South Africa 57

7.0 Summary

1.0 Introduction to Plantation Agriculture

Before we study sugar plantations in Natal (South Africa), it is important to define plantation and describe its characteristics. After this you shall be able to distinguish the type of commercial arable farming discussed in the previous topic with plantation agriculture. You should note that the concept of plantation farming is not common in Botswana. As such, I will mostly give you information that you need to read and understand before you move on. Thus, our approach in this topic will differ slightly from the one we used in the last three topics.

1.1 What is Plantation Agriculture?

A Plantation is an estate or a large piece of land in which a certain type of crop or plant is grown and processed. It is a large farm with the cultivation of a limited number of cash crops, carried out using scientific and efficient methods. In Africa, plantation crops include sugar, tea, cocoa, tobacco, cotton, rubber and grapevine.

1.2 Characteristics of Plantation Agriculture

Now that we know the meaning of plantation agriculture, let us discuss the characteristics of plantation agriculture. They are as follows:

- Plantation estates are very large, covering thousands of hectares and are normally run by huge foreign or local private companies.
- Most plantations in Africa were established during the colonial era in the 19th century, when European countries ruled over African countries. They were owned by foreigners who produced raw materials for industries in their own countries.
- Plantations are labour intensive, in that they employ a large number of workers. In the case of labour strategies, workers are recruited from neighbouring countries, leading to the development of plural societies, that is, societies made up of different ethnic groups.
- Plantations are also capital intensive. Many plantations use a lot of money in their investments. They have their own factories for processing crops. They also have their own infrastructure. For example, light railway lines and roads for the transportation of harvested crops to the factory and the market.
- Plantations usually specialise in the production of a single crop. In other words, they practice what is known as **monoculture**. In a few cases, two or more different crops are grown.
- Crops on plantations are normally intended or grown for export. Only few countries have agro-based industries which process plantation products.
- Many plantations increase their output by buying local produce or by buying the same product from small scale farmers.
- Plantation management provides housing, food and medical facilities and at times elementary education to their employees within the plantation.

Now that we have discussed general characteristics of plantation agriculture, let us move onto our main topic which is specific to sugar plantation particularly in Kwa-Zulu Natal (South Africa).

2.0 Sugar Plantations in Natal (South Africa)

I am sure we all know what sugar cane is or what it looks like. We use a lot of sugar cane products, particularly sugar. Sugar cane is a tropical grass from which sugar is made. It is grown in many parts of Tropical Africa. One of the most important producing areas in Southern Africa is the province of Kwa-Zulu Natal in South Africa. The province lies on the south eastern coast of South Africa. On the map (Figure 1), try to find the location of the province of Kwa-Zulu Natal.



Figure 1: Cane producing areas (Kwa-Zulu Natal Province)

Source: Turner H. (1994): Africa South of the Sahara

I hope you were able to locate the Kwa-Zulu Natal province on the map. Also, the map key shows that of all provinces of South Africa, Kwa-Zulu Natal is the one producing sugarcane.

2.1 Historical background of cane growing in Kwa-Zulu Natal

We have mentioned before that Kwa-Zulu Natal is one of the most important sugar producing areas in Africa. However, this does not mean that sugarcane originates in Kwa-Zulu Natal. It was introduced there in 1847 by a man called Morewood. Sugar cane was introduced in those years when there was no machinery for processing it, and also when transport was very poor.

The first farmers to settle in Kwa-Zulu Natal tried many crops. It was only after many failures that they tried sugarcane. Mr. Morewood encouraged them by providing free sugar cane cuttings. Most farmers were successful because the climatic conditions were favourable for cane cultivation. After 1910 there was a great improvement in transport, particularly railways and roads. Improvements in rail/road transport also meant an expansion of the sugar market. There were more large farms (estates) owned by individuals and large companies. Both farms and estates varied in size. Small farms owned by individuals varied between 20 and 100 hectares, while large estates are in thousands of hectares, separated into units of 600 hectares. Most small farms did not have their own mills. Therefore, they sold their cane to nearby estates.

2.2 Ownership

Plantations in Kwa-Zulu Natal are owned at three levels. These are:

- Extensive farms owned by large foreign companies
- Large farms owned by small companies or white farmers
- Small scale farms owned by Indians and very few black South Africans.

The overall administration of the sugar industry is in the hands of the South African Sugar Association (SASA).

3.0 Distribution of Sugarcane Farms

You have located the province of Kwa-Zulu Natal on the map. Now let us look at the distribution of sugarcane farms in this area.

Sugarcane plantations are found on the coastal lowlands of Kwa-Zulu Natal and southern Mozambique. These plantations cover an area of 200 000 hectares. The cane is grown as far south as latitude 30°S due to climatic effects of the warm Mozambique current. The map (Figure 2) shows the distribution of sugarcane plantations in the province of Kwa-Zulu Natal.

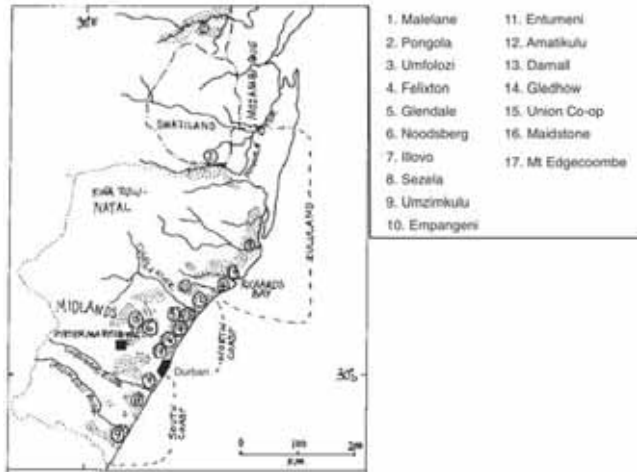


Figure 2: The distribution of sugarcane plantations in the province of Kwa-Zulu Natal.

Source: Turner H. (1994) Africa South of the Sahara



Activity 1

Study the map (figure 2) and answer the following questions in the spaces provided.

1. The cane is not only grown on the coastal areas of Kwa-Zulu Natal. It is also grown further inland. What is the name of this inland area?

2. The coastal lowlands are divided into 3 areas as shown in brackets on the map. Name these 3 areas.

3. Name the ocean on the east coast of Kwa-Zulu Natal.

Feedback

Now that you have completed the activity, check your answers. Remember that all answers are

on the map.

1. The cane is also grown further inland, in an area called **Midlands**.
2. The three coastal areas in which sugar cane plantations are concentrated are the **Zululand, North Coast and South Coast**.
3. The **Indian Ocean** on the east coast of Kwa-Zulu Natal has a great influence on the climate of the area.

4.0 Physical and Climatic Conditions Necessary for Sugar Cane Growing

In the historical background of cane growing in Kwa-Zulu Natal, we have mentioned that farmers were successful in the growing of sugar because of favourable climatic conditions. Let us then discuss climatic conditions required for the cultivation of sugar cane. These are:

- High temperatures throughout the growing period, with mean monthly temperatures not falling much below 21°C. The warm Mozambique current of the Indian Ocean provides such temperatures.
- Abundant moisture (rainfall) - Sugar cane grows best where annual rainfall is between 1000 mm to 1200 mm. The rain should be well distributed throughout the growing season. However, a drier weather is required when the cane has reached maturity or just before harvesting.
- A period of dry sunny weather for ripening and harvesting is also important.

Study the climatic graph for Durban (figure 3). It clearly shows that Durban has favourable climatic conditions for sugar cane cultivation, as described above.

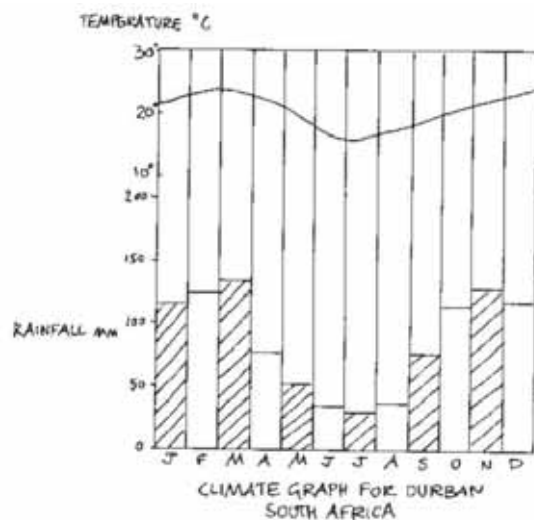


Figure 3: Climatic graph of Durban

Source: Minns W.J. (1991): A Geography of Africa

Other physical conditions necessary for the cultivation of sugar cane include:

- Well drained soils - cultivation and harvesting of the cane is easier if the land is flat. Kwa-

Zulu Natal has fertile alluvial soils along river valleys. The land is also gently sloping towards the coast.

- Abundant water supply for irrigation, particularly where rainfall is not evenly distributed throughout the growing season. Water for irrigation is obtained from both rivers and underground sources (boreholes).

4.1 Cultivation of sugar cane

We now know all the physical conditions required for sugar cane cultivation. Have you ever thought of growing sugar cane in your garden? If not, perhaps after learning more about sugar cultivation, you can try.

The following steps are followed when sugar cane is grown.

- (a) Pieces of cane are cut from stems of growing sugar cane. These are called **stem cuttings** or **setts**. A cutting should be about 15 to 20 cm long and must have 2 to 5 buds (see fig 4).



Figure 4: A stem cutting with buds

These cuttings are obtained from the upper middle part of good quality cane.

In the case where seeds are used, the plants are first produced in a nursery where they are kept for a year and well treated for diseases.

- (b) The soil is well tilled and broken with ploughs. This is done to enable roots to spread easily during the growing period.
- (c) Planting takes place in September to November. Contour shallow furrows which are 140 cm apart are dug. The cuttings are laid horizontally in these furrows and covered with soil. In large estates, machines (see fig 5) are used for planting the cane in these furrows.



Figure 5: Machines used for planting sugarcane

(d) After 2 to 3 weeks of planting, the roots begin to develop and the shoots develop shortly afterwards. Some of the first shoots (primary shoots) are stronger. Figure 6 shows cane cutting which has already developed roots and shoots.

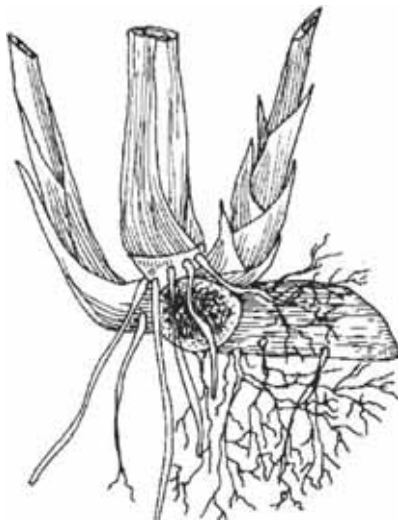


Figure 6: Cane cutting which has already developed roots and shoots

Source: Turner H. (1994): Africa South of the Sahara

- (e) Weeds are removed and the soil around the base of the cane is hoed. This enables moisture to penetrate in the soil.
- (f) Fertilisers are added during the early stages of growth. The cuttings which are not well developed are also removed and quickly replaced.

- (g) The lower leaves of the cane which die first are usually removed and used to cover the soil around the cane, thus retaining moisture in the soil. The removal of lower leaves is called **trashing**. Sometimes leaves are removed by burning. This method is not good as the yields may be slightly reduced.

4.2 Harvesting of sugar cane

As explained earlier, harvesting is determined by the weather conditions. Dead leaves are a good sign of ripe cane. Once the cane is ripe, harvesting starts, usually from May and lasts till December. The cane is cut by hand using long knives called **machetes**. After the leaves are removed, the canes are collected in bundles and then transported in big lorries to the mills.

Do you think harvesting of cane is an easy job? The answer is 'no', as harvesting is more strenuous (tiresome and difficult) than planting.

During harvesting, the cane is cut to the last bud. After harvesting, new shoots develop. This type of sugar cane is described as a **ratoon crop**. Ratoons may be harvested 3 to 4 times before the fields are ploughed. Study the picture (Fig 7) below, which shows the cutting of cane by hand.



Figure 7: The cutting of cane by hand



Activity 2

Answer the following questions in the spaces provided.

1. Other than climatic factors, state two other physical conditions which are necessary for the cultivation of sugar cane.

2. How does the planting of cane in small farms differ from that of large estates?

3. What are ratoon crops?

Feedback

I expect you to have written the following answers.

- 1. The physical conditions necessary for the cultivation of sugar cane include well drained fertile soils and an abundant water supply for irrigation.*
- 2. On small farms, human labour is used for planting while on large farms machines are used.*
- 3. Ratoon crops are canes which have grown from the remaining cane after harvesting. These are harvested 2 to 3 times before ploughing again.*

5.0 Transportation of Sugar Cane to the Mills

After sugarcane is harvested it must be delivered or transported to the mills within 48 hours of cutting. Do you think there is any special reason for this? We will find the answer to this question later when we discuss processing of sugar.

Some of the cane is transported by trucks, trains, tractors and trailers. In large estates, even small trains collect the cane from the fields to the factory.

Now that we know how sugar cane is cultivated and harvested, let us now find out how it is processed.

Processing of sugar starts as soon as it arrives at the factory. This is because the juice in the cane declines rapidly after cutting. All mills or factories have power cranes which unload the cane from trains or lorries onto a conveyor belt (moving rubber canvas). Figure 8 shows a crane offloading cane from a lorry.

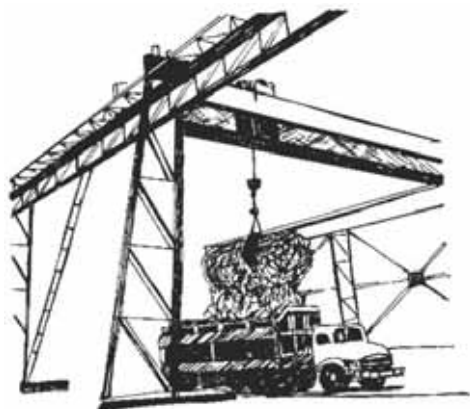


Figure 8: A crane unloading cane from a lorry

5.1 Stages in the processing of sugar

At a mill like Tongaat, north of Durban, once the cane is offloaded onto a conveyor belt the following stages of processing are then followed.

(a) Juice extraction

The cane is first chopped into short lengths by revolving knives. Chopped cane is then passed through a series of contra – rotating rollers which crush and squeeze out the juice. The solid matter of fibre left after the juice has been removed is called **bagasse** or **megasse**. In many sugar factories, bagasse is fed into boilers as fuel. Bagasse can also be used to make wall boards and coarse types of paper.

(b) Clarification (removal of impurities)

The juice is clarified by adding a small quantity of lime and then heating it. The juice is then passed over filter mud which removes the impurities. Filter mud now contains the impurities removed from the juice. Filter mud is mixed with bagasse to make fertilizers, which are returned to the fields.

(c) Evaporation

The juice has water content of 50 – 90%. To remove the water, the juice is sent to the evaporators which allow the steam escape. The juice left behind is thick syrup.

(d) Crystallization

From the evaporators the syrup goes into vacuum pans where further evaporation results in the formation of sugar crystals.

(e) Centrifuging or the separator

The vacuum pans discharge massecuite, that is, a dense mixture of sugar crystals and molasses. Molasses is the thick and sticky syrup which does not form sugar grains. The massecuite is then put into a centrifugal machine which consists of perforated drums. These drums rotate within a fixed casing. The sugar crystals remain within the drum while the molasses drain out through the holes and collect in the casing. Molasses can be used as animal feed or can be distilled into alcohol e.g. rum. The sugar crystals are then obtained to make brown sugar. In order to make white sugar, brown crystals have to go through further refining.

Using the diagram (**figure 9**), go through all 5 stages in the processing of sugar. Try to describe what is happening at each stage. If you are stuck at any stage refer back to the description of the stages above.

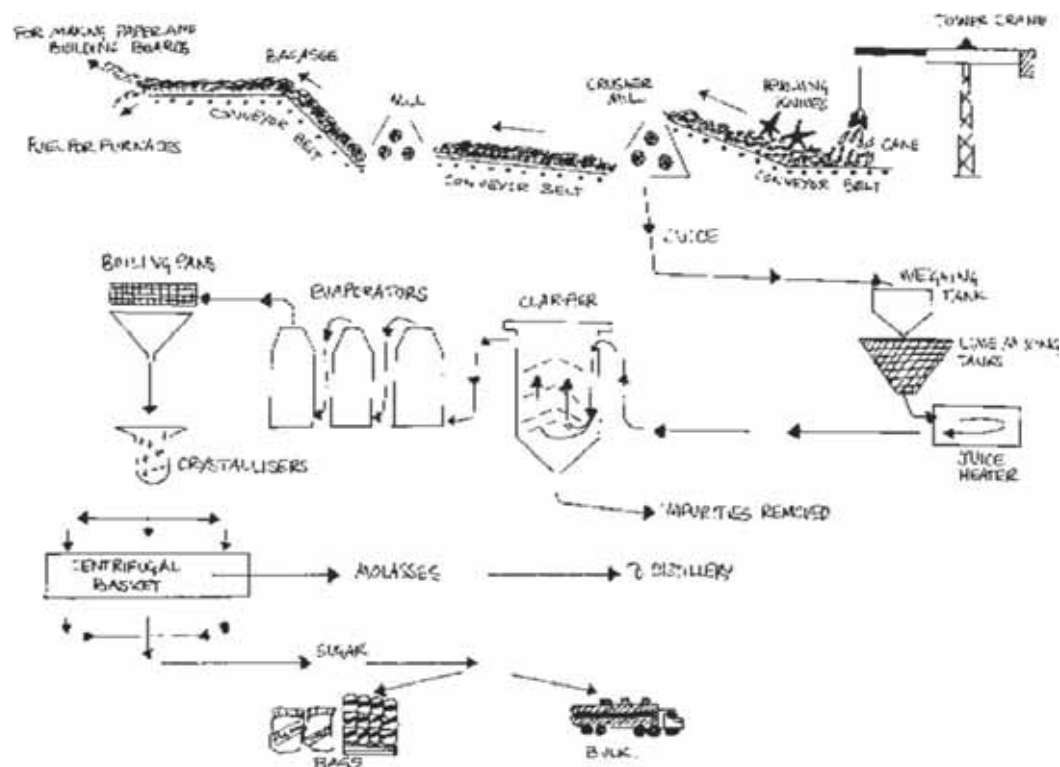


Figure 9: Stages in the processing of sugar

Source: Turner H. (1994): Africa South of the Sahara

The biggest of all mills is at Tongaat which produced 209 000 tonnes of raw sugar in 1979. Other processing mills include:

- Hullels
- Mount Edgecombe
- Glendale
- Stanger
- Darnall
- Melville
- Empangeni
- Illovo
- Sezela

5.3 Uses of sugar

Think of any 10 things which are made of sugar or the cane by-products. These are divided into:

- non-food uses
- commercial uses

- chemical uses
- home uses

There are also some by-products of sugar. Study figure10, which shows some uses of sugar and processing by-products.

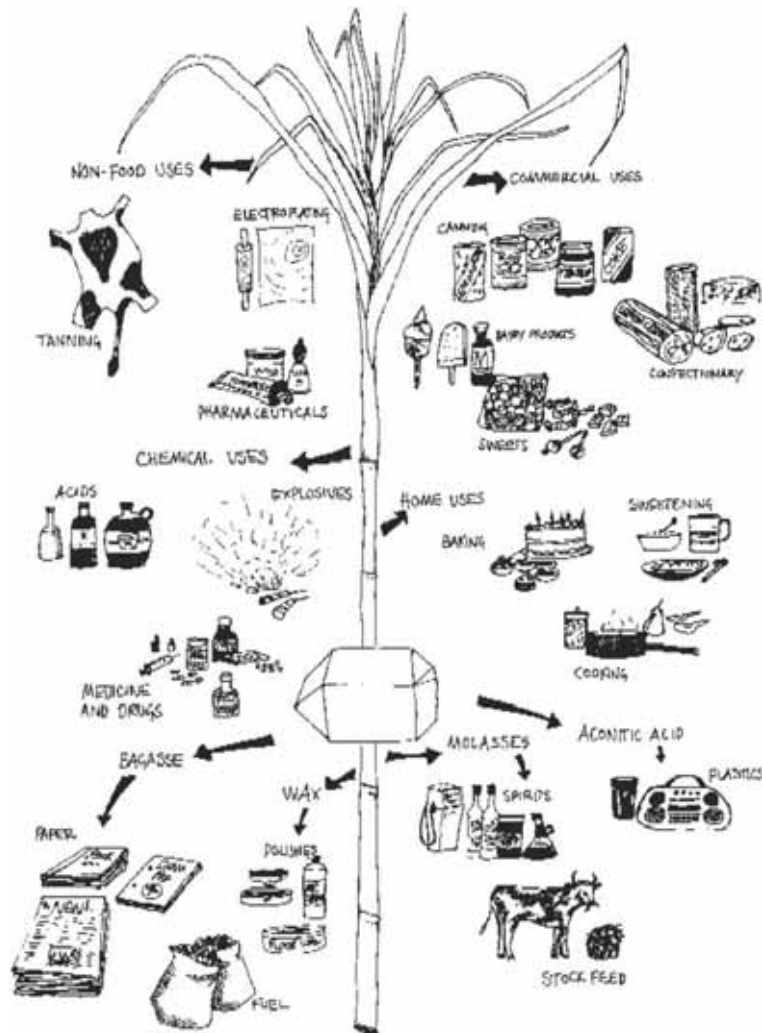


Figure 10: Uses of sugar and the by-products of its processing
Source: Minns, W. J. (1984): A Geography of Africa; page 70

5.4 Marketing of sugar

Sugar is transported to Durban by rail and road where it is stored in huge buildings (silos). From Durban the sugar is loaded into ships and exported to Japan, South Korea, Canada, United Kingdom, USA, Europe etc. Some of it is consumed locally.



Activity 3

Using figure 10 complete the table below by giving examples of the uses of sugar.

Non-food uses	Commercial uses	Chemical uses	Home uses	By-products

Feedback

This is an easy exercise, since all answers are on the diagram. You may have listed:

Non-food uses	Commercial uses	Chemical uses	Home uses	By-products
<i>Electro-planting</i>	<i>Dairy products</i>	<i>Acids</i>	<i>Baking</i>	<i>Bagasse-paper</i>
<i>Tanning</i>	<i>Confectionary</i>	<i>Explosive drugs</i>	<i>Sweetening</i>	<i>Wax - polish & fuel</i>
<i>Pharmaceuticals</i>	<i>Canning</i>	<i>Medicines</i>	<i>Sweets Cooking</i>	<i>Aconicacid Plastics Molasses Spirit Stock feed</i>

6.0 Problems Experienced by Sugar cane Plantations

- Pests and disease, e.g. ratoon stunting disease, insects -leafhopper & trash worm.
- High rate of evaporation with low rainfall may cause salinity and soil deterioration. The growing of a single crop (sugar cane) over a large area increases the risk of spreading the diseases. The spread of disease can have devastating effects on sugarcane production.

6.1 Advantages of sugar plantations to the economy of South Africa

- Employment creation to South Africans, for both skilled and unskilled workers.
- South Africa gets foreign exchange through exporting sugar and its by-products.
- Through taxation of workers' salaries, and imported machinery, the government gets revenue which is then used to develop the country.

6.2 Disadvantages of sugar plantations to the economy of South Africa

- Multinational companies take away profits from sugar industry to their respective countries.
- Fluctuation in sugar prices on world market in the 1980s affected the sugar industry in South Africa and the economy as well. With sugar cane being a permanent crop, it is not easy to switch to a more marketable crop.

7.0 Summary

In this topic you have learnt that a plantation is a large farm with the cultivation of one or a limited number of cash crops, using scientific and efficient methods. Most plantations in Africa were established during the colonial era and therefore are owned by foreigners. Crops produced in plantations are intended for export.

In South Africa, sugar cane is grown extensively in the province of Kwa-Zulu Natal, where the warm Mozambique current has provided favourable climatic conditions. Large farms have their own mills or factories. Small farmers sell their cane to large estates. Cane farms in Kwa-Zulu Natal are administered by the South African Sugar Association (SASA). Sugar from the mills is transported by rail/road to Durban where it is stored in huge silos. From Durban it is exported by ships to Japan, South Korea, United Kingdom and the United States. Some of the sugar is consumed locally.

To continue our discussion about plantation agriculture, the next topic will focus on cotton production in the Gezira area of Sudan.

But before you continue with Topic 5, do Exercise 4 under the Assignment section. This will help you to check your understanding of the whole topic. Please take your time to answer the questions and then check your answers against the ones provided at the end of the unit.

Topic 5: Plantation Agriculture: Cotton in the Gezira (Sudan)

Introduction

In Topic 4 you were introduced to plantation agriculture. You have learnt that a plantation is extremely large, covering thousands of hectares and is run by a huge company. Cash crops from plantations are destined for foreign or outside markets. In this topic we are going to look at yet another plantation agriculture case study: **cotton farming in the Gezira (Sudan)**. This case study will enable you to study plantation agriculture in a different environment. Again we shall focus on aspects of site/location, inputs and outputs, processes involved, benefits, problems and their solutions. This topic shall be easy to follow and understand since we have covered all these aspects in the previous topic.

Learning Objectives

At the end of this topic you should be able to:

- locate on a map of Africa, the Gezira cotton farming area
- state the inputs and outputs of cotton farming in the Gezira
- describe all processes involved in cotton farming
- discuss the benefits, problems and the solutions of the Gezira cotton farming.

Topic Contents List

1.0 Description of a cotton plant and cotton

2.0 The growing of cotton in the Gezira (Sudan)

2.1 Advantages of the Gezira location

2.2 Conditions under which cotton grows

3.0 Historical background of the Gezira scheme

3.1 How is the scheme organised?

4.0 The cultivation of cotton

4.1 Perennial irrigation at the Gezira

4.2 Harvesting of cotton

4.3 The processing of cotton

4.4 Marketing of cotton

4.5 Benefits of the scheme

4.6 Problems of the scheme and their solutions

5.0 Summary

1.0 Description of a Cotton Plant and Cotton

We know that man's first clothing was made from leaves and animal skins. Today most of our clothes are made from natural and synthetic fibres. Cotton is one of those natural fibres made from the fruits of a cotton plant. It is another crop grown on a plantation scale. Before we learn more about the growing of cotton, let us describe the cotton plant.

Cotton is made from the fibres of the fruit of a cotton plant. Study Figure 1(a) below which shows the height to which the cotton plant grows. It is an annual crop which grows to a height of about 1.2 metres before it flowers. The fruit is like a pod and this is called a **boll**. When the boll opens, both the cotton fibre and seeds can be seen. Let us look at figure 1(b) which shows a cotton plant with flowers, a pod before it opens and an open cotton boll. A mass of white fibres in a boll is often called cotton **lint**. The lint is spun into a continuous thread, which is then woven into cloth.

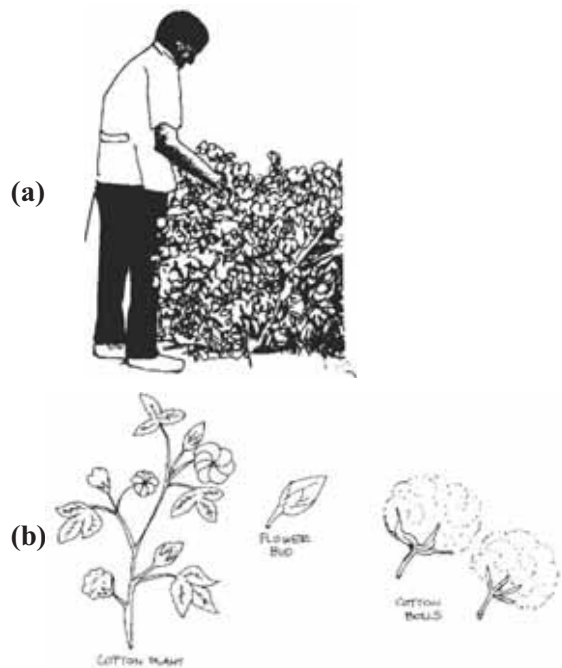


Figure 1: The cotton plant and cotton boll

Cotton is classified according to the length of its fibre. **Long staple cotton** has a length of more than 3 centimetres. It produces finer **yarn** which can be made into fine cloth. **Short staple cotton** is less than 3 centimetres and it can be made into coarser cloth. Most cotton grown is short staple.

We have just described a cotton plant. Let us now focus on the production of the crop in the Gezira. Like I did in the previous topic, I will mostly give you information that you need to read and master. This is because your prior knowledge of what pertains in other parts of Africa regarding Agriculture may be limited.

2.0 The Growing of Cotton in the Gezira (Sudan)

Now that we can describe a cotton plant, let us study one of the largest cotton plantations in the world. First let us find out where this cotton irrigation scheme is located. Study the map (**figure 2**) which shows the location of the scheme.

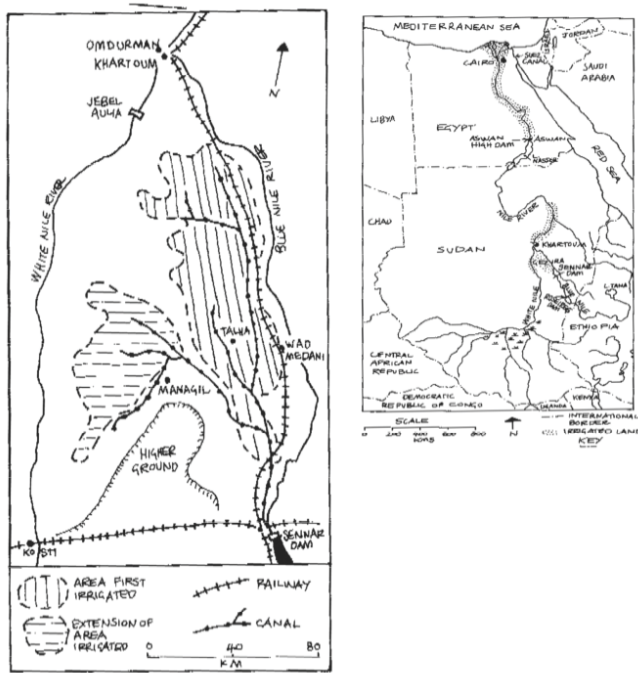


Figure 2: Location of the Gezira scheme

Source: Turner, H. (1994): Africa South of the Sahara

The scheme covers an area of about 800 000 hectares. It is situated between the Blue and White Niles in Sudan. The scheme also lies south of Khartoum (the capital city) and north of the Sennar dam. There are many advantages of this location. Study the map (**fig. 2**) and try to give at least one advantage before you read the next section.

2.1 The advantages of the Gezira location

(a) Adequate water supplies

The Nile river is the major source of water. During the low water season of the Nile, adequate water supply for irrigation is ensured by the Sennar dam and the Roseires dam.

(b) Gentle sloping land

The scheme is in a region of flat or gently sloping land. The land is sloping gently from the Blue Nile to the White Nile. This makes both drainage and irrigation cheaper. The costs are reduced through the use of gravity flow, that is, water can flow easily from higher parts to the lower parts. As a result of this, the Gezira has the lowest irrigation costs in the world. Pumping expenses for such a large farm are greatly reduced.

(c) Fertile dark-brown clay soils

During the floods, the Nile deposits silt on its valley. The clay content of the soil is quite high, so there is no need of water proof-lining of the canals.

(d) The land is well above the water table

With the clay type of soil, we would expect a problem of waterlogging, but this does not occur

because the land is well above the water-table.

(e) Favourable climatic conditions

The climate of the Gezira is ideal for the cultivation of long staple cotton under irrigation, as described.

2.2 Conditions under which cotton grows

We will now look at conditions under which cotton grows. After this you should be able to tell if the Gezira is suitable for growing cotton. Cotton grows successfully under the following conditions:

- A growing season with an annual rainfall of between 500 mm and 1000 mm or the same amount of irrigation water.
- A growing season of about 200 days at a temperature of around 21°C. The place must be completely frost free.
- There must be plenty of sunshine, especially when flowers are forming and also when the fruit is ripening.
- A dry harvest season to avoid any damages which might be caused by the rain.
- Rich deep soils.
- Abundant labour for tendering the plants and harvesting.

When relating the above conditions to the location advantages, we now know that the Gezira is indeed suitable for the growing of cotton. Try as much as possible to match the location of the Gezira to the conditions outlined above and make your own opinion whether or not the scheme is located in a good area. The activity below will assist you in doing that.



Activity 1

What advantages does the Gezira have for cotton growing?

Feedback

The Gezira has the following advantages for growing cotton.

- *Abundant water supply from the Nile river, Sennar and Roseires dams.*
- *Fertile silt soils or rich dark-brown clay soils.*
- *Land above-water table which prevents the problem of waterlogging.*
- *Gentle sloping land which reduces drainage and irrigation cost.*

Let us now look at how this scheme came about.

3.0 Historical Background of The Scheme

The idea of the scheme came about in 1904. Experimental crops were first produced in 1911. The Sennar dam was completed in 1925. The Sudan government nationalised the scheme in 1950 and also set up the Sudan Gezira Board to manage it. In 1962, the Gezira was doubled in size as the Managil extension was completed. This extension has made the Gezira the largest irrigation scheme under one management in the world. In 1966, the Roseires dam was completed. This further ensured adequate supply of water for irrigation and domestic purposes. Study the map (**figure 2**) again and locate the Gezira and Managil extension. The two areas are almost the same size.

3.1 How is the scheme organised?

The scheme is organised at three levels which involves the government, tenant farmers, and the Sudan Gezira Board. The government is responsible for both irrigation and provision of land. The tenants work on the fields to produce cotton. They are responsible for planting, weeding, thinning, harvesting and clearing irrigation canals. There are about 74 000 tenants each owning about 16 hectares on the Gezira and 4 hectares on the Managil extension. The Sudan Gezira Board manages the plantation. It is also responsible for all the production processes and the marketing of cotton.

Having learnt how farming is organised in the Gezira, let us now find out how cotton is cultivated.

4.0 The Cultivation of Cotton

Modern methods of farming are used, for example, the use of machinery as shown by figure 3 below. The cotton seeds are planted in rows of about 1 metre apart. This is done to give the plants enough space as they grow. The sowing of seeds is done in spring. Throughout the growing season, the fields are weeded and sprayed to control insect pests such as the boll weevil. Figure 3 shows cotton thinning done by hand-operated tools like the long sticks shown in the diagram.



Figure 3: Cotton thinning done by hand

The problem of soil erosion is greatly reduced by adding fertilisers to the soil and practicing

mixed farming. Cotton is inter-planted or grown in rotation with other crops. This rotation of crops involves following some parts of the farm. Other crops grown include leguminous crops, maize and cattle fodder. The growing of other crops also reduces the spreading of diseases.

This is how cotton is planted. We have also mentioned that cotton is an irrigated crop. Let us discuss that further to show how it is done at the Gezira.

4.1 Perennial irrigation at the Gezira

We have already mentioned that the Gezira is an example of a large scale irrigation scheme in the world. The method of irrigation used here is called **Perennial irrigation**. Water from the reservoir is led through the main canals using gravity flow. Figure 4 shows the Sennar dam and the main canals. Smaller canals leading to the fields are dug from the main canal. From these canals there are thousands of smaller channels developed in a rectangular system and decreasing in size. The channels carry water throughout the whole scheme.

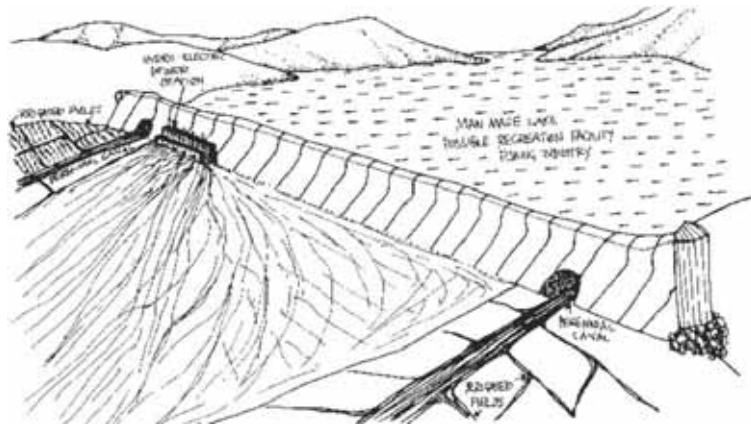


Figure 4: Perennial irrigation



Activity 2

Study the farmer's calendar and a climatic graph for the Gezira and answer the following questions.

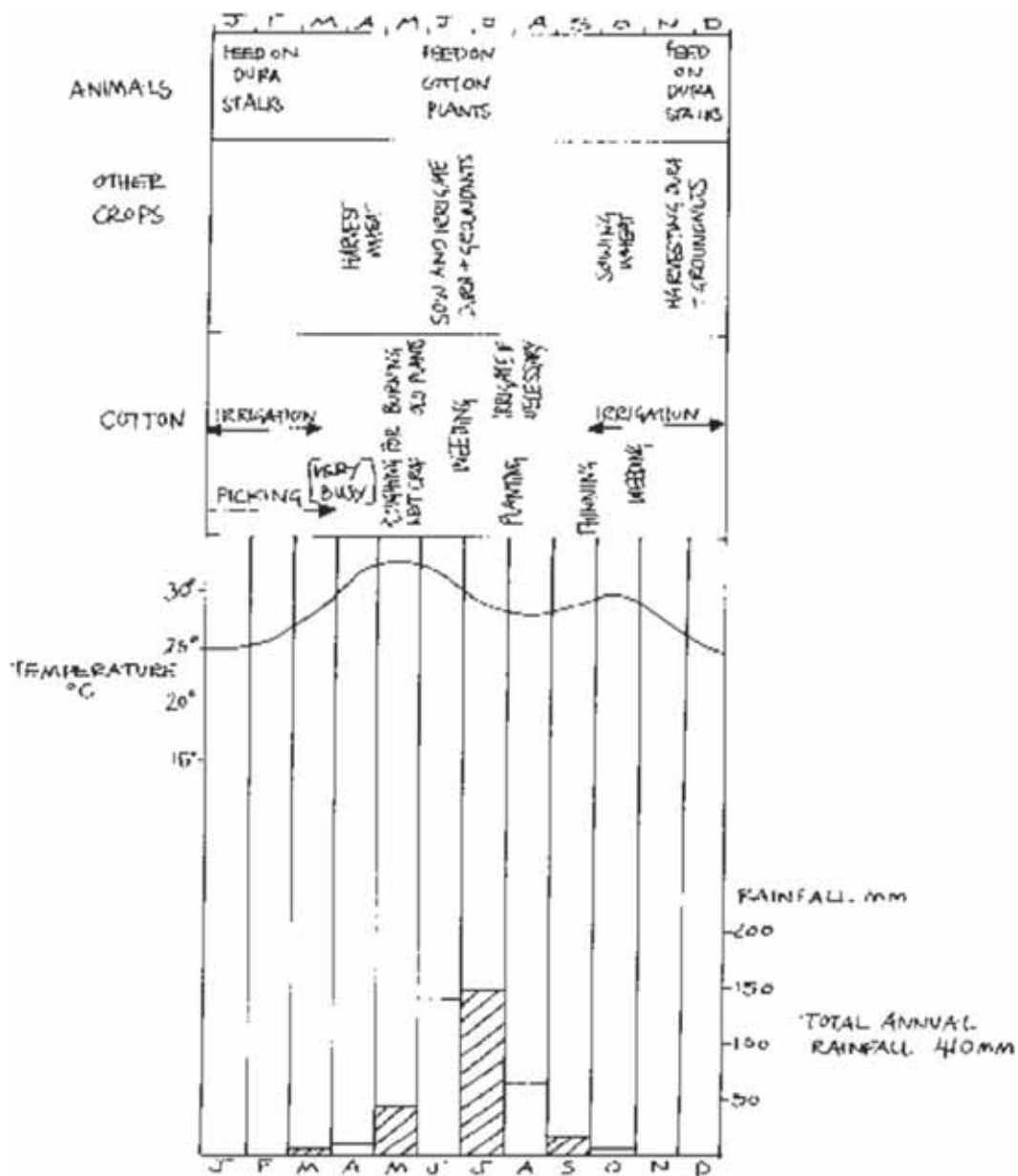


Figure 5: Climatic graph for the Gezira
 Turner, H. (1994): Africa South of the Sahara

1. List two activities conducted during the wet season.

2. In which two months is there less or no irrigation?

3. Why is cotton picking done during the dry period?

Feedback

After studying the graph carefully, I expect the following answers.

- 1. The graph shows that ploughing and weeding are done during the wet season.*
- 2. When cotton is ripe or almost ripe in January and February, there is less or no irrigation.*
- 3. Cotton picking is done during the dry season to avoid rain which can cause great damage to open cotton bolls.*

You have a clear picture of how cotton is grown, let us go on and discuss how it is harvested.

4.2 The harvesting of cotton

As soon as the cotton bolls burst open, they are harvested. From our last activity we have suggested why cotton harvesting is done during the dry season. This is to avoid rain which can cause great damage to the fibres. Abundant labour is required for picking the bolls. Although machines are used, human labour is still preferred because it is selective. Why do you think hand picking is necessary? It is necessary because the cotton bolls do not all open at the same time.

Figure 6 shows cotton picking by a machine.



Figure 6: Cotton picking by a machine

Like any other crop, after harvesting cotton it has to be processed. Have you ever seen sorghum being processed after harvesting? Well, that is for you to find out if you are not familiar with the process. Meanwhile, let us focus on cotton processing at the Gezira!

4.3 The processing of cotton

At the beginning of this topic we learnt that the fibres in the cotton bolls are called **lint**. The first stage of processing involves separating the lint from the seeds. This is called **ginning** and it is done in a machine called a **gin**. A factory where ginning is done is called a **ginnersy**. The lint is then packed into bales which are sent to factories. In these factories, the lint is spun into a continuous thread called **yarn**. The yarn is then woven into cotton cloth.

Having learnt how cotton is processed, let us now find out about its marketed.

4.4 Marketing of cotton

We have already mentioned that the Sudan Gezira Board is responsible for the marketing of cotton. There is a railway system which delivers the lint to at least 10 ginnersies which are at Hasaheisa, Manangan and Barakat. Try to locate these places and the railway system on the **map (figure 7)**. From these ginnersies cotton is sent to Khartoum and to Port Sudan by railway, where it is then exported to Europe.



Figure 7: Cotton ginneries

Source: Turner, H. (1994): Africa South of the Sahara



Activity 3

1. Briefly give the meaning of the following words:

- (a) lint _____

(b) ginning _____

(c) yarn _____

2. The Gezira scheme is organised at 3 levels which involves the government, farmers and the Sudan Gezira Board. Give the major responsibility of each part of the organisation.

(a) Government

(b) Tenant farmer

(c) Sudan Gezira Board

Feedback

If you have carefully read through the topic I expect you to have the following responses.

1.
 - (a) *A lint is a cotton fibre.*
 - (b) *Ginning is a process whereby cotton seeds are removed from the lint.*
 - (c) *Yarn is a continuous thread made by weaving the cotton lint.*
2. *The Gezira scheme is organised at three levels. The responsibilities at each level are:*
 - (a) *the government is responsible for irrigation and provision of land.*
 - (b) *tenant farmers are responsible for growing cotton.*
 - (c) *Sudan Gezira Board manages the farms and market the cotton.*

We have talked a lot about the Gezira scheme so far. But is it of benefit to anybody? Let us discuss that.

4.5 Benefits of the scheme

The scheme has brought the following benefits:

- The economy of Sudan obtains revenue and foreign exchange. The money has been used to pay for some imports and in the developments of the country.
- The scheme has created financial security resulting in a higher standard of living for people living in the Gezira.
- Many people are employed by the tenant farmers. In other words, the scheme has created

employment for many people in Sudan.

- Farmers are also trained in various aspects of plantation work and acquire specialised skills. Adult education is also provided and encouraged.
- There are many wells which provide clean water for domestic purposes.
- Sporting and other leisure amenities are also available.
- Eucalyptus forests are developed to provide building wood.

4.6 Problems of the scheme and their solutions

Although the scheme has many benefits as mentioned above, it also experiences some problems. However, efforts are made to overcome them. The problems experienced are as follows:

(a) Diseases and Pests

Diseases like blackarm and leafcurl ruin the cotton plants. Pests like boll worm and leaf hopper are common and they also cause great damage. Spraying is continuously done in order to fight these diseases and pests.

(b) Weeds

In particular, the seid weed, which competes with crops for soil nutrients.

The weeds are kept under control by weeding and deep ploughing.

(c) The silting up of canal

Silt accumulates in canals causing another major problem. As a result regular dredging is necessary.

(d) Bilharzia

This is another serious problem. People are advised to take the necessary precautions to prevent this disease: for example, avoiding swimming in flood water and boiling water before drinking it.

We have now come to the end of the topic. It is now time to come up with the summary, that is, the main points or ideas of this topic.

5.0 Summary

The Gezira cotton scheme is the largest irrigation scheme under one management in the world. The main cash crop is cotton. However, this is grown in rotation with other crops for food and cattle fodder. Irrigation water is provided by the Nile river. The two important dams for irrigation along this river are the Sennar and Roseires dams. The scheme is organised at 3 levels which involves the government, tenant farmers and the Sudan Gezira Board. The lint from the farms is transported by rail to the ginneries at Hasaheisa, Manangan and Barakat. From the ginneries cotton is sent to Khartoum, then to Port Sudan for export to Europe.

Benefits brought by the scheme include, foreign exchange earnings, job creation, acquiring skills, provision of water and other social amenities. Problems experienced include pests and diseases, weeds, bilharzias and silting of canals. Continuous spraying is done to combat (fight) pests and diseases. Dredging is also done to solve the problem of silting.

This topic also brings us to the end of arable farming. In the next two topics, we will shift our focus to pastoral farming.

But before you continue, check your understanding of Topic 5 by doing Exercise 5 under the Assignment section of the unit.

Topic 6: Subsistence Pastoral Farming in Botswana

Introduction

So far, our discussions have been focusing on arable farming. The next two topics will focus on pastoral farming. I am sure you still remember the meaning of pastoral farming from the unit introduction. Just like arable farming, pastoral farming can be done at both subsistence and commercial levels. Let us discuss these two farming methods further.

In our discussion of subsistence pastoral farming in this topic, we will define this system so that it is not confused with commercial pastoral farming system. You will learn the characteristics of this farming system, and then consider the changes that this farming system is going through and factors that are influencing these changes.

Topic Objectives

By the end of this topic, you should be able to:

- define subsistence pastoral farming
- describe the characteristics of subsistence pastoral farming in Botswana
- describe inputs, activities, output, problems and possible solutions in subsistence pastoral farming
- describe the impact of pastoral farming on the environment
- describe changes occurring in subsistence pastoral farming in Botswana.

Topic Contents List

- 1.0 What is subsistence pastoral farming?**
 - 1.1 Characteristics of subsistence pastoral farming in Botswana
- 2.0 Subsistence pastoral farming in other parts of Africa**
- 3.0 Impact of pastoral farming on the environment**
 - 3.1 Pastoral and arable farming relationship
 - 3.2 Changes taking place in pastoral farming
- 4.0 How does Botswana government assist pastoral farmers?**
- 5.0 Problems facing subsistence pastoral farming in Botswana**
- 6.0 Summary**

1.0 What is Subsistence Pastoral Farming

Subsistence pastoral farming is the rearing of animals that can provide food (e.g. milk, meat), raw materials (e.g. hides) and draught power; that is, the muscle power of pulling or carriage for the

farmers' own needs. Common examples of animals kept are cattle, goats, sheep, donkeys, horses and camels. All these animals are herbivorous. Herbivorous animals are animals that survive by feeding on plants and grasses only. In Botswana, our studies of pastoral farming will focus on the rearing of cattle. They are the most important domestic animals in Botswana. Cattle farmers obtain milk and meat from their cattle. They also use cattle to meet their social obligations such as payment of bride price (*bogadi*), or they are used in exchange for goods or services.

1.1 Characteristics of subsistence pastoral farming in Botswana

This type of farming is common. In many settlements and villages people keep some livestock in the yard. They graze during the day and they are kraaled in the yard at night. They may also grow some crops if the climate and soils of the area are favourable. The practice of raising both livestock and crops is called mixed farming. Subsistence pastoral farming itself is the rearing of animals or livestock to meet the needs of the family. There is rarely any surplus for sale, only in cases of critical needs for money like when one needs to buy some clothes or pay school fees. The motive therefore for keeping the livestock is not to make profit or to make farming a business.

I believe you have been to the cattle-post at some point. It may be your relatives' cattle-post or one for a local farmer. In any case, even if you come from the urban areas, you definitely have seen cattle grazing along the road somewhere in Botswana. Those are mostly kept under the subsistence farming systems. Let us discuss characteristics of such a farming system.

In Botswana, subsistence pastoral farming is characterised by:

(a) Land tenure system

It is carried out in communal areas. Communal areas are land areas that belong to the communities. Every member of the community has the right to graze his livestock in communal areas. This means that livestock farmers share the grazing resources. It is common to see animals belonging to different farmers mixed in the same rangeland, that is, land consisting of natural vegetation that provides forage for grazing animals (e.g. cattle) and browsing animals (e.g. goats). Grazers feed mainly on grass, while browsers feed mainly on leaves of trees and shrubs. Therefore subsistence pastoral farming in Botswana is characterised by communal land tenure system.

(b) Types of animals kept

Pastoral farming in Botswana is dominated by the rearing of cattle which are most important for providing milk, meat, draught power. Cattle are also important for meeting social obligations such as marriage ceremonies, bride price, funerals, exchange for goods or services etc. Small stock (i.e. sheep and goats) are also kept but on a smaller scale compared to cattle.

(c) Range conditions

Rangelands are generally found in areas that are either far away from populated areas (i.e. the cattle posts); or unsuitable for arable farming. Animals can survive longer than crops in areas prone to drought. Western Botswana is known for lack of rainfall, sandy soils, lack of surface water and saline underground water. As a result, large cattle ranches are concentrated to the west,

while the north and eastern Botswana is more suitable for arable farming as we learnt in Topics 1-3.

(d) Family labour intensive

It is generally the male members of a family that are closely attached to the keeping of animals. The activities undertaken include; building kraals for the animals, herding, milking, training cattle to provide draught power, dehorning, ear-marking, branding and dipping where possible. All these activities are viewed as roles for males. Thus, it is generally the boys who would go to or stay at the cattle posts. In very rare instances, girls may be involved in these activities e.g. if there are no boys in the family.

(e) Animal breed

The Tswana breed of cattle is the dominant in Botswana. However, farmers are beginning to appreciate exotic breeds such as the Simmental, Brahman, Afrikander, Hereford, Jersey, Brown Swiss and Tuli. Some farmers prefer to cross-breed the local breed with exotic the ones for improved milk and beef output or resistance to diseases.

That is the situation in Botswana. How about other parts of Africa? Read the section below and compare it to the Botswana situation.

2.0 Subsistence Pastoral Farming in Other Parts of Africa

One form of subsistence pastoral farming common in Africa is Nomadic Pastoralism.

This system involves continual movement of farmers with their livestock from place to place in search of new grazing lands, water or moving away from areas infested with diseases and parasites e.g. tsetse fly. These are the reasons for moving from place to place. Nomadic pastoralism does not exist in Botswana but is found in other parts of Africa e.g. the Masai in East Africa and the Fulani in West Africa.

(a) The Masai

They are found essentially in parts of Kenya and Tanzania. They keep a breed of cattle known as the zebu. The Masai keep cattle essentially for the supply of blood which forms an important component of their diet. Blood is extracted from live cattle by opening an artery from the neck of an animal to let blood run out. This is done to an animal that does not seem to be suffering from any ill-health. The blood is consumed raw while it is still fresh from the animal. Thus, the Masai would not kill cattle for meat. They eat the meat only when the animals die from old age.

(b) The Fulani

These nomadic pastoralists are found in the Sahel regions of West Africa. The Sahel is a belt of a semi-arid environment just below Sahara desert. Their seasonal movements are dictated by the prevalence of tsetse fly in the wetter south. Tsetse fly transmits animal disease called *nagana* or **sleeping sickness** in humans. Tsetse flies breed and spread faster in humid conditions. Thus, the Fulani normally migrate south during the dry season. When the rains start, they move their animals to the drier north to escape from the tsetse flies. Normally, men start a northward migration, herding the animals in spring. The women remain to grow subsistence crops and fodder crops (crops for animal feeds) near river valleys. The men set up semi-permanent settlements on sub-Saharan pastures before returning south at the end of the rainy season. This

seasonal migration of pastoralists is known as **transhumance**. In Lesotho, transhumance involves animals being kept on upland pastures during the crop growing season in the lowlands. The animals are brought to the lowlands after crop harvest.

I hope you remember I asked you to compare the subsistence pastoralism practiced in Botswana with those practiced somewhere else in Africa. Did you realise subsistence pastoral farmers in Botswana are more settled than those in other parts of Africa?

Now, let us see the impact of this type of farming on the environment.

3.0 Impact of Subsistence Pastoral Farming on the Environment

As we have seen, subsistence pastoral farming is a communal activity. Every member of the community brings his/her animals on the same piece of communal land. As a result subsistence pastoral farming has a great impact on the environment. This impact includes:

(a) Degradation of rangelands

Rangeland degradation is the depletion of natural vegetation in the rangeland. It is the result of overstocking of animals in communal areas that leads to overgrazing of the rangelands.

(b) Increased rate of desertification

Overstocking of animals also leads to desertification i.e. the process whereby more and more land becomes more and more like a desert, with less vegetation cover. This occurs when the overgrazed land fails to recover its vegetation. This is the process which deserts are spread.

(c) Increased soil erosion

Where there are too many animals in the rangeland, the soil conditions deteriorate. Once animals trample and loosen the soil, the soil becomes more vulnerable to erosion by winds and running water.

In Topic 2, we discussed subsistence arable farming. In this topic, we are discussing subsistence pastoral farming. Is there any relationship between the two? Let us discuss.

3.1 Pastoral and arable farming relationship

We should acknowledge that subsistence pastoral farming is closely related to subsistence arable farming. Can you mention ways in which the two systems are related?

Here are some ways in which they are related.

- First, the animals are used to provide draught power (muscle power for pulling) during the ploughing of the lands to grow crops.
- Secondly, animals feed on crop remains after harvest, and
- Thirdly, animal droppings are used as manure to fertilise crop fields.

Therefore balanced arable and pastoral farming can sustain the productivity of the environment.

Human activities do change with time. The same applies to the pastoral farming system as discussed below.

3.2 Changes taking place in pastoral farming

Now, the changes occurring in subsistence pastoral farming include the following:

- Livestock farmers are gradually shifting from using cattle for draught power to raising beef cattle for the market.

Traditionally, livestock farmers put value on large numbers of cattle, which reflected his social status. But of lately, many cattle owners see the value of quality rather than quantity of their livestock. They keep improved breeds of cattle, in numbers that can be easily managed. When cattle have reached a stage of processing for beef, they sell them out to the Botswana Meat Commission without delay.

- The other change is that of cattle breeds kept by farmers. In Botswana, the dominant breed is the Tswana. In the past, it was the only cattle breed kept by local farmers. However today, they keep mixed or cross-breeds. The Brahman, the Simmental and the Hereford are some of the exotic breeds kept by local cattle farmers today.
- The traditional system of ‘mafisa’ is dying off. The *mafias* system is where by a farmer would keep cattle for another farmer. It was seen as a mutual benefit in that the one keeping the animals would benefit from the milk and the draught power they provided. The other one would be free from the tiring husbandry tasks, and could seek cash employment in urban areas; or even in most cases, at the South African Mines.

We can conclude that the changes occurring are due to the importance attached to commercialisation of farming. Farmers aim to maximise profit out of their farming activities. They want to recover the costs incurred in securing the inputs. You should understand that farming is a system that goes through stages as shown in figure 1.

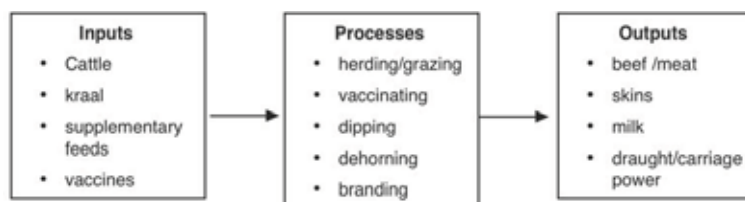


Figure 1: Stages in a farming system

Let us discuss these stages briefly.

Inputs are things that the farmer provides. In the case of animal husbandry, inputs include supplementary feeds such as lucerne, molasses, and winter lick. These are nutritional feeds that the farmer may provide for livestock in addition to the natural input of forage (grasses and shrubs that animals feed on in the bush). Supplements are meant to improve the quality and quantity of beef and milk output from the livestock. Other inputs include vaccines to prevent animal diseases, and labour to take care of livestock on a daily basis. However, it is important to note that generally subsistence farmers are not able to provide the necessary inputs. In fact, it is the commercial farmers who can afford to provide the farmer’s inputs.

Processes in a farming system refer to all the activities that the farmer does in maintaining the livestock. In the case of subsistence farming in Botswana, farmers build kraals for their animals,

they milk, they train animals to pull (provide draught power), they herd, they earmark, they brand and they dehorn.

It is often by doing this (performing processes), that the farmer is able to get the output as listed in figure 1 above. So, outputs are what you get by transforming inputs through processes.

4.0 How does the Botswana Government Assist Subsistence Pastoral Farmers?

Some of the efforts of the Government to assist farmers include:

- provision of cordon fences to control spread of diseases such as foot-and-mouth.
- provision of free vaccination to prevent diseases such as anthrax
- subsidised artificial insemination services, to produce cross-breeds that can resist drought or produce quality beef or milk
- bull subsidy scheme so that farmers can buy better breeds of bulls at lower prices
- provision of loans for dams fences and boreholes
- Tribal Grazing Land Policy (TGLP), to reduce stocking rates or overstocking in communal areas.

The output of a farming system is the end product of the system. In pastoral farming, the output include: milk, beef (meat) and dairy products such as butter, cheese, yoghurt, as well as hides for manufacturing leather goods.



Activity 1

1. State any **three** characteristics of subsistence pastoral farming in Botswana.

2. What is meant by nomadic pastoralism?

3. Describe any **three** impact of subsistence pastoral farming on the environment in Botswana.

Feedback

1. *You most probably stated any of these:*
 - *It is carried out in communal areas*
 - *There is no proper range management*
 - *The rearing of Tswana cattle is dominant*
 - *Labour provided by male members of the family.*
2. *Nomadic pastoralism refers to the continual movement of farmers with their livestock.*
3. *Subsistence pastoral farming has the following impact on the environment.*
 - Soil erosion**- *animal hooves loosen the soil and make it liable to erosion.*
 - Overgrazing** - *communal areas are easily overgrazed because there is no proper range management .*
 - Desertification** *is accelerated by overstocking and overgrazing.*
 - Pollution** *of surface water resources by agricultural materials washed in from nearby farmlands.*

5.0 Problems Facing Subsistence Pastoral Farming in Botswana

Can you think of problems that your parents and brothers normally relate concerning animal rearing? You probably can brainstorm some of them as drought, cattle stray, insufficient pastures, predators, lack of fodder crops or feed supplements, and animal diseases. We will briefly elaborate on each of these problems and suggest possible solutions to each problem.

Drought: It is the general lack of rain. There are years when the rains are insufficient to support the growth of grasses or provide water for livestock. The animals will be thin and the milk and beef output will be low and of poor quality. In severe cases animals may die. As a result the farmer's income will be low as they may lose the animals altogether.

Possible solutions: Boreholes can be drilled to provide drinking water. Supplementary feeds can be provided to save the animals from starvation. Fodder crops (i.e. crops grown for feeding to animals) can be grown by irrigation methods.

Cattle stray: It involves a few animals moving away from the herd to distant areas/districts.

Possible solution: Farmers should keep a manageable size of herd. The radio Botswana Programme, 'Matimela' helps announce stray animals, which farmers can identify by brands.

Diseases: common animal diseases are foot-and-mouth, lung diseases (also known as **Contagious Bovine Pleuro-Pneumonia – CBPP**), anthrax, brucellosis, *nagana*, lumpy skin.

Possible solutions: First, farmers should dip the animals regularly to eliminate ticks and other insects. The government provides free vaccination to prevent diseases such as anthrax and brucellosis. The government also makes effort to eradicate the tsetse fly which transmits *nagana* (sleeping sickness). Veterinary services provide vaccines and information on animal health.

Furthermore, cordon fences have been erected to control movements of animals, including wild animals such as buffalo which can spread foot-and-mouth.

6.0 Summary

In this topic, you learnt about the features of subsistence pastoral farming. It is a common system in Botswana. You learnt also about the Masai and Fulani pastoralists who are nomads. Soil erosion, overgrazing are the major environmental problems caused by pastoral farming. You learnt also, about changes that are taking place in subsistence pastoral farming in Botswana. Basically, the traditional methods of animal husbandry are gradually being replaced by modern commercial methods. You learnt also about the problems faced by pastoral farming, and government efforts to assist farmers overcome some of the problems. The next topic is about commercial pastoral farming, which I have just said is gradually replacing traditional methods.

It is now time for you to work on Exercise 6. Remember to check your answers like you were advised in the previous topics.

Topic 7: Commercial Pastoral Farming

Introduction

In contrast to Topic 6 which introduced you to subsistence pastoral farming, in this topic, you will learn about commercial pastoral farming system. You will realise that this system is different from the subsistence system, which we discussed in Topic 6. The difference is mainly with regard to the way the land is acquired and used, and the aim for rearing cattle.

Topic Objectives

By the end of this topic, you will be able to:

- define commercial pastoral farming
- locate commercial pastoral farming areas on a map of Botswana
- describe the characteristics of commercial pastoral farming
- describe some government programmes designed to help commercial pastoral farmers.

Topic Contents List

- 1.0 Characteristics of commercial pastoral farming**
- 2.0 Factors affecting pastoral farming**
- 3.0 Problems faced by pastoral farmers in Botswana**
- 4.0 Government efforts to assist livestock farmers**
- 5.0 Summary**

1.0 Characteristics of Commercial Pastoral Farming

We have already discussed the concept of commercial farming in Topic 3. We also discussed that commercial farming can be extensive or intensive. Commercial pastoral farming is capital intensive. What do you understand by the term 'capital intensive'? You have read about it when you were dealing with arable farming business. As such, try to apply the definitions you have learnt under arable farming to pastoral farming.

Capital intensive means that a lot of money is put into the farming system. For instance, in buying or hiring land for a ranch, buying vaccines, supplementary feeds, paying for labour etc.

It is carried out in commercial or freehold farms such as those in the Ghanzi or the Lobatse-Gaborone Block (see the fig 1). Under freehold land tenure, an individual has complete ownership of land and is free to use it the way he/she chooses. Can you now tell the difference between communal land tenure and freehold land tenure?

Yes, under communal land tenure, the land belongs to the community and nobody takes the responsibility to use rangelands sustainably. But under freehold land tenure, the farmer takes all the responsibility of managing the farm. Ideally, freehold is better for encouraging agricultural production.

The labour is employed. A commercial farmer employs people (usually men) to take care of the animals. Freehold farm blocks include Ghanzi, Gaborone-Lobatse, Tuli and Tati blocks, see the map below.

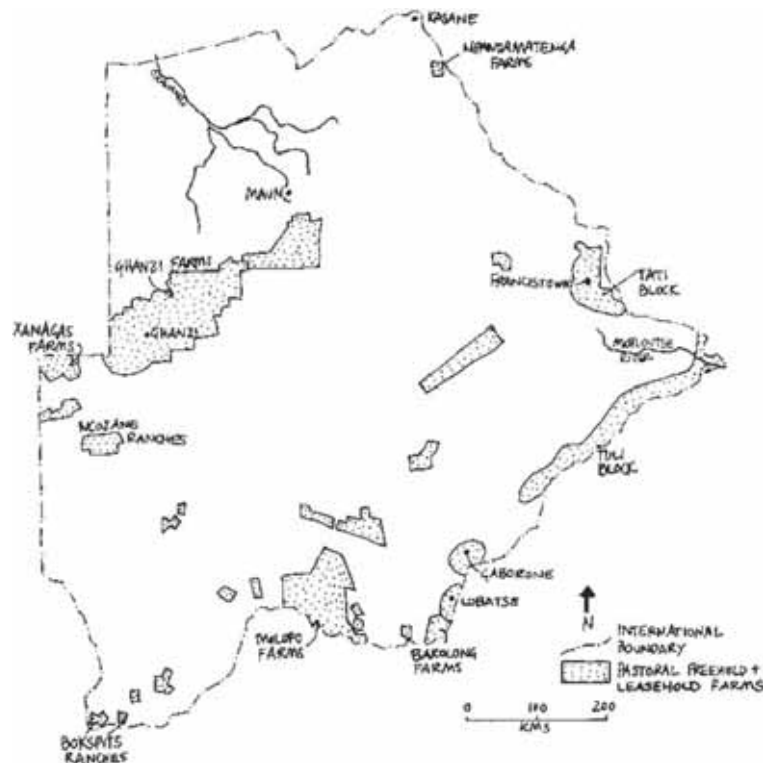


Figure 1: Botswana: Commercial pastoral freehold farm blocks



Activity 1

Study the map (fig.1) and answer the following questions.

1. Name the **three** land tenure systems of pastoral farming in Botswana.

2. Name **two** commercial ranches in Botswana.

3. What advantages does ranching have over free range system?

Feedback

1. - communal / customary
- freehold
- leasehold
2. -Ghanzi block
- Gaborone-Lobatse block
- Tati block
- Tuli block
- Molopo CDC farms.
3. Ranching

- *animal movement is controlled*
- *grazing is controlled e.g. rotational grazing*
- *animals are regularly checked, dipped, watered, fed with supplements*
- *high beef and milk output*

Free range

- *no control, animals can go missing*
- *overgrazing can easily occur*
- *no regular maintenance*
- *low beef and milk output.*

2.0 Factors Affecting Pastoral Farming

(a) Climate

You should have learnt that crops are affected by the conditions of climate, in terms of amounts of rainfall, levels of temperatures. Similarly, animals are also affected by these conditions. Higher amounts of rainfall are good in that they lead to fresh and plentiful pastures. Animals such as cattle and goats do well in warm than cold seasons. Thus, temperatures should preferably be moderate for most livestock.

(b) Land tenure systems

Land tenure refers to the way the land is owned and used. In Botswana there are two land use systems of communal and freehold land tenure. Do you remember what each of these systems involves? You are right if you said that communal land is the land that belongs to the community, whereas freehold land is owned by the individual or a private company. The individual tenant has absolute ownership of the land under freehold system. He can use it any way he wants, or even sell it, or lease (loan it out) it to another farmer.

(c) Cultural factors

Most subsistence pastoral farmers regard livestock, particularly cattle, as a source of wealth and prestige. As such, they do not use their livestock wisely; instead they tend to keep larger and larger herds just for prestige. This tendency readily leads to the problem of overstocking of animals in a limited rangeland.

(d) Breed of animals

Certain breeds of cattle do better than others under certain climatic conditions. Thus, some breeds of animals can withstand drought much better than others. Also, some animal breeds yield better milk or beef than others. The Hereford, for instance, is best known for beef while the Jersey is known for milk. The Brahman can withstand drought better than the Tswana breed.

Farmers sometimes choose to keep breeds produced from two different breeds. For instance, a Simmental bull can be made to mate with a Brahman cow to produce an offspring between the two breeds. This process is known as **cross-breeding**. Cross-breeding is normally done in order to improve the milk or beef output of a pure breed. It is also done to produce a breed that can resist harsh conditions such as drought.

There are many more factors affecting pastoral farming. Discuss with your study mates and even your tutor these factors and see how they would affect you if you were to be a pastoral farmer.

Next let us discuss problems faced by these pastoral farmers.

3.0 Problems faced by livestock farmers in Botswana

Problems faced by livestock farmers include the following:

(a) Drought

Botswana's climate is characterised by low and unreliable rainfall. As a result, grazing lands get degraded due to lack of sufficient rainfall. Prolonged drought also kills livestock.

(b) Overgrazing

Overgrazing occurs as a result of overstocking. We have already established that every farmer aims to increase his herd. As a result, the grazing areas are severely overgrazed.

(c) Lack of fodder crops

During drought, most animals die because farmers cannot provide supplementary feeding. Supplementary feeding is the provision of extra feeds for animals to supplement the natural forage.

(d) Animal diseases

Cattle diseases such as foot-and-mouth, anthrax, lung diseases (contagious bovine pleuropneumonia – CBPP) can adversely impact on animal mortality. Some years ago many cattle were killed in Ngamiland because of lung disease (CBPP).

(e) Shortage of grazing land

The livestock farming compete for land with other land use activities e.g. wildlife. This competition for land has often caused friction between farmers and wildlife conservation activists.

With all these problems, it is evident that farmers should be assisted somehow.

Do you still remember what we said in Topics 1 and 2 about food security and sufficiency? In case you forgot, go back and refresh your mind. Also, remember that food comes from both crops and animals. Just like we discussed earlier about how government assists arable farmers, let us do the same with pastoral farmers.

4.0 Government efforts to assist livestock farmers

Now that we know the problems faced by pastoral farmers, let us find out efforts made by the government to assist them. They include the following:

4.1 The Tribal Grazing Land Policy (TGLP)

We have already noted that land use system is one factor that affects pastoral farming. In 1975 the Botswana Government introduced the TGLP. The policy is all about improving access to grazing land for livestock farmers in the country. The objectives of TGLP include among others:

- (i) to reduce livestock numbers in communal areas.
- (ii) to create commercial ranches for big cattle owners.
- (iii) to improve the quality of grazing areas, by limiting overgrazing.

(iv) to improve the living standards of livestock farmers in communal areas.

(a) Evaluation of TGLP

The TGLP succeeded in creating commercial ranches in the Ghanzi Block, and having large herds of cattle transferred to the commercial areas. However, we cannot say that TGLP has been altogether successful. There are some problems:

- (i) the big farmers did not manage the ranches properly, and the perimeter fences collapsed.
- (ii) the cattle from the ranches moved freely back to communal areas.
- (iii) the problem of overstocking and overgrazing continues in both commercial ranches and communal areas. Every farmer aims to increase his herd, and as a result, overstocking occurs.
- (iv) another management problem of TGLP ranches is that the ranchers (farmers) operate their ranches like cattle posts. The farmers themselves reside in urban areas where they may be working as civil servants and have little time to attend to their farms.

From the above listed points, you would realise that the TGLP has mixed results. Below is a list of some of the problems that could still make pastoral farming problematic despite government intervention.

4.2 Artificial insemination (AI)

The Ministry of Agriculture provide technical assistance to farmers to help them cross-breed their herds. AI involves a process of obtaining semen (reproductive fluid) from a bull and introducing it into the uterus of a cow which is in heat (i.e. one which is ready for mating).

4.3 Bull subsidy

It is a programme to assist syndicate or community farms of low-income groups. The main aim of the bull subsidy is to assist farmers to improve their herds by selling them better quality bulls of Brahman, Simmental, Tuli, Tswana and Bonsmara breeds at subsidised prices.

4.4 Free vaccination

The Ministry of Agriculture provides free vaccination to prevent animal diseases such as anthrax, foot-and-mouth and *brucellosis*.

4.5 Cordon fences and quarantine camps

The Government has erected fences along district boundaries to prevent the movement of animals from one district to another. The main aim of cordon fences is to prevent the spread of animal diseases, such as foot-and-mouth, from one district to another. Cattle are regularly dipped at quarantine camps to control ticks and other parasites.

Drought, animal diseases, overstocking and shortage of grazing lands are other problems. However, some efforts are being made to overcome some of these problems. For instance, supplementary feeds are to overcome shortage of pastures, vaccination and dipping to control diseases. For example, Government at times supplies subsidised bales of hay during drought.



Activity 2

1. Explain how each of the following may have a negative impact on livestock farming:

(a) culture

(b) climate

2. State any **two** problems faced by pastoral farmers in Botswana. State possible solutions to each problem.

Problem	Solution

Feedback

- Farmers keep large herds for social status, resulting in overgrazing.*
 - Lack of rainfall results in shortage of pastures and overgrazing/rangeland degradation.*

2.

Problem	Solution
<i>Diseases</i>	<i>Vaccination</i>
<i>Shortage of water</i>	<i>Boreholes drilled</i>
<i>Shortage of pasture</i>	<i>Supplementary feeding</i>
<i>Overstocking</i>	<i>Rotational grazing</i>

6.0 Summary

You have learnt that commercial pastoral farming is about capital investment. A lot of money is

put into the farming system to make profit.

Climate, animal breeds, culture and land use system are factors that influence pastoral farming. You learnt about some of the efforts of the government to assist or help farmers increase the output from their farms. They include: the Tribal Land Grazing Policy, Artificial Insemination Programme, free vaccination, cordon fences and quarantine camps.

Inputs of the commercial pastoral system include: commercial ranches, supplementary feeds, vaccines, exotic animal breeds and hired labour. The processes or activities include fencing of ranches, regular vaccination and dipping, provision of water by building dams or pumping boreholes, dehorning and branding. Milking is also done in the case of dairy farming. The outputs are beef and milk.

Drought, animal diseases, overstocking and shortage of grazing lands are some of the problems facing pastoral farmers. However, some efforts are made to overcome some of these problems. For instance, supplementary feeds are to overcome shortage of pastures, vaccination and dipping to control diseases.

You can now work on Exercise 7 and thereafter verify your answers with those provided as you have done in previous topics.

Topic 8: Efforts and evaluation of schemes to increase agricultural output and the impact of agriculture on the environment

Introduction

You are coming to the end of this unit. You would have realised that the content of this unit is extensive but each of the topics have similar trends. In Topics 1, 2 and 3 you have learnt about subsistence and commercial arable farming in Botswana. At this stage you should be able to state the major characteristics of these agricultural systems. We have also discussed the problems farmers of either system face. This topic will therefore focus on the evaluation of schemes the Botswana government has over the years put into place to promote agricultural production. These schemes are ALDEP, ARAP, CEDA and other programmes. You may have heard of some of these schemes. Please note that some of these government programmes have been phased out but we still have to assess the role they played in improving agricultural output. We shall also discuss the response of arable farmers to the schemes, as well as their problems in using them. The second part of the topic will address the impact of agriculture on the environment, such as, soil erosion, deforestation, salination and pollution. Our examples shall be drawn from farming systems in Botswana. We will also suggest possible solutions to these environmental problems.

Learning Objectives

At the end of this topic, you should be able to:

- evaluate the impact of government schemes such as ALDEP, ARAP, and FAP aimed at improving agriculture in Botswana
- discuss the response of arable farmers to government schemes

- discuss the benefits and problems of accessing the assistance of these schemes
- discuss the impact of agriculture on the environment.

Topic Contents List

1.0 Government schemes aimed at increasing agricultural output

2.0 Arable Lands Development Programmes

- 2.1 How was ALDEP assistance obtained?
- 2.2 Which other institutions were involved with ALDEP?
- 2.3 Limitations of ALDEP
- 2.4 How can the problems that ALDEP faced be avoided?

3.0 Accelerated Rainfed Arable Programme (ARAP)

- 3.1 What did ARAP achieve?
- 3.2 Drought Relief for Arable Farmers Programmes (DRAPF)
- 3.3 What problems did ARAP and DRAPF face?
- 3.4 What is Citizen Entrepreneurial Development Agency (CEDA)?

4.0 Impact of Agriculture on the Environment

- 4.1 Deforestation
- 4.2 Soil erosion
- 4.3 Soil salinisation
- 4.4 Pollution

5.0 Summary

1.0 Government Schemes Aimed at Increasing Agricultural Output

In the previous topic we have identified problems affecting agriculture at both subsistence and commercial levels. These problems have resulted in low agricultural output. The government through the Ministry of Agriculture has made some efforts to examine its policies aimed at improving agricultural output. After identifying problems facing arable farming, it came up with the following policy objectives.

- improvement of food security at both household and national levels
- diversification of agricultural production base
- increased employment opportunities within the agro-based industries
- provision of secure and productive environment
- conservation of scarce agricultural and land resources.

In order to implement (carry out) the above policy objectives, certain strategies were to be decided. The main strategies decided upon involved a widespread use of modern farming methods through intensified extension services and government-financed programmes. Among these programmes were Arable Land Development Programme (ALDEP), Accelerated Rainfed Arable Programme (ARAP), Drought Relief for Arable Farmers Programme (DRAPF), Crop

Production Unit (CPU), Financial Assistance Policy (FAP) etc.

In this topic we will discuss the main programmes, some of which have been phased out. Let us discuss one programme at a time.

2.0 Arable Lands Development Programme (ALDEP)

You probably remember about ALDEP, which was launched in 1980 as an attempt to overcome problems facing agriculture in Botswana. It was formed in order to:

- increase food production so that the country becomes self-sufficient and reduce food imports
- improve incomes of small farmers
- create jobs and reduce the problem of rural-urban migration.

This programme was actually aimed at low-income households who cultivate less than 10 hectares. ALDEP identified more than 70 000 people in need of assistance. So far, ALDEP has helped more than 35 000 farmers. The implementation of this programme was done in phases. During the first phase which started in 1980, farmers were assisted with draught power, farming tools, fencing materials and water catchment tanks.

In July 1996 phase 2 of this programme commenced (started) with the aim of strengthening extension services and training, facilitating technology transfer and encouraging effective use of previously obtained technology. Farmers who qualified for ALDEP packages benefited a lot. The ALDEP package included draught power, fencing materials, water tanks, farm tools/implements (such as ploughs, cultivators, harrows, planters and scotch carts), threshing machines, chaff cutters and fodder seeds.

Farmers had to acquire this package under the **down payment/grant scheme**. According to this scheme, female headed households paid 10% while male headed households paid 15% of the total cost of the package they required. The balance in each case was paid as a grant through this programme.

The down payment/grant scheme was handled by the Ministry of Agriculture. Farmers had to apply through their District Agricultural Officer and through their local Agricultural Offices.

2.1 How was ALDEP assistance obtained?

Farmers who could apply for the scheme or who were eligible for this scheme were those who satisfied certain conditions. From the local farmers and the media you may have heard about some of these conditions.

You may still ask farmers in your area to tell you the story of ALDEP and how they used it.



Activity 1

1. List any **three** conditions which farmers had to satisfy in order to benefit from ALDEP.

2. Were most farmers able to meet ALDEP requirements? Explain your answer.

Feedback

Most farmers were not able to meet the required contributions in order to benefit from ALDEP scheme because of widespread poverty. Also farmers living and working on communal lands didn't have the necessary documents.

Only those who satisfied the following conditions could apply for ALDEP packages. These are the conditions for getting ALDEP assistance.

- *not owning more than 40 cattle or earning an income of more than P20,000 per annum.*
- *being in possession of (having) the National Registration Card (Oman).*
- *being actively involved in arable farming.*
- *having a Land Board Certificate.*
- *agreeing to undertake crop management practices and attending training courses as advised by the Agricultural Demonstrators.*

There were additional conditions for specific packages. For example, an applicant could not get water catchment tanks without a galvanised roof catchment system.

2.2 Which other institutions were involved with ALDEP?

In order to achieve its objectives, ALDEP also used institutions such as National Development Bank (NDB), Botswana Agricultural Marketing Board (BAMB), Co-operatives and the Financial Assistance Policy. We have already discussed some of these institutions in Topics 1, 2 and 3. NDB lends money to farmers. For example, farmers may get loans to buy machines and develop water resources. BAMB supplies farm inputs such as bags, seeds and fertilisers. Farmers can also sell their produce to BAMB. Farmers were given grants (a free gift of money) under Financial Assistance Policy (FAP). This money could be used to pay the farm workers and source other inputs. A farmer was required to contribute 10 or 15 % per cent of the total cost of a project depending on whether they were male or female headed household respectively.

2.3 Limitations of ALDEP

Do you think ALDEP successfully achieved all its objectives? Maybe you can find out from your local farmers. But to my mind, not all objectives were achieved because of the following reasons:

- Poor climatic conditions which include high summer temperatures, low rainfall and long periods of drought. All these have resulted in crop failure, despite ALDEP assistance.
- Inability of farmers to meet their contributions of either 10% or 15% of the total cost. This is due to widespread poverty among small farmers.
- The programme was not effectively implemented because of shortage of specialised personnel (skilled manpower) and inadequate transport for extension workers.
- Some farmers were reluctant to adopt the new farming methods due to their traditional beliefs.
- Poor infrastructure which resulted in poor farm-industry linkages. In other words, the farmers are not closely linked to the industries which consume their products.
- High input costs. Therefore, farmers were not able to meet their contributions in order to benefit from the grant.

2.4 How were the problems that faced ALDEP addressed?

In order to address some of the above mentioned problems, the following strategies were adopted.

- Teams of agricultural specialists were to carry out extension work with farmers.
- Providing infrastructure in highly productive areas to reduce marketing costs.
- Encouraging farmers to produce drought tolerant crops such as sorghum.
- Providing information based on agro-climate, financial assistance and available technology.
- Strengthening farmer training on technical and farm management.
- Forming a joint venture on farm research and ensuring proper adoption of available technologies.

Not all strategies adopted were successfully implemented (carried out). This led to ALDEP being phased out in the year 2000.

3.0 Accelerated Rain-fed Arable Programme (ARAP)

Do you also remember this assistance scheme? ARAP was another programme which worked with ALDEP to improve agricultural output in Botswana. ARAP was launched in 1985 to help medium scale farmers, but it was later opened to all farmers. It was introduced as a drought recovery measure, that is, to assist farmers who were hard hit by drought. The main problems addressed by ARAP were as follows:

- shortage of draught power for ploughing
- shortage of seeds
- water shortages.

In addition to addressing these problems, ARAP had to carry out the following functions:

- Most farmers switched from animal ploughing to tractor ploughing, which meant that tractor owners got all the ploughing subsidies and the use of draught power was stopped. This resulted in the termination of ARAP since its methods were flouted.

3.4 What is Citizen Entrepreneurial Development Agency (CEDA)?

At present, most of the schemes discussed above have long been discontinued. Even FAP and SMME are being phased out and replaced by CEDA. CEDA is a money lending agency which is administered by the National Development Bank (NDB). The agency was formed to address the shortcomings of programmes like FAP and SMME. It deals with problems affecting development and participation of citizens in all sectors of the economy. CEDA focuses on the promotion of viable (practicable or feasible), sustainable, citizen-owned businesses through:

- provision of finance (giving loans) to start or expand a business
- monitoring or closely supervising the financed business
- providing management skills to entrepreneurs
- sharing of risks in case of business failure.

The scheme is available to new start up businesses, for the expansion of existing businesses, and for purchasing shares in foreign owned businesses. Specific requirements for CEDA loans are that the applicant must supply:

- business plans / proposal giving details of how the business will generate income
- evaluation of proposals
- premises where the business will operate
- security against the loan, that is, a property which can be sold to recover the loan
- compulsory reporting on progress, providing information on the performance of the project from time to time.



Activity 2

How will CEDA benefit arable farmers in Botswana?

Feedback

As we have mentioned earlier, CEDA has been formed to assist all citizens to participate in all sectors of the economy. Through this scheme arable farmers can secure loans for purchasing farm equipments or machinery, expanding their farms, for hiring commercial farms, and for starting arable commercial businesses e.g. market gardening.

4.0 Impact of Agriculture on the Environment

In the previous topics of this unit, you have learnt that agriculture is an important economic activity which provides food and raw materials. As the world's population increases the demand for food and raw materials also increases. This has resulted in the environment being put under stress. More land is cleared for cultivation, new seeds and fertilisers are used to increase production. Most countries have used various methods to double the production of cereals. This is known as the **green revolution**.

Now we shall discuss examples of the impact of agriculture on the environment. These impacts are:

- deforestation
- soil erosion
- salination
- pollution.

4.1 Deforestation

We have already learnt a lot about forests in Unit 7. Forests cover a large area of the earth's surface. The map (figure 1) shows the distribution of the 3 main types of forests, which are: coniferous, deciduous and the evergreen tropical rain forests.



Figure 1: Distribution of the 3 main types of forests

In Unit 7, we discussed the importance of forests in regulating climate, releasing oxygen to the atmosphere and absorbing carbon dioxide, preventing soil erosion, providing a wide range of food and raw materials, being part of the hydrological cycle and providing a habitat for both plant and animal species. Forests are also an important source of income and employment. Even though we are aware of the importance of forests, they are being removed at a fast rate. This process of removing forests is called deforestation.

- (a) Reasons for deforestation

We have seen trees or forests in our local areas being cut for various purposes. Try to list reasons for cutting trees in your area. In many parts of the world forests are cleared for agriculture or the cultivation of crops. Both commercial and subsistence farmers clear land for farming. We have learnt that plantations are very large farms. This means that large pieces of land are cleared for plantations. In the tropical regions shifting cultivation is practiced. It is also known as the slash and burn method. It is a system of agriculture where farmers cultivate pieces of land for about 4 to 5 successive years and then shift to new land with the intention of coming back when the previous land has regained fertility.

What impact does shifting cultivation have on the environment?

The trees on these small plots are felled, and then burnt. Therefore, a lot of land is cleared of forests as farmers shift to clear another area. In other words, they cause deforestation.

(b) The Effects of deforestation

We have learnt that farming at both subsistence and commercial levels cause deforestation. The clearing of forests for crop cultivation has the following impact on the environment:

- forests are part of the ecosystem and their destruction can cause the extinction of some animal and plant species.
- the soil loses its fertility from lack of vegetation humus. The nutrient cycle is also broken.
- the area becomes bare of vegetation and then is exposed to various agents of erosion. The top soil may be leached or eroded.
- floods or a greater run-off may occur during heavy rains as less water infiltrates the soil.
- the climate of a deforested area may be modified as less water returns into the atmosphere through evapo-transpiration. This would mean less rainfall and sometimes drought conditions.
- Evaporation increases in areas bare of vegetation.
- The burning of forests, for example, through the 'slash and burn' method of cultivation, increases carbon-dioxide in the atmosphere. This increases what is called 'the greenhouse effect' which changes global temperature and rainfall patterns.

4.2 Soil erosion

We have already mentioned one of the major causes of soil erosion, that is, deforestation. The land cleared for crop cultivation is exposed to agents of erosion. Even though top soil is classified as a renewable resource, when it is bare of vegetation the removal of soil is faster than soil formation. This is because normally the roots of vegetation bind soil particles together and reduces erosion. Vegetation also adds humus to the soil. This also binds soil particles together. Trees also act as windbreakers therefore, they reduce soil erosion caused by wind.

Unsustainable methods of farming also cause soil erosion. Some countries like Lesotho are mountainous and there is shortage of farmland. Farming takes place on steep slopes when ploughing down the slope, water run-off is fast and increases soil erosion. Another unsustainable method of farming is growing crops throughout the year. Examples of annual crops are sorghum and maize. Such annual crops do not give the land a chance to recover organic matter. Shifting cultivation or 'slash and burn' farming also reduces organic matter that is necessary for humus

formation in the soil. Chemical fertilisers used by commercial farmers are rich in salts. They are used to increase crop production, but they break down the structure of soils.

Soil erosion has the following impact on the environment:

- land loses top soil and becomes infertile
- huge gullies or dongas may cover large areas
- eroded material deposited in rivers, lakes/dams and the sea destroys marine life
- land which has lost top soil becomes compacted and hard, thus increasing water run-off and flooding
- hard and compacted areas have less water infiltration and this results in the water table being lowered.

(a) Possible solutions to soil erosion problems

Can you think of any ways that soil erosion can be lessened in your local area. Some of the solutions to soil erosion include:

- contour ploughing - ploughing across the slope
- terracing - ploughing across the broad steps that run across the slope
- strip cropping - planting different crops in alternating rows, for example, maize and legumes
- intercropping - planting several crops together in strips
- crop rotation - planting a field with different alternating crops from year to year
- tree planting - practicing afforestation or reafforestation
- using organic fertilisers, that is, compost, animal manure and green manure.



Activity 3

For each of the following, state their **three** effects on the environment.

1. Deforestation

2. Soil erosion

Feedback

The answers for the above activity are from sub-sections 'deforestation' and 'soil erosion'.

1. *The effects of deforestation on the environment are as follows:*
 - *land loses top soil and becomes infertile*
 - *the ecosystem is disrupted and some animal and plant species become extinct*
 - *climate of deforested area may be modified (changed)*
 - *the nutrient cycle may be broken due to loss of organic matter.*
2. *Soil erosion can lead to the following environmental problems*
 - loss of top soil leaving compacted and hard ground*
 - huge gullies or dongas can be created*
 - silting up of rivers, dams, lakes etc thus destroying marine life*
 - increased water run-offs, flooding and low water table due to less water infiltration.*

4.3 Soil salination

We have discussed a lot about irrigation in commercial farming. Apparently 16 per cent of the world's crop land is now irrigated, and this produces a large amount of the world's food. Do you still remember sources of irrigation water? Irrigation water can be obtained from rivers, dams, lakes and underground. This water is a dilute solution of various salts. These salts were dissolved in water as it flows through soil and rocks. Only a small amount of these salts is required by crops in order to grow.

We know that, during irrigation, some water sinks into the ground and some of it evaporates. The evaporating water leaves undissolved salts on the top soil. Continuous irrigation will result in the accumulation of salts on the ground. This process is called **salination**. This is common where drainage is very poor and water contains a lot of salts.

(a) The consequences of salination are as follows:

- water may not be easily absorbed into the saline soil, thus causing increased water run-off and lowering of the water table.
- saline soils formed are not suitable for most crops

(b) Possible solutions to the problem of salination

Attempts or efforts made to solve this problem include:

- the use of excessive (more) irrigation water so that salts can be flushed out of the top soil.
- heavily salinised soils can be left fallow (out of production) for some years, so that rain water can flush out some salts.

4.4 Pollution

In Topic 3, you have learnt that farmers use agricultural chemicals such as fertilisers and pesticides to increase their output. What type of pollution can be associated with the use of these

chemicals? The correct answer is water pollution. Not all fertiliser chemicals are used up by crops. Only a small quantity is used up by plants. On the other hand, there are pesticides used for eradicating (getting rid of) pests. When pests are eradicated, what happens to the pesticides being used? Some agricultural chemicals used are slowly degradable, that is, it takes a long time to be broken down. For example an insecticide called DDT takes a long time. When it rains, these chemicals are carried by running water.

(a) The effects of water pollution on the environment

- Agro-chemicals pollute both underground and surface water and this may kill both plants and animals.
- It also affects soil ecology as micro-organisms and their habitat are destroyed.
- Agro-chemicals may increase soil acidity, thus, retarding plant growth.

(b) Solutions to the problems of salination

Pollution being caused by the use of agro-chemicals can be reduced by:

- using organic manure instead of chemicals
- using degradable agro-chemicals.



Activity 4

1. Briefly explain how the use of irrigation water and agro-chemicals affects the environment.

(a) irrigation water

(b) agro-chemicals

2. What is the advantage of using organic fertilisers?

Feedback

If you have carefully read about salination and pollution, then you should have the following answers:

1. (a) *Irrigation water causes salination which may increase water run-offs and lower the water table. It also makes the soil more saline and this retards plant growth.*
(b) *The use of agro-chemicals pollutes water. This disrupts the ecosystem. Some marine plants and animals may become extinct.*
2. *The use of organic fertilisers improves the soil structure as it helps to bind soil particles together.*

5.0 Summary

In the first part of the topic, we discussed government schemes such as ALDEP, ARAP, DRAFP etc aimed at increasing agriculture output. These programmes were formed in order to increase food produce so that the country becomes self-sufficient and reduce food imports, improve incomes of small farmers and to create jobs so as to reduce rural-urban migration.

Not all objectives of these programmes were achieved due to poor climatic conditions, widespread poverty, poor infrastructure, shortage of extension workers, and farmers being reluctant to adopt new management and technical skills due to their traditional beliefs.

Certain strategies were adopted in order to solve some of these problems. Such strategies included: training more agriculture specialists to carry out extension functions, improving infrastructure in highly productive areas, on-farm training and encouraging farmers to grow drought resistant crops.

Achievements made through these programmes included increasing productivity per hectare and increasing production land. Some drought relief programmes like ARAP were discontinued in order to be reviewed or revised and perhaps introduced again when drought occurs. CEDA has been introduced to address the shortcomings of past government schemes. Through CEDA farmers can acquire loans.

In the second part of the topic, we discussed the impact of agriculture on the environment, for example deforestation, soil erosion, salination and pollution. Both subsistence and commercial farmers cause deforestation as they clear land for crop cultivation. This exposes the cleared land to agents of erosion. Deforestation and soil erosion can be reduced by planting trees and practicing sustainable methods of farming.

Salination is caused by continuous use of irrigation water, especially where drainage is poor or where there is a high rate of evaporation. Both surface and underground water can be polluted by agro-chemicals such as fertilisers and pesticides. Salination and water pollution have a great impact on the ecosystem.

You have come to the end of the topic and it is now time for you to do Exercise 8.

Unit summary



Summary

In this unit you learnt about the two branches of agriculture known as arable farming and pastoral farming. You learnt that Agriculture is critical to Botswana's economy. The same could be said about some African countries like South Africa and Sudan (whose plantation farming you learnt about in Topics 4 and 5 respectively).

Topic 1 gave you a general overview of agriculture. In there, we defined the different farming systems found in Botswana. In Topics 2 and 3, we then looked at Botswana's arable farming at both subsistence and commercial levels. Here, we used case studies like Tuli Block (Talana Farm) and Pandamatenga farms to discuss commercial arable farming while we used the rest of the country to discuss subsistence arable farming. Topics 4 and 5 took us to commercial arable farming in the wider region, where we discussed plantation agriculture, particularly, sugar in Kwa-Zulu Natal (South Africa) and cotton in the Gezira (Sudan).

Topic 8 concluded our discussion on arable farming, where we focused on the impact of agriculture on the environment. We also evaluated the impact of government assistance schemes in promoting arable farming, such as Arable Land Development Programme (ALDEP) and CEDA as well as discussing the future prospects of arable farming in Botswana.

In Topics 6 and 7 we addressed pastoral farming or animal husbandry. Pastoral farming involves the rearing of animals. In this unit we concentrated on the rearing of cattle in Botswana.

It is my hope that you now understand why we need to study Agriculture within the subject Geography. Try to link what you have studied in this unit to the rest of your course.

That marks the end of this long but informative unit. Once you are happy with your level of understanding of this unit, please work on the assessment and submit it to your tutor for marking.

Just before you move onto your assessment, try the following activity with a peer.

Read about any government scheme aimed at increasing agricultural output in your country. In a group evaluate the impact of this scheme in increasing agricultural production. Write a brief report of your discussion and compare it with other peer groups or show it to your instructor or tutor for feedback.



Exercise1

Write your answers in the space provided against each question.

Assignment

1. Define the following terms: [4 marks]

(i) arable farming

(ii) subsistence arable farming

(iii) commercial arable farming

(iv) mixed farming

2. One of the problems in developing land for agriculture is that there is competition over use of land. State some of the competing demands for farming land.

[4 marks]

3. Explain **two** ways in which subsistence arable farming differs from commercial arable farming. [4 marks]

4. List **three** physical factors influencing arable farming in

Botswana.

[3 marks]

5. In the land tenure map of Botswana below, locate any three freehold areas and any two leasehold areas where commercial farming is practiced [5 marks]

Total = [20 marks]

Exercise 2

Write your answers in the space provided against each question.

1. What are the natural inputs of subsistence arable farming?
[3 marks]

2. (a) What type of subsistence farming is practised by most rural households in Botswana. [1 mark]

- (b) State the chief output of this farming system in Botswana and explain how it is influenced by physical (environmental) factors.
[4 marks]

3. You have learnt that low output is the major characteristic feature of subsistence farming. What are the main reasons for this?
[5 marks]

4. Study crop production and rainfall diagram (figure 2) and answer the following questions. [7 marks]

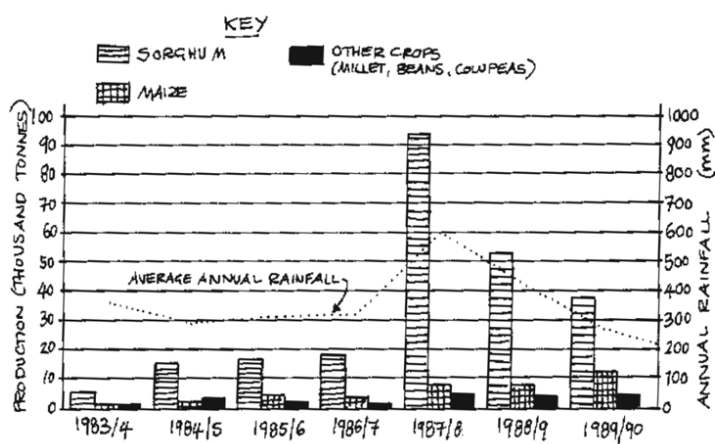


Figure 2: Crop production and rainfall, 1983/ 84 to 1989/90.
Source: May, D. (1998): *Geography of Botswana* page 108.

- (a) Which crop has been produced in the smallest quantities?

- (b) Which crop was produced in the largest quantities?

- (c) In which year was crop production lowest?

- (d) What happens to crop production as rainfall changes?

- (e) What was the difference in sorghum production between the years 1987/88 and 1989/90?

(f) Explain the trend in the sorghum production from the years 1987/88 to 1989/90.

(g) According to this graph, sorghum is the most drought resistant crop. How does the graph show this?

Total = [20 marks]

Exercise 3

Answer all questions in the spaces provided.

[1 mark each]

1. (a) State 3 physical factors influencing intensive cash crop farming.
- (b) State 4 human factors affecting intensive cash crop farming.
- (c) List 4 human inputs of this farming system.
- (d) List any 4 outputs of this farming system.

Total = [15 marks]

Exercise 4

Write your answers in the space provided against each question.

1. Describe the characteristics/features of a plantation/estate.
[4 marks]

2. Describe the physical conditions necessary for the cultivation of sugar.

[6 marks]

3. Give the meaning of the following words:

[3 marks]

(a) ratoon crop

(b) molasses

(c) monoculture

4. State **two** advantages of sugar plantations to South Africa.

[2 marks]

Total = [15 marks]

Exercise 5

Study figure 8, which shows the Gezira irrigation scheme map together with the graph showing the climate of the area.

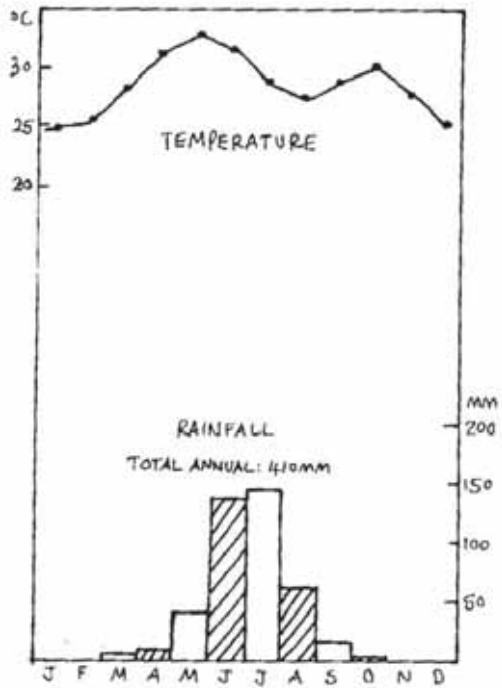


Figure 8: Climatic graph of the Gezira

1. Suggest why a dam is needed in such an irrigation scheme.

[1 mark]

2. Suggest, with reasons, the months of the year in which irrigation is required.

[4 marks]

3. Describe the methods of irrigation used in a large perennial scheme such as this.

[3 marks]

4. State, with reasons, the physical advantages which areas, such as the one shown, have for large scale irrigation.

[4 marks]

5. State the advantages of perennial irrigation over the older traditional methods of irrigation.

[3 marks]

Total = [15 marks]

Exercise 6

Write your answers in the space provide against each question.

1. Define these terms: [6 marks]

(i) transhumance

(ii) rangeland

2. Describe the changes occurring in subsistence pastoral farming in Botswana. [5 marks]

3. State **two** examples of each of the following aspects of pastoral farming: [8 marks]

(i) Inputs:

(ii) Processes

(iii) Problems

(iv) Output

4. What is being done to increase the output from pastoral farming in Botswana? [5 marks]

Exercise 7

Answer all the questions in the space provided against each question.

1. What is zero grazing? [1 mark]

2. State the negative effects of pastoral farming on the environment. [3 marks]

3. Describe the main problems of pastoral farming in Botswana. [5 marks]

4. What is being done to increase the output from pastoral farming in Botswana? [7 marks]

5. Describe factors that led to the failure of the Tribal Land Grazing Policy. [4 marks]

Exercise 8

Write your answers in the space provided against each question.

1. Give **one** way in which farmers have benefited from the following: [4 marks]

- (a) ALDEP

(b) ARAP

(c) FAP

(d) NDB

2. State **three** problems which had affected ARAP and DRAFP.

[3 marks]

(a) Briefly explain why CEDA was formed and how it may benefit arable farmers in Botswana.

[4 marks]

4. Briefly explain how arable agriculture cause the following:

[2 marks]

(a) salination

(b) water pollution

5. State the negative impact of the following on the environment.
[2 marks]

(a) deforestation

(b) soil erosion

Total = [15 marks]

Answers to Self-assessment Exercises

Exercise 1

1.
 - (i) crop production or the growing of crops.
 - (ii) growing crops for own/family's use /home use/consumption.
 - (iii) growing of crops for sale / market / profit
 - (iv) growing of crops and rearing of livestock at the same time.

2. Some of the competing demands for farm land are:
 - settlements
 - infrastructure e.g. roads
 - game reserves and parks
 - economic activities like mining.

3.
 - subsistence farming does not require a lot of capital while commercial farming is capital intensive (requires a lot of capital)
 - subsistence farming rely on family labour while commercial farming uses employed / hired labour
 - subsistence farmers use crude or simple tools and traditional methods of farming while commercial farmers use advanced machinery and modern or scientific methods of farming.

4. Physical factors influencing arable farming in Botswana are:

- climate
- relief
- soils.

Exercise 2

1. Natural inputs for subsistence arable farming include:
 - rainfall
 - temperature
 - land.

2. (a) The type of subsistence farming practiced by Batswana is known as **sedentary** or **settled** subsistence farming.
 (b) Sorghum is the chief or main output.
 Physical factors influencing the production of sorghum:
 - Rainfall of at least 350 mm
 - Sunshine for ripening
 - Fertile soils.

3. Reasons for low output
 - pests and diseases
 - inadequate rainfall
 - drought
 - infertile soils
 - lack of knowledge.

4.
 - millet, beans and cowpeas
 - sorghum
 - 1983/84
 - crop production changes according to rainfall amount
 - 57 or 58 or 59 thousand tonnes
 - Sorghum production declined / decreased
 - Sorghum production remained high compared to other crops during periods of low rainfall.

Exercise 3

A. Physical factors

- land/soil
- water

temperature.

B. Human factors

capital

market

labour

government policies

land tenure (ownership)

C. Inputs

labour

capital

seeds

fertilisers

irrigation equipment

insecticides/pesticides

D. Outputs

vegetables

potatoes

cabbage

tomatoes

sorghum

maize

cotton.

Exercise 4

1.
 - Plantations are very large estates or farms covering thousands of hectares.
 - They are owned by huge foreign companies or multi-national companies.
 - Plantations are labour intensive or employ a large number of workers.
 - Plantations are capital intensive or use a lot of money in their investment.
 - Plantations usually specialise in one crop or a limited number of cash crops.
 - Crops grown on plantations are normally intended for export.
 - Plantations have their own infrastructure e.g. roads, rail, medical facilities and at times elementary education.

2.
 - Abundant moisture and high temperatures throughout the growing season.
 - Well drained fertile soils.
 - Abundant water supply for irrigation where rainfall is not evenly distributed.

3. (a) Ratoon crop - the cane that grows from the remains of the harvested one.
 (b) Molasses - thick sticky juice which remains after the removal of sugar crystals.
 (c) Monoculture - the practice of growing one crop.
4. -Creates employment
 -A source of revenue/income.

Exercise 5

1. A dam is needed in this irrigation scheme when water level in the Blue Nile is at its lowest level.
2. Irrigation is required in November, December, January, February and March, when rainfall is low.
3. Perennial irrigation is used:
 Water from the reservoir behind the dam is led through main channels using gravity flow. From then the water is led through thousands of kilometres of smaller channels developed on a rectangular system, decreasing in size.
 Other methods of irrigation used are traditional methods like Shaduf, central pivot and Archimedes screw.
4. The physical advantages of this area are as follows:
 - **relief:** the land is gently sloping from the Blue Nile to the White Nile.
 This makes both irrigation and drainage cheaper. Irrigation costs are reduced through gravity flow.
 - **climate:** low rainfall helps to reduce the risk of damage by pests and diseases. Abundant sunshine for cotton flowering and also when the fruit is ripening. The dry season for harvesting.
 - **soils:** fertile silt soil or dark brown clayed soils essential for plant growth.
5. Advantages of perennial irrigation over traditional irrigation methods.
 - a large area can be irrigated
 - does not require much human labour
 - it is cheaper
 - areas far from the river can be irrigated
 - most of the land is used continuously.

Exercise 6

1. (i) **Transhumance:** Seasonal migration of farmers with their livestock.
 (ii) **Rangeland:** The land for grazing animals.
2. • livestock are for beef and milk, rather than muscle power and prestige.

- exotic cattle breeds are introduced.
 - animal husbandry gets expensive, and 'mafisa' system is disappearing.
 - family labour is replaced by hired labour.
 - reliance on natural inputs of rain and bush pastures is declining. Boreholes and supplementary feeds are provided.
3. (i) **Inputs:**
- supplementary feeds
 - labour
 - money for vaccines etc.
- (ii) **Processes:**
- milking
 - dipping
 - vaccinating
 - dehorning
 - branding
 - herding/watering
- (iii) **Problems:**
- diseases
 - animal stray
 - drought
 - shortage of pasture.
- (iv) **Output:**
- milk
 - meat
 - hides.
- 4.
- provision of disease control fences
 - provision of free vaccination to prevent diseases
 - artificial insemination services
 - bull subsidy scheme
 - training of farmers
 - provision of borehole water
 - provision of supplementary feeds
 - cross-breeding/selective breeding.

Exercise 7

1. Animals are not allowed to wander about. They stay in the same place where they are provided with feeds.
2.
 - soil erosion
 - loss of vegetation
 - desertification
 - pollution.
3.
 - drought
 - overgrazing / overstocking
 - shortage of pasture
 - few fodder, crops grown
 - communal land tenure
 - diseases
 - competition for land with other land uses
 - cattle regarded as store of wealth rather than source of income.
4.
 - disease control / veterinary services
 - cordon fences / quarantine camps
 - artificial insemination
 - bull subsidy scheme
 - boreholes
 - education / training to farmers
 - rotational grazing
 - cross-breeding
 - supplementary feeding.
5.
 - farmers stay away from their farms
 - untrained herd boys
 - ranch fences are not properly maintained
 - overstocking / overgrazing continues.

Exercise 8

1.
 - (a) ALDEP: Through the downpayment/grant scheme farmers acquired draught power, fencing materials, farm tools etc.
 - (b) ARAP: Provided draught power, fencing materials, fertilisers, seeds and services like destumping, weeding and crop protection.
 - (c) FAP: Farmers may obtain grants with the minimum contribution of 10% of the required amount.
 - (d) NDB: Gives loans to farmers to purchase machinery and other farming equipment.

2. - shortage of extension workers
 - were carried out in a short period and they involved huge government financial outlays.
 - most farmers switched from the use of draught power to tractors, and this benefited tractor owners than poor farmers.
- (a) CEDA was formed to address the shortcomings of FAP and other programmes.

Through CEDA, farmers may acquire loans to purchase their farm requirements and also to expand into commercial arable farming. They may also acquire business management skills.
4. (a) **Salination**- continuous irrigation where there is high rate of evaporation or poor drainage leads to accumulation of salts.
- (b) **Water pollution** - running water carries with it undegradable agro-chemicals used by farmers.
5. (a) **deforestation** - exposes land to agents of soil erosion
 - disrupts the ecosystem and some plant and animal species become extinct
 - reduces humus in the soil or affects the nutrient cycle
- (b) **soil erosion** - land becomes infertile with loss of top soil
 - land becomes hard and compacted and rain is unable to infiltrate.
 - this increases water run-offs and low water table
 - silting of rivers, dams, lakes and the sea, resulting in loss of marine life
 - huge gullies and dongas are created by running water.



Assessment

Directions for students:

1. Answer **all** questions.
 2. Write all your answers on a separate answer sheet.
 3. Marks for each question are shown in brackets.
 4. You may take 1 hour to complete this assessment task.
 5. Submit your answers to your tutor for marking.
-

1.(a) Choose **one** area of intensive, irrigated, cash-crop farming within Botswana.

(i) Draw a sketch map of Botswana. Name and locate the area you have chosen on a sketch map of Botswana you have drawn. On your map, mark and name two geographical features which indicate clearly the position of the area. [2 marks]

(ii) Explain the meaning of cash crop farming. [1 mark]

(iii) Describe, in detail, the main characteristics of intensive farming. [5 marks]

(iv) State the human influences which affect the type of crops grown on these intensive farms. [5 marks]

(b) (i) Describe how arable land area in Botswana may be increased. [6 marks]

(ii) Describe the problems which are likely to arise from the need to increase arable land and improve agricultural output. [6 marks]

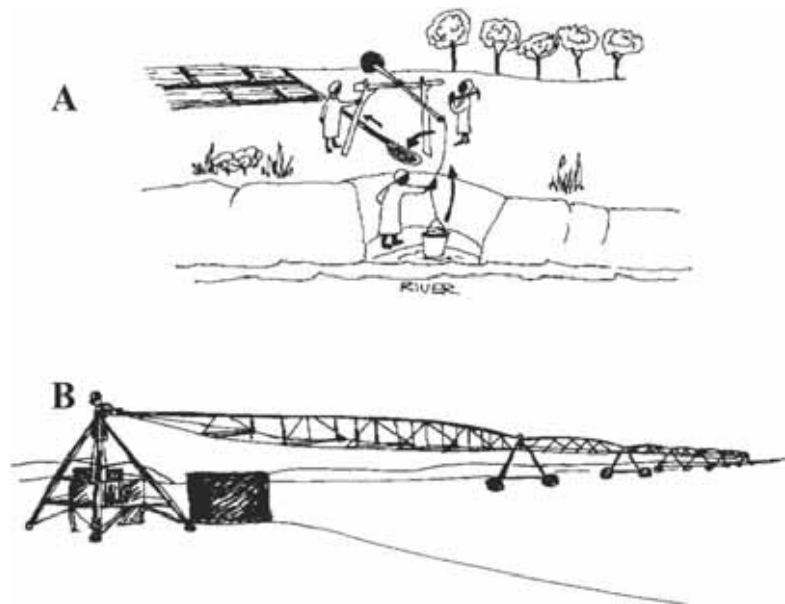
2.(a) With reference to your studies of plantation (estate) farming in South Africa (Kwa-Zulu Natal) and Sudan (Gezira) answer the following:

(i) Explain briefly how plantation farming developed. [2 marks]

(ii) State the economic factors which determine the location of plantations. [2 marks]

- (iii) Many plantations are run by large multinational companies.
Why is this sometimes a disadvantage? [4 marks]
- (iv) Describe the problems and benefits of the plantation system of agriculture to the economy and people in the area where it is practiced. [9 marks]

(b) Look at Figures A and B



(i) What methods of irrigation are shown by figures A and B? [2 marks]

(ii) Name and describe the other methods of irrigation used on commercial farms in Africa south of the Sahara. [6 marks]

3. Pastoral farming has had a great effect on the environment in Botswana.

(a) State the **negative** effects of pastoral farming on the environment. [3 marks]

(b) Describe the problems, **other than soil erosion**, of pastoral farming in Botswana. [3marks]

(c) What is being done to increase the output from pastoral farming

in Botswana?

[4 marks]

Total = [60 marks]

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Unit 12

Tourism

Introduction

Welcome to Unit 12 of the Geography Grade 12 programme. In this unit we are going to look at Tourism. Tourism is one of the many interesting topics because it involves several aspects of our environment and is one of the world's largest industries. This is not a totally new topic in the sense that it is related to those things that we already know. In your Junior Certificate program, you have learnt a lot about tourism. Tourism is also related to several topics in this Geography course such as 'The utilization and management of natural resources' covered in units 6 to 9. In this unit, we will learn about the use and protection of wild animals, also known as **fauna**. You will also learn about the use and protection of our vegetation or forests (**flora**). Wild animals, natural vegetation and other natural resources play a major role in Tourism. They form a foundation for the Tourism Industry in Botswana.

Remember that Tourism is said to be an industry. It is therefore related to Units such as Processing and manufacturing industries Unit 13 as well as Unit 14 on Mining. All of these topics are common in the sense that they deal with how the government gain revenue or money. The tourism industry leads to the establishment of a variety of industries, or economic sectors. This is **called economic diversification**. This unit will take you through different types and aspects of tourism. In addition we have included information on factors influencing tourism. This information will help you understand tourist attractions and the importance of conserving them.

As you study tourism and even after your studies, you will appreciate the importance of tourism to the country's economic development. This unit will "open your eyes" and make you aware and understand the importance of protecting your wild animals, natural vegetation and other natural resources. The study of tourism presents ample future employment and educational prospects.

The unit is divided into 5 topics as follows:

Topic 1: Introduction to tourism

This unit introduces you to key concepts in the study of tourism. The concepts include tour, tourist and tourism. We will also look at different categories of tourism with particular attention to ecotourism and sustainable tourism. We will also differentiate between domestic and international tourism. Finally, we will discuss sources and destinations of tourists.

Topic 2: Factors influencing tourism

In this unit we will look at the factors influencing the existence, demand, growth or development and operations of the tourism industry. These factors are divided into physical, economic, political and social categories. Examples mostly drawn from Botswana are given under each category.

Topic 3: Coastal and Inland Tourism

Topic 3 distinguishes between coastal and inland tourism. The first part of the topic focuses on inland tourism with a case study drawn from Botswana. The second part dwells more on coastal tourism with case studies from Kenya – Mombasa and South Africa – Durban. For both types of tourism we will look at the attractions, tourist activities and the economic benefits.

Topic 4: Impact of tourism

In this topic you will understand the negative and positive impacts of tourism. You will also distinguish between economic, social and environmental impacts of tourism. Most examples are drawn from Botswana. We will also assess policies and frameworks examining the impacts of tourism.

Topic 5: Problems facing tourism and the role of stakeholders in the development of tourism.

This is the last topic and it focuses on problems facing the development of tourism. These problems are experienced by most developing countries. Possible solutions to these problems are given. The last section covers the role of stakeholders in the development of tourism in Botswana.



Outcomes

Upon completion of this unit you will be able to:

- Identify and locate inland and coastal tourist attractions
- Define and discuss major aspects of tourism
- Discuss the importance of tourism to the country's economic development.
- Discuss the positive and negative impact of tourism in Botswana and in either Kenya and/or South Africa.
- Utilise the economic importance of both inland and coastal tourism in areas studied using statistical data.
- Explain the impact of tourism on the country's socio-economic development and the environment.
- Evaluate the role of stakeholders' (government, local community, NGOs and private sector) in the development of tourism in Botswana.
- Analyse the problems facing the development of tourism in Botswana and suggest possible solutions.

Time

You will need two hours to study each topic. Note that this unit has 5 topics. It means you will need a total of 10 hours to study the whole unit. You might finish studying the topic in less than two hours or exceed your study time as this is determined by your reading pace and understanding of the lesson. At the end of the unit, there is an assignment section. The assignment is divided into 5 self-assessment exercises which you are required to do. Each exercise is for a particular topic. It should take you 30 minutes to do each assignment. You therefore need a total of 2 hours 30 minutes to do this assignment. To further test your understanding of the unit, you must do a tutor marked assessment exercise. The assessment should take you about 1 hour to complete.

Teaching and Learning Approach

In order to promote active learning, we engage you in several discussions throughout the unit by asking you questions and asking you to share your own experiences. This is meant to give you a chance to demonstrate and enhance your critical thinking skills. We also offer our experience or perspectives on raised questions based on possible responses.

We also tried to guide you to some resources useful for learning. There is a variety of information that you can use to learn more about important concepts in tourism. Most libraries in your country have some information on tourism. There are some magazines, pamphlets, books, etc which contain important information on tourism. Some of the recommended books can be found in the reference section found at the end of the unit. If you live near any tourism centre such as an educational centre or national park you are advised to collect any relevant information from such centres. If you have access to the internet, you may access links given. The internet links are meant to give you more information on a particular topic. Do not worry if you have no access to the internet, as content provided in each topic is adequate. If you are registered with any distance education provider, you are advised to make use of their learner support components such as study centres, tutorials, radio programmes and counselling support.

Study centres are resourceful because you may have access to additional resources, maps and relevant videos. In addition, a study centre provides an opportunity to meet and discuss the

subject with other learners. Furthermore, remember that your tutors are available to assist you with any difficulties you are experiencing in this unit. Note that the amount of time allocated for tutorials is very limited and you are therefore advised to read the course material well in advance or at least before you attend tutorials. This will help you raise questions on difficult areas of your study materials.

I would like to once again emphasise that, active learning or effective participation throughout can help you conceptualise and understand the unit content. Only after reading through the text, attempting all activities and questions you will be in a better position to link tourism with other industries and economic sectors covered in units 11, 13 and 14.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the information relevant to different sections of the topic and form part of your learning. They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt an activity before looking at the feedback given immediately below the activity. If you do not do well in the activities do not be discouraged, as you may review the section related to the activity and later carry on with the topic with more concentration. You are advised to review the sections you did not do well before continuing with the topic.

On completion of each topic, you are advised to go to the assignment section found at the end the unit. You will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score low you must not be discouraged, but appreciate the marks and try again by going over the topic and the exercise.

The assignment self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the assignment. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, then go on to the next unit.

Glossary

At the beginning of this unit there is also a glossary of words that have been used in the unit. These are words which might be difficult for you to understand. The words are explained in simple ways or terms in this unit. You are also encouraged to refer to dictionaries available in the local libraries and study centres.



Terminology

Attractions:	Things of interest to people
Coastal area:	Area between land and sea
Diversification:	To vary something
Conservation:	Preserving of or preventing from waste, damage and loss
Economy:	Sector which deals with finances, the production, exchange and distribution of goods and services

Endangered species:	Plant or animal species threatened by extinction
Fauna:	Animals species of a particular area
Flora:	Plants species of a particular area
Inland:	Inside or the interior of a country
Poaching:	Illegal Hunting
Safari:	Guided tour
Stakeholder:	Person(s) who holds a share or interest in a particular business
Wilderness:	An untouched, undamaged natural area

Topic 1: Major Aspects of Tourism

Introduction

Welcome to the first topic of unit 11. This is a very important topic because it introduces you to the key concepts for understanding tourism. In other words, it provides the basis for understanding tourism as an industry and an economic sector. The meaning of these key concepts is given and their explanations are made easier by the use of examples.

1.0 Introduction to Tourism

We all have questions on tourism because this is the word we hear or see every day in the media and from other people. Some of the questions we may ask ourselves are as follows:

- What is tourism?
- Who is a tourist?
- Is there any tourism in my village/town/country?
- Why do tourists visit my village/town/country?
- When did tourism first take place?
- How does tourism benefit my people/country?

You will learn answers to these questions as we progress through this unit. You may have other questions as well. Note them down and at the end of the unit check whether they have been answered. If they have not been answered, ask your tutor at the learning centre or other learners. We will begin by discussing a question on when tourism first took place. I believe that it's best to start with the past to understand the future.

It is not known when tourism first took place, but it is believed that it started with the birth of the idea of travelling to unknown places. Can you think of any reasons of travelling to unknown areas thousands of years back and how people travelled? In your junior school history you learnt that pre-historic people travelled short distances to search for food, water and security. A number of years later, they may have travelled for pleasure or to make more discoveries about the earth. Man has always been curious to find out what lies behind the horizon. People first walked, rode on domestic animals or sailed to other places. Tourism increased with the advent of technology, which led to improvements in transport. We can then conclude that tourism has always been there in historical times. Let's now move on to the first and second question.

Both words, **tourism** and **tourist**, are derived from the word **tour**, meaning to "travel or take a journey". Tourism takes place world-wide in all countries. Actually it is viewed as one of the world's largest industry. It serves as the mainstay of most countries. In other words, it is the largest source of income for most countries. It is an important economic sector in many countries. In countries like Botswana, dependent on mineral economy, tourism has become a significant economic diversification strategy. We can simply say that it has become an important way in which Botswana can vary her investments.

To have a deeper understanding of tourism, first let us find out what a tourist is.

1.1 What is a tourist?

In order to understand tourism and a tourist let's start with this exciting activity. It requires you to reflect on your own experience.



Reflection Activity 1

We have all travelled to new places. Do you remember when you first visited a new place like a city or a town? Think of one of those interesting places you visited. Using your own experience of any visit, answer the following questions:

1. Name the place that you went to visit.
2. What was the reason for your visit to this place?
3. How did you travel to this place?
4. How long did you stay in this place?
5. What interesting things did you see or do in this place?
6. Would you like to visit this place again or recommend a visit to this place to anyone? Give reasons.

Feedback

To give you feedback, I will share with you my own experience. I went to visit Maun, one of the major tourist attractions in Botswana. I took an hour and a half morning flight from Gaborone to Maun. Maun is a gateway to the famous Okavango delta (known to be the largest inland delta in the world) and Moremi Game Reserve. I was immersed by the breath-taking scenic beauty of the delta with variety of wildlife species which I viewed from air, boat and land safaris. I lodged at the Old Bridge Maun Campsite which offered me the best comfortable and secure camping experience for all three nights I stayed there. In the camp, I enjoyed varied activities including sunset watching, horse rides, swimming, watching colourful sunrise and sunset, bird watching, canoe rides and boat cruises, fishing and interacting with local friendly people learning their culture. My stay in Maun was a wonderful experience and how I wish I had stayed for more than two days. I have recommended a tour of the Okavango delta to my friends and relatives because I believe that it is a "must see" location and an affordable tourist attraction.

Did you know that if you have moved from your place of usual residence to another place that makes you a tourist? In the first activity you have named a place you went to visit and that made you a tourist in that town or village. Remember that, the word Tourist comes from the word **Tour** that means to travel or a journey made to visit places. The tour or journey that is made differs from one person to another depending on the purpose of the journey, the distance to be travelled, the amount of money to be spent on the journey and many others. It can be a one day tour, or a tour that take weeks or even months. Tourists do not reside permanently in places they visit.

The **World Tourism Organisation** defines **tourists** as people who "travel to and stay in places outside their usual environment for more than twenty-four hours and no more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited."

If you look at the definition of a tourist, you will see that my visit to Maun made me a tourist because I had travelled to Maun for a short period of time for leisure.

Try the following activity to find out if you now know what a tourist is.



Activity 2

Read the following statements or short paragraphs and identify the ones which are more precise about a tourist. Put a tick (✓) against those statements which are talking about a tourist and a cross (X) against those which are not necessarily about a tourist. You can also use True or False

Statements	Comment
A. Wabo travels from Gaborone where he is working to his home village to visit his critical sick mother in hospital. Wabo will spend two days in his village.	
B. Sego heard about the monument of the late first President of Botswana, Sir Seretse Khama located on top of Serowe Hill. She does not know the late President and has never been to Serowe before. She travels to Serowe to see the monument.	
C. Tana who lives in Serowe hears of a new wholesaler opening in Gaborone. Since goods will be sold at a lower price, she decides to go to Gaborone for two days of shopping. She spends two nights in one of the lodges in the town.	
D. Mpho's school term has just ended, and he travels to the cattle post where he normally spends his holidays, helping his father to look after their livestock.	
E. Kago wins a FIFA ticket and travels to South Africa to watch the finals of the world cup football match	

Feedback

Not all of the statements are talking about a tourist. You will realize that all people in each statement are involved in travelling from one point to another. Among the above five statements, three B, C and E are talking more precisely about someone who is a tourist. These people are travelling to places outside their normal residence and are travelling for business or pleasure. The other two statements are just talking about ordinary travellers. Wabo is travelling to his village to attend family matters while Mpho is travelling to his normal holiday destination. If people are travelling to their normal destination, that does not make them tourists. Note that the activities that Wabo and Mpho perform do not make them tourists. We will look at activities that tourists indulge in later in this topic. It is also important to note that people on transit or having a stopover at a certain location for less than 24 hours are also tourists.

You now have an understanding of the of what a tourist is and are now ready to tackle the second of the questions listed above, that is, "What is a tourism?"

1.2 What is tourism?

You might have heard people talking about tourism as an economic activity or industry. Yes! It is true, tourism is an economic sector linked to tourists and their activities. Before we discuss further on this industry let us look at the definitions of tourism from different sources.

Tourism Society of England (1976) defined it as "Tourism is the temporary, short-term movement of people to destination outside the places where they normally live and work and their activities during the stay at each destination. It includes movements for all purposes."

Mathieson and Wall (1982) came up with the definition of tourism as "the temporary movement of people to destinations outside their normal places of work and residence, the activities undertaken during their stay in those destinations, and the facilities created to cater to their needs."

The definitions all show that tourism is an activity that involves travelling or movement to other places for a purpose. Note that the movement is outside normal home or work place. This is actually the movement we related to when discussing what a tourist is. In addition tourism is associated with certain activities that take place in special facilities.

You may still be wondering if you will recognise tourism industry if you come across one. Of course you may recognise it but it is not as visible as other industries. For this reason, Geographers call tourism an "Invisible Industry" in the sense that you cannot see, weigh and touch tourism. Can you think of any other industry in Botswana? Find out how the industry you have named differ from the tourism industry.

Let us take Kalahari Soap Industry (KIS) as an example. We can locate the area where the industry is found. We can also identify the buildings where the production of soap is taking place. We can also touch and see the building and the soap (products) produced in the industry. Tourism industry is unique and invisible because it does not directly involve the manufacturing of goods. There is no special building where manufacturing is taking place. A tourist industry is different from this type of industry because it cannot be physically seen or touched. However, there are activities and products identified with this industry.

You now know that tourism is not physically visible, but I hope you can recognise one when you come across it. Another that we have mentioned earlier, which forms part of tourism definition is 'activities'. There are certain activities and special facilities that are closely associated with tourism. Before we list them, try Activity 3 and see if you know anything about the activities associated with Figure 1.



Activity 3

Fig. 1 below shows one of the tourist activities, river canoeing. Think and write a list of more tourist activities facilities or resources associated with them.



Figure 1: Canoeing at the Okavango Delta

Source: <http://wikitravel.org> retrieved Feb 2010/02/06

Feedback

Tourist destinations have different tourist activities. Tourist Activities associated with the above diagram include:

- | | |
|--|--|
| <i>River rafting - river</i> | <i>Canoeing – lake/river/reservoir</i> |
| <i>Elephant riding- Game Park</i> | <i>Gliding - bridges</i> |
| <i>Walking safari- game park</i> | <i>Bird watching – game park/reserve</i> |
| <i>Trophy hunting –game park</i> | <i>Fishing – ponds/rivers/lakes</i> |
| <i>Night Safari – game park/reserve</i> | <i>Camping – bush/mountains/ parks</i> |
| <i>Skiing – mountains/water features</i> | |
| <i>Surfing – sea/ oceans with strong waves</i> | |
| <i>Sunrise/sunshine/ star gazing viewing</i> | <i>- open areas with clear skies</i> |
| <i>Animal riding – animal parks</i> | |

You may not be familiar with some of the activities listed above. However, you may write a list of tourist activities in your area or that you have experienced as a tourist. Discuss some of the tourist activities with your family, friends or other learners at a study centre. You may want to talk about activities you would engage in when you visit your dream tourist attraction. From the tourist activities that you have learnt, we can come up with categories or types of tourism. In the next section we discuss the categories of tourism.

2.0 Categories of Tourism

We can distinguish between many types of tourism. Tourism may be categorised as follows:

Ecotourism

Sustainable Tourism

Domestic and international Tourism

Adventure tourism

Cultural Tourism

Consumptive and Non-consumptive tourism

In this topic we will only concentrate on **common** types of tourism, namely: ecotourism and sustainable tourism. We will also look at domestic and international tourism. These are the main types of tourism. First let us look at ecotourism because it is a new concept compared to other types and is becoming popular worldwide.

2.1 What is Ecotourism?

Have you ever come across the term **ecotourism**? You may have heard about it in the local radio or newspaper. The term ecotourism was created in 1983 by Hector Ceballos-Lascurai, a Mexican architect and environmentalist. The original term described "**nature-based travel to relatively undisturbed areas with an emphasis on education.**"

If you would like to meet the man himself who coined the term visit the you tube video link below http://www.youtube.com/watch?v=WOWV4LD_Amc

In this video Hector Ceballos-Lascurai explains how he coined this term. **ECO** abbreviations added to tourism can be simplified as follows;

E for ecological or environmental

C for cultural heritage

O for oriented travel

Ecotourism also known as **ecological tourism or nature travel** is also defined by The International Ecotourism Society (TIES) 1990, as "Responsible travel to natural areas that conserves the environment and improves the well-being of local people." This definition has further been expanded by describing the eight characteristics of ecotourism, which are:

- Involves travel to natural destinations.
- It focuses more on human interaction with wilderness and therefore emphasises to a high degree on environmental and ecological education.
- Provides environmental education to nature travellers hence making them strong advocates for environmental conservation.
- Provides direct financial benefits for conservation and the local communities.

- Provides financial benefits and empowerment for local people.
- Delivered in the field by qualified interpreters.
- Ecotourism provides local benefits - environmentally, culturally and economically.
- Includes programs that minimize the adverse effects of traditional tourism on the natural environment, and enhance the cultural integrity of local people.

The following activity will help you understand ecotourism further and encourage you to apply your understanding to your local situation.



Activity 4

Read the extract below and answer the following questions. If you are studying alone analyse the extract and ensure that you understand it well. If you study in a group, discuss the meaning of what you have read with your group and apply it to your own situation or environment. Use the questions below to guide your discussion and/or individual reading.

“Whether called nature tourism or ecotourism, recreational and educational travel, it is based on natural attractions and is a promising means of advancing social, economic, and environmental objectives in developing countries. It offers countries new opportunities for small-enterprise investment and employment and increases the national stake in protecting their biological resources. However, making ecotourism a positive economic and environmental tool requires policies that foster responsible nature tourism development, broad-based and active local participation in its benefits, and conservation of developing countries' biological heritage.”

Source: <http://www.untamedpath.com/Ecotourism/benefits.html> Retrieved 2010/03/12

1. Are you practicing ecotourism in your community or country?
2. What is the evidence of this practice in your local area or country?
3. What is being done to promote eco-tourism in your country or by your local community?
4. What are benefits of eco-tourism in your country
5. What are the disadvantages of ecotourism
6. Does your country have any policy that foster responsible tourism? If your answer is yes, write down the main guidelines of this policy. If your answer is no, explain why.

Feedback

Almost all countries are now practicing ecotourism. We know that there is no way you can take nature walk without disturbing or causing damage to the natural environment. This a clear example of disadvantages directly related to tourism. In the passage you learnt that ecotourism

offers countries new opportunities for small-enterprise investment and employment and increases the national stake in protecting their biological resources. However, efforts are made to minimise the destruction to the environment by sensitizing or making people aware of the importance of conserving their environment. As mentioned in the passage, ecotourism fosters local participation in the conservation of their biological heritage.

In Botswana, a National Ecotourism Strategy developed by the Department of Environmental Affairs, has been developed to encourage local communities to participate in ecotourism activities by keeping their environment clean, protecting their wild life, learning and implementing new environmental management strategies. Local communities are motivated to conserve their environment by the benefits they reap from the tourist industry. The passage mentions some economic benefits in the form of business enterprises.

The industry has created ample employment opportunities in game reserves and parks, the hotels and other related industries. Through tourism they earn income and foreign exchange used to pay for import and other developments such health, education, national security, and provision of energy and water. On the other hand, tourists are educated as well as encouraged to participate in ecotourism by keeping the environment clean and ceasing from carrying out activities harmful to the environment. Some tourists work voluntarily with the local communities through duties such as the planting of trees.

Our discussion has so far helped you understand ecotourism. Let's now move on to another common type of tourism, 'sustainable tourism.'

2.2 What is Sustainable Tourism?

Do you think sustainable tourism is the same as ecotourism? To answer this question, look at the definitions of sustainable tourism below

1. **Sustainable tourism** is an industry committed to making a low impact on the environment and local culture, while helping to generate income and employment for local people. The aim of sustainable tourism is to ensure that development is a positive experience for local people, tourism companies, and tourists themselves

Source: http://en.wikipedia.org/wiki/Sustainable_tourism retrieved 2010/03/12

2. The [UN-World Tourism Organization \(UN-WTO\)](#) has defined sustainable tourism as an enterprise that achieves an effective balance among the environmental, economic, and socio-cultural aspects of tourism development in order to guarantee long-term benefits to recipient communities.

Source: http://www.nric.net/tourism/what_is.htm retrieved 2010/03/12

Most people confuse the term ecotourism with sustainable tourism. Let us now find out how they differ. Of course, they are closely related, but we can still note down the differences.

Look at the two definitions and go back and compare them to the definitions of ecotourism. Are the definitions the same? Before you answer this question let's look at some of the most important attributes of sustainable development. They are as follows:

- Focus on balancing the needs of tourists and local people while protecting and preserving future opportunities

- Minimizes environmental impacts using benchmarks
- Can be achieved by cooperation between the government and other stakeholders such as Safari companies, Park managers
- Improves contribution to local sustainable development
- Emphasises tourism development that avoids damage to the environment, economy and cultures of the locations it takes place.
- Sustains the wellbeing of local people by using finances accrued from to tourism to improve the livelihood of local people or to reduce poverty.
- Stresses local ownership and participation
- Supports efforts to conserve the environment
- Provides opportunities to diversify local the local economy by promoting both micro and small business enterprises.

In Activity 5 you have an opportunity to answer the question asked above by focusing on the similarities and differences between ecotourism and sustainable tourism.



Activity 5

Write down the similarities and differences between ecotourism and sustainable tourism.

Feedback

As mentioned earlier, most people confuse the term ecotourism with sustainable tourism. First let's find out how they are similar.

You may have noted that they both emphasise contribution to environmental conservation and biodiversity.

They ensure that financial gains from tourism benefit the local community.

Finally they both emphasise on respect and preservation of local culture.

Let us now find out how they differ. Of course, they are closely related, but we can still note down the differences

First we can note down that Ecotourism promotes responsible travel that reduces impact on the environment, creates awareness and respect for local cultures and contributes to the economy of the local people, while sustainable tourism emphasises tourism that contributes significantly to sustainable development, enhances cultural integrity of the local people and environmental conservation.

To a higher degree, ecotourism focuses more on human interaction with the natural environment as a tourist. The focus is therefore in promoting environmental awareness and education. Sustainable Tourism, on the other hand, focuses on all the developments that meet the needs of both tourists and locals while at the same time protecting and preserving them for the future. For

this reason you will find sustainable tourism typically involved in the conservation of a wider range of resources such as forests, mountains, coral reefs.

In addition to the main features of sustainable tourism, it is important to know that Community-based sustainable tourism (CBST) is a form of sustainable tourism which allows the participation of locals at the management level and typically allows a more intimate understanding of the environment. The use of local knowledge also means an easier entry level into a tourism industry for locals whose jobs or livelihoods are affected by the use of their environment as tourism locations. The involvement of locals restores the ownership of the environment to the local community and allows an alternative sustainable form of development for communities and their environments that are typically unable to support other forms of development.

The following activity will help cement your understanding as you will have to reflect on your experience.



Reflection

Reflect on your own experience and answer the following questions.

Questions

1. Is your community involved in sustainable tourism?
2. Why is your community an important stakeholder in sustainable tourism?
3. Give one example as evidence of sustainable tourism practiced by your community.

Feedback

To give you feedback, I will share my experience.

Tourist attractions in my local area include game reserves, waterfalls, caves and rock paintings, arts and many cultural activities. My community practices sustainable tourism. They have formed an association that has promoted a sense of ownership of natural resource. Through this association, local people are directly involved in the management and utilization of all resources associated with tourism in their area. Benefits reaped include village development such as the community hall, reading room, pre-school, all made possible by funds sourced from tourist projects.

You have now seen the differences and similarities between ecotourism and sustainable tourism. Let us now move on to discuss other types of tourism that we have mentioned earlier, starting with Domestic and International Tourism.

2.3 Domestic and International Tourism

Domestic Tourism, also known as Internal Tourism refers to travel or visits made by people to different parts of their country. In other words, it is traveling done by people within their country. Have you ever traveled as a tourist in your country? In Africa, domestic tourism has not received much attention until recently. When people talk of tourists, they normally refer to people from outside their country. For example, in Botswana about 50% of the population has never visited

any game reserve or park. This is partly because tourism is assumed to be an expensive venture and possibly a waste of time.

Is it important to promote domestic tourism? In Botswana, there is a peak season for tourism. During this season, tourists from outside the country visit in large numbers. During low season, tourism industry decline. Local tourism should therefore be promoted to fill this gap or cushion the tourist industry during the low season.

Domestic tourists may travel for the following reasons:

- Leisure/holiday/, recreation/sports
- Visiting relatives or friends
- Religion/pilgrimage
- Business
- Study/education
- Health/medical treatment

Most countries are now actively promoting domestic tourism because it is seen as a way of boosting the economy. Strategies to promote domestic tourism include reduced travel and accommodation fees and also incentive tour packages to individuals, families, corporate, government, and parastatal organizations.

You now understand that domestic tourism involves traveling within the country. Let us now move on to look at international tourism.

2.4 International Tourism

This is when people travel outside their region or country. Tables 1 and 2 below are showing the top 10 countries as the most visited and the top 10 most tourists receipt (between 2006 and 2008) by the number of international travelers.

Table 1: Top 10 most visited countries

Rank	Country	UNWTO Regional Market	International tourist arrivals (2008)	International tourist arrivals (2007)	International tourist arrivals (2006)
1	 France	Europe	79.3 million	81.9 million	78.9 million
2	 United States	North America	58.0 million	56.0 million	51.0 million
3	 Spain	Europe	57.3 million	58.7 million	58.2 million

4	 China	Asia	53.0 million	54.7 million	49.9 million
5	 Italy	Europe	42.7 million	43.7 million	41.1 million
6	 United Kingdom	Europe	30.2 million	30.9 million	30.7 million
7	 Ukraine	Europe	25.4 million	23.1 million	18.9 million
8	 Turkey	Europe	25.0 million	22.2 million	18.9 million
9	 Germany	Europe	24.9 million	24.4 million	23.5 million
10	 Mexico	North America	22.6 million	21.4 million	21.4 million

Table 2: International tourism receipts

Rank 	Country 	UNWTO Regional Market 	International Tourism Receipts (2008) ^[9] 	International Tourism Receipts (2007) ^{[3][9]} 	International Tourism Receipts (2006) ^[10] 
1	 United States	North America	\$110.1 billion	\$96.7 billion	\$85.7 billion
2	 Spain	Europe	\$61.6 billion	\$57.6 billion	\$51.1 billion
3	 France	Europe	\$55.6 billion	\$54.3 billion	\$46.3 billion
4	 Italy	Europe	\$45.7 billion	\$42.7 billion	\$38.1 billion
5	 China	Asia	\$40.8 billion	\$37.2 billion	\$33.9 billion
6	 Germany	Europe	\$40.0 billion	\$36.0 billion	\$32.8 billion
7	 United Kingdom	Europe	\$36.0 billion	\$38.6 billion	\$33.7 billion

8	 Australia	Oceania	\$24.7 billion	\$22.3 billion	\$17.8 billion
9	 Turkey	Europe	\$22.0 billion	\$18.5 billion	\$16.9 billion
10	 Austria	Europe	\$21.8 billion	\$18.9 billion	\$16.6 billion

Source: <http://en.wikipedia.org/wiki/Tourism> Retrieved 2010/03/12



Reflection

Study the 2 tables above, and using analysis skills that you have acquired from Unit 10 on Research Skills, briefly make an analysis. In other words, if you were the one carrying out a research and coming up with the above tables how would you interpret them?

Feedback

Examples:

- *The top 10 most visited countries and top 10 tourism receipts are all developed countries.*
- *France is the most visited country in the world but the USA leads in receiving the highest amount of revenue from tourism.*

You may also note the trend of visits or tourism receipts between the years 2006 and 2008. Have you noticed any increase or decrease?

Keep your analysis in mind as we progress through the next section that takes us to sources and destinations of tourists as mentioned earlier.

3.0 Sources and Destinations of Tourists

A source refers to where something originates. Table 1 shows the top ten countries in the world from which tourists come. Therefore sources of tourists are places where tourists come from. Destinations refer to places they are going to visit. Table 2 shows the Top 10 countries receiving the highest number of tourists.

Botswana is not amongst the top 10 countries but people still travel in and out of the country. Your country might not be in the top 10 lists in the world. Can you think of any reasons why it's not in the top 10 listed countries? We will find out the reason later as we progress through the topic.

Study the Table 3 which shows Tourist Arrivals by Country of Residence, 2007

	Leisure	VFR	Business	Other	Total
Africa					
South Africa	102,843	164,876	52,396	159,358	479,473

Zimbabwe	41, 102	541,930	17,586	51,674	652,292
Zambia	8,076	19,025	5,225	48,266	80,592
Namibia	4,889	11,207	1,269	46,933	64,298
Swaziland	694	1,100	390	1,503	3687
Malawi	462	2,001	400	1,040	3,903
Other Africa	3,053	5,400	1,287	3,246	12,986
Total Africa	161,119	745,539	78,553	312,020	1,297,231
Americas					
USA	21,009	1,737	624	1,398	24,768
Canada	2,634	359	125	219	3,337
Other Americas	677	159	54	94	984
Total	24,320	2,255	803	1,711	29,089
East Asia/Pacific					
Australia	6,396	588	336	597	7,917
Japan	2,341	90	20	390	2,841
Other EAP	2,512	1,019	304	470	4,305
Total EAP	11249	1697	660	1457	15063
Europe					
United Kingdom	14056	2914	1295	1435	19690
Germany	1,1635	843	208	1,180	13,866
Netherlands	6,183	567	103	659	7,512
France	4,636	256	114	402	5,408
Italy	2,787	310	55	282	3,434
Other Europe	14,107	1,553	567	1,422	17,649
Total Europe	53,394	6,443	2,342	5,380	67,559
Other	7,063	24,99&	2,442	11,707	46,209
Total	257,145	780,931	84,800	332,275	1,455,151

Source: Department of Tourism – Tourism Statistics 2006-2009

From the table you can see that most tourists who visit Botswana come from the African region. You can see that the African countries listed in the table are closer to Botswana. More tourists come from those countries because of the shorter distance of travel to Botswana as compared to travelling to other countries, therefore allowing them to spend less money on travel. From this

table, you can still see that most tourists visiting Botswana are from South Africa. Can you think of a reason of more visitors from South Africa? Botswana is a landlocked country and conducts most of her business with South Africa. In other words, Botswana is doing more trade business with South Africa than other countries in the region.

Do Activity 3 as it will help you understand more about sources and destinations of tourists of other countries. This activity asks you to carry out a little research on sources and destinations of tourists for other countries.



Activity 6

List down **three** areas or countries where tourists who visit any country, other than Botswana, come from. Give reasons why tourists come from the areas you have named. You may want to compare your results with what you learnt about Botswana.

Areas	Reasons
(a) _____	(a) _____
(b) _____	(b) _____
(c) _____	(c) _____

Feedback

Let's take Namibia for example; most of the tourists who visit Namibia come from the neighbouring countries, mainly South Africa, Zimbabwe, Zambia, Botswana etc. The majority of the tourists come from South Africa and countries in North America and Europe. In Africa, many tourists visiting Namibia come from South Africa. This is because South Africa is closer to Namibia, hence transport is cheaper. There is also a good linkage between South Africa and Namibia i.e. roads, rail-line, air links. Not as many as compared to those from South Africa, come from Europe and North America because of high cost of air travel.

We have now come to the end of our topic discussions. The summary below gives you a brief outline of what you have learnt so far.

3.0 Summary

In this lesson you learnt key concepts tour, tourist and tourism essential in the understanding of the topic tourism. You learnt that that tourism takes place worldwide in all countries and is viewed as one of the world's largest industry. It serves as the mainstay of most countries. In other words, it is the largest source of income for most countries. Tourism is defined as a range of activities that involves travel to other places for different purposes.

You have looked at two main categories of tourism; ecotourism and sustainable tourism. Ecotourism or nature travel emphasises on environment and ecological education and respect for local cultures. It also emphasises on using tourism's financial benefits on local communities. Sustainable development emphasises tourism that promote environmental conservation, economy and cultures of the country where it takes place. In addition, it aims to balance between meeting both tourists and people's needs and protecting the environment for future use.

You have also discussed domestic and international tourism. Tourism, whether domestic or internal, has the same definition. The visit is still temporary and involves certain activities related to pleasure or business. Domestic tourism involves internal travel or travelling within the country and International tourism involves travelling outside the country. For both domestic and

international tourism we looked at their sources and destinations of tourists. Sources are places where tourists come from and destinations are places which they visit.

In our next topic we will look at factors influencing the establishment and flourishing of tourism. This topic is very important to help you understand tourist attractions and their economic importance.

Topic 2: Factors Influencing Tourism

Topic 1 introduced you to important concepts of studying tourism. Topic 2 is going to take you further to understand all factors influencing the establishment or development of tourism as an industry. As you go through this topic, it is very important to bear in mind the definitions of tourism you learnt in Topic 1 and also reflect on your own experiences. You learnt the significance of tourism as an economic sector and an industry, generating foreign exchange as well as employment. Tourism, like any other industry has some factors that influence its existence, demand and operations. You may ask yourself what these factors are all about. When dealing with factors influencing the tourism industry, we are looking at those things or aspects that make the existence or operation of tourism possible. A combination of these aspects will make the existence of tourism easier. That is the tourism industry would be impossible or difficult without these factors. Most factors influencing the tourism industry are the same for any other industry. You will learn about factors influencing other types of industries in unit 13 and you will then be able to compare the factors mentioned in these two units. This topic presents the opportunity to explore why few or no tourists visit some areas while others are a **honey pot** or areas visited by a large number of tourists.

Learning Objectives

On completion of this topic you should be able to:

- List general factors influencing tourism
- Describe factors influencing the development of tourism
- Discuss factors influencing the operations and demand of tourism

1.0 Factors Influencing Tourism

Before you learn about factors influencing tourism you are going to learn about the factors that influence the location or existence of an industry in general. Note that you will come across these factors again in the next unit when studying processing and manufacturing industries. You have to compare the general factors influencing the location of an industry with those that influence tourism as an industry.

The following are some of the factors that influence the location of an industry:

- **Water** – required for processing goods, cleaning and drinking

- **Land** – for building infrastructure
- **Labour** – for making goods and providing services
- **Transport and communications-** to contact suppliers and buyers and other service providers
- **Raw material** – to be processed or manufactured into finished products
- **Market** – for selling finished goods
- **Machines** – required for processing or manufacturing of goods or providing required the services

A combination of some of the factors above will make the existence and operations of an industry possible. You must know that one factor alone cannot influence the existence or operation of an industry. Note that the development of some of these factors can increase the demand of tourism. For example, if a tourist resort is built around a waterfall, the continued demand for tourism will depend on the development of other supportive factors like good infrastructure.

Factors influencing tourism can be divided into big categories such as physical, human or social, political and economic factors.

From the above list of factors, money is an example of an economic factor while water is an example of a physical factor and finally labour can be taken as an example of a human factor.

Factors influencing tourism can be divided into the following groups:

Table 5: factors influencing tourism

Groups	Examples
Physical Factors	(a) Temperature (b) Rainfall (c) Land (d) Air (e) Water features
Political Factor	(a) Security (b) Political stability (c) Government policy
Economic Factor	(a) Money (b) Transport and communications (c) Technology – new transportation methods
Human Factor	(a) Labour (skilled and unskilled) (b) Culture (c) Health

Let us now look at some examples of each category of the factors influencing tourism in more detail. These factors do not differ from those that influence tourism in any other industry.

1.1 Physical Factors

Physical factors are also known as natural factors. You have learnt about physical factors in earlier units. They are natural occurring things and they are not influenced or created by human beings.

(a) Weather Conditions

In unit 4 you learnt about regions of the world experiencing different climatic conditions. Tourists from cold regions such as Europe prefer to visit areas with cool to warm temperatures. Tourists who visit Botswana enjoy the warm and hot conditions experienced in the country, especially during summer time. Some tourists prefer to visit in winter when the grass is usually short which makes most animals visible.

Touring is also easier or better during dry season because of less water borne diseases and the dirt roads in places such as game parks or reserves are more accessible.

Most tourists enjoy an environment with bright sunlight. You must remember that some countries do not have enough sunlight as clouds always cover the sky. Tourists also enjoy unpolluted fresh air. Some tourists come from industrialized countries where the air is polluted by gases released from the industries. Most countries in Africa including Botswana are less developed and have few industries, hence less air pollution.

(b) Land

A large piece of land is needed to establish Game reserves and National Parks. You must know that these Game reserves and National Parks are homes for our wild animals. A vast land of wilderness with beautiful scenery is required in tourism. The Central Kalahari Game Reserve covering 52, 800 km² is the largest game reserve in Botswana and the second largest in the world. You can see that this land is bigger than countries like Lesotho, Swaziland, Denmark and Switzerland. Can you think of other large piece of land reserved for wildlife and tourism? You may have heard about the Kruger National Park in South Africa.

Land for tourism should be unpolluted and free from any developments or settlement. Establishment of town and development of infrastructure will disturb wildlife.

Some tourist attractions are also landmarks

(c) Desert

In the past, deserts were known to be inhospitable and inaccessible environments of no interests to anybody from other environments. Today that has changed, as deserts are now becoming more popular tourist attractions. There is growth in desert tourism, hence boosting the economy of the desert countries.

The Namib Desert case study below is meant to show you several desert physical factors that influence tourism.



Case Study: The Namib Desert

Study figure 2 below and read the extract that follows.



Figure 2: Namib Desert

Source: http://en.wikipedia.org/wiki/Namib_Desert retrieved 2010/03/14

The **Namib Desert** is a desert in Namibia and southwest Angola that forms part of the [Namib-Naukluft National Park](#). The name "Namib" is of Nama origin.

The desert occupies an area of around 80 900 km² (31 200 square miles), stretching about 1000 miles (1,600 km) along the Atlantic Ocean coast of Namibia. Its east-west width varies from 30 to 100 miles (50-160 km). The Namib Desert also reaches into southwest Angola. It is one of the 500 distinct physiographic provinces of the South African Platform physiographic division.

Having endured arid or semi-arid conditions for at least 55 million years^[2], it is considered to be the oldest desert in the world after the Atacama Desert in Chile. The Namib's aridity is caused by the descent of dry air of the Hadley Cell, cooled by the cold Benguela current along the coast. It has less than 10 mm (0.4 inches) of rain annually and is almost completely barren.

A number of unusual species of plants and animals are found only in this desert. One of these is *Welwitschia merabilis*, one of the most unusual species. *Welwitschia* is a shrub-like plant, but grows just two long strap-shaped leaves continuously throughout its lifetime. These leaves may be several meters long, gnarled and twisted from the desert winds. The taproot of the plant develops into a flat, concave disc in age. *Welwitschia* is notable for its survival in the extremely arid conditions in the Namib, sometimes deriving moisture from the coastal sea fogs.

Although the desert is largely unpopulated and inaccessible, there are year-round settlements at Sesriem, close to the famous Sossusvlei and a huge group of sand dunes, which at more than 300

meters high are among the tallest sand dunes in the world. The complexity and regularity of dune patterns in its dune sea have attracted the attention of geologists for decades. However, they still remain poorly understood.

The interaction between the water-laden air coming from the sea via the southerly winds which are some of the strongest winds of any coastal desert and the dry air of the desert cause immense fogs and strong currents, causing sailors to lose their way. Along with the Skeleton Coast further north, it is notorious as the site of many shipwrecks. Some of these wrecked ships can be found as much as 50 metres inland, as the desert slowly moves westwards into the sea, reclaiming land over a period of many years.

The Namib Desert is an important location for the mining of tungsten, salt and diamonds.

Access is by light aircraft from Windhoek (the capital of Namibia, about 480 km north-east of the centre of the desert), Swakopmund and Walvis Bay at the north end of the desert, or overland on gravel roads.

Source: http://en.wikipedia.org/wiki/Namib_Desert, retrieved 2010/03/12



Activity 1

Read the above extract and answer the following questions.

1. List **four factors influencing tourism** in the Namib Desert?
2. List **five** possible tourist activities of the Namib Desert.

Feedback

In the feedback below I have combined factors influencing tourism with tourist activities. Your answer could have included any four factors and five activities from what is provided here.

1. *The sand dunes of Namibia are an amazing spectacular feature due to their large size, patterns and change of colours at sunrise and sunset. Tourists visit sand dunes just to see them or sand ski.*
2. *The Namib Desert has attractive rare plants. Tourists would visit the desert to see and take pictures of different plant species.*
3. *Unusual wild animals like the giant lizards and gemsbok are some of the tourist attractions. Some animals can be seen in game reserves and parks that offer services like safari rides and walks.*
4. *Historical remains like ship wrecks are also a tourist attraction. Tourists would visit such sites to take photographs and learn the history behind the sites.*
5. *Some tourists are fascinated by the harsh climatic conditions of the desert. Tourists visit the desert to experience harsh climatic conditions and see how people have adapted to this environment.*

6. *The desert sandy soil provides for sporting activities such as the desert race. You were required to mention four other activities.*

(d) Water Features

Water features like rivers, waterfalls, mountains, and lakes are all important tourist attractions. Tourists visit such places for boat riding, canoeing, water sports and fishing or just to view the scenic beauty of the place. Figure1 below is one of the world's tourist attractions in Africa, Victoria Falls.



Figure1: Victoria Falls. Source: http://wikitravel.org/en/Victoria_Falls retrieved 2010/03/12

If you would like to view more slide shows of the Victoria Falls visit the link:
http://www.afrizim.com/Pics/Slide_Shows/Activities/Elephant_Ride.asp

As mentioned earlier, a feature like the Victoria Falls cannot promote tourism alone. It has to be supported by other factors. As we progress through this topic, note those factors.

1.2 Political Factors

Politics also play a major role in the location and establishment of tourism. We shall look at two of these factors that are common to most countries.

The following is an example of one of the factors that fall under political factors.

(a) Security and Political Stability

Politics also play a major role in influencing tourism. A country that has wars or conflicts will not attract tourists. A politically stable country is a country that is peaceful, and such a country will attract many tourists. Tourists are ill-treated, tortured, kidnapped or even killed in countries that are politically unstable.

Political instability does not affect tourists only. Wildlife (both natural vegetation and wild animals) are disturbed or destroyed during cross-fire (gunfire and explosions). In order to understand the concept of political stability and instability go through the following activity.



Activity 2

Sudan is one of the politically unstable countries because of the civil wars. Carry out a mini research to find out about the political situation in Sudan. In what way do you think this political situation has affected the tourism industry in Sudan? If you want to learn about Sudan's political instability, you may listen to the radio news including Radio Botswana or read newspapers. It is a topical issue almost every day in all radio stations.

Feedback

After learning about Sudan from your study, you must have realised that security is one of the key factors influencing Tourism. Sudan has diverse tourist attractions. Some of these are wildlife, historical sites, coastal reefs, waterfalls and rapids along the Nile River. Despite these stunning tourist attractions, the development of tourism is affected by the security situation, as this is highly unstable in several areas of the country, particularly in the Darfur region. This war-torn area is a fighting ground for civilians at war and is a NO GO TOURIST AREA.

Besides security and political stability, political factors include government policy and legislative frameworks that are discussed in the next section.

(b) Government Policy and Legislative Frameworks

Tourism is an important economic sector for most countries; therefore, a national policy to direct its operations and growth is essential. As mentioned in the previous topic, Botswana like most countries has a strategy to develop and expand tourism. This aim is guided by the following.

- Tourism policy
- Botswana Tourism Master Plan (2000)
- Tourism Development Framework (2001)
- Botswana National Tourism Strategy (2002)
- Botswana Tourism Act (1992)
- Botswana Tourism Regulations (1996)

The above policy and legislative frameworks were all created to promote tourism while conserving the natural environment, especially wildlife. The Tourism Department and the Environmental Affairs Department under the Ministry of Environment, Wildlife and Tourism together with the recently established Botswana Tourism Board are responsible for implementing the national policy on tourism.

We have looked at the political factors influencing tourism. Let us move on to economic factors.

1.3 Economic Factors

Economic factors are all primary elements related to financial matters.

(a) Money

Capital finance or money is used to develop tourist attractions such as national parks and game reserves. These national parks and game reserves are used to accommodate and protect our wild animals.

A lot of money is also used to construct hotels, motels, lodges etc. Tourists are accommodated in hotels, motels and lodges they pay for the accommodation. The money paid by tourists belongs to the government.

Money or capital finance is used to buy food for tourists and for paying workers such as hotel attendants, game wardens etc.

You have learnt the importance or uses of money in the tourism industry. Can you think of any other major use of money in tourism? Can you find out how other tourists from other countries reach your country?

(b) Transport and communication

Transport and communication play a major role in tourism. Without transport it would be very difficult for tourists to travel from one country to another. Money is used to construct better roads, international airports, small airstrips, railway networks etc.

A country with improved transport and communication will attract many tourists. Which type of transport system is commonly used by many tourists who come to Botswana? You learnt earlier that most tourists who visit Botswana come from South Africa. This means that the majority of the tourists use road transport.

Air transport is also important because it links those countries which are far away with your country. The construction of the Sir Seretse Khama International airport, Kasane, Maun and Francistown airports, make travelling by tourists to Botswana much easier. You must remember that air transport is faster and more expensive as compared to other transport systems.

The next factors we shall look at are human factors. We will only focus on three human factors, namely labour, health and culture.

1.4 Human Factors

Human factors are those factors which are influenced by human beings and they are sometimes called man-made factors.

(a) Labour

Both skilled and unskilled labour is important in tourism. People are employed in different sectors of the tourism industry. Under tourism industry people are employed as Game wardens, cooks in hotels, tour guides, drivers, hotel attendants etc. All of these people are very important because without them the tourism industry will have problems.

(b) Health

Epidemic outbreaks can affect tourism. Can you think of any disease outbreak that can hinder tourism? Malaria, Cholera, TB, H1N1, Measles' outbreaks are some of the common epidemics which had affected tourism. Places free of diseases are attractive to tourists.

(c) Culture

Culture is increasingly becoming a global tourism market. In your JC history or social studies program, you have learnt that culture is the whole way of life for a certain group of people of community. Do you still remember aspects of culture? Examples of cultural aspects include language, customs, tools, crafts, dress, food, religion, music and dance. Many people today are actively involved in developing aspects of their culture that attract the curiosity of tourists. Botswana still receives tourists who are curious about Basarwa (Bushmen). Tourism provides an opportunity for Basarwa to showcase their culture. Associations like the Kuru Development Trust were established to assist Basarwa to venture into tourism.

6.0 Summary

In this topic you learnt that tourism is influenced by a number of factors. These factors relate to the location, development, operations and demand of the tourism industry. The factors are classified under four major categories as physical, economic, social and human factors. We have given examples of factors under each category; for instance, examples discussed under physical factors include temperature and rainfall, land and water resources. We looked at how each factor contributes to the development of tourism. The Victoria Falls was an example of a physical factor that has made the development of tourism possible. Some political factors like insecurity affect the potential of tourism in places like the Darfur region in Sudan. This shows that a place can have abundant tourist resources but if security is a problem, the industry will not exist in that place.

Topic 3: Coastal and Inland Tourism

Introduction

In topic 2, we discussed factors influencing tourism. These factors will be mentioned again in this topic as we discuss inland and coastal tourism. The first part of this topic will focus more on inland tourism. We will visit some of the inland tourist attractions which you might find fascinating too. Examples of inland tourist attractions will be drawn from Botswana. We also look at sources of inland tourism and the mode of transport and communication used. The second part of the topic will focus on coastal tourism with examples drawn from Mombasa in Kenya and Durban in South Africa. For each type of tourism, we will discuss the economic importance of tourism using statistical data.

Learning Objectives

At the end of this topic, you should be able to:

- distinguish between coastal and inland tourism
- locate and describe inland tourist attractions
- justify the economic importance of both inland and coastal tourism using statistical data
- describe sources and destinations of tourists and
- describe the mode of transport and communication used by tourists

1.0 Inland Tourism

First let us look at inland tourism because most countries experience inland tourism. Inland tourism takes place inside a country and away from the coast. This type of tourism is common in countries which are landlocked. A landlocked country is a country which is surrounded by other countries instead of seas and oceans. The word **Inland** means inside the country and away from the coast. You must remember that this type of tourism also occurs in those countries with access to the sea as long as the place of attraction is inside the country and away from the coast.

1.1 Inland Tourist Attraction

In topic 1, you learnt that tourist attractions are things of great interest to tourists. They are those things which will make tourists leave their homes for business or pleasure. These things will make tourists more attracted to them since they are beautiful, interesting and exciting. Tourist attractions are pleasant and filled with exciting things which will always draw the attention of tourists.

Tourist attractions vary from physical features or natural features such as mountains, lakes, valley etc to wildlife i.e. wild animals and vegetation (flora and fauna). Botswana has many tourist attractions. Can you name some of them? Remember that you came across them in the previous topic.

2.0 Tourist Attractions (Case study: Botswana)

Botswana is amongst those lucky countries which still have a variety of wild animals as well as a beautiful scenery or unspoiled wilderness.

Remember that most of the attractions are found in the northern and north western parts of the country. There are more attractions in the northern part of the country because the natural environment is not that disturbed or spoiled. In the northern part there are few developments and less people as compared to the eastern part of the country. Most people live along the eastern part of the country. We also find more developments in the eastern part of the country. Let us now look at some of the tourist attractions in Botswana which are typical of inland tourism.

2.1 Examples of Attractions

Wildlife

This is considered a number one tourist attraction. It includes wild animals such as birds, reptiles, mammals etc as well as the natural vegetation. Tourists are more interested in photographing and hunting wild animals. In Botswana the Chobe National Park and Moremi wildlife reserve receive a large number of tourists. National Parks and Game reserves (see figure 1) are used to keep and protect wildlife. From the previous topic, do you still remember the name of the largest game in Botswana? Look for it on this map.



Figure 1

Source: <http://wikitravel.org/en/Botswana> retrieved 2010/03/23

We have mentioned that the Chobe National Park is the most visited park in Botswana. This park covers an area of 10 698 km². Try the activity below to find out what make this park attractive to tourists.



Activity 1

Look for the Chobe National Park on the map – figure 1. In the space below, write down features that you think tourists would consider attractive. To answer this question, you may have to ask for help around or go to the library and research about the Chobe National park.

Feedback

Now let us look at those features. You will notice that there are both physical and manmade attractions. Under human factors we have the following:

- *secondary roads which makes the park accessible*
- *Kasane airport making the park accessible by air*
- *Camp sites, Lodges and hotels to provide enjoyable and memorable accommodation*
- *Safari Companies and trained staff like tour guides*

Under physical attractions, we do have the following:

- *Water sources like the Chobe river – wild animals gather around the water sources during the dry season, making them visible to tourists*
- *Savuti landscape – characterised mainly by a sandy ridge, rocky outcrops and a depression.*
- *Linyati river and swamps – a bird and wildlife habitat*
- *Hills – many rocky outcrops forming small hills*
- *Pans – which hold water and forms a habitat for birds*
- *Wild animals*

The photograph (figure 2) below shows some of the wildlife found in game reserves and parks. The park is a home of a variety of wild animals, ranging from reptiles, mammals and birds.



Fig 2: Some of the wild animals found in Botswana.

Source: <http://en.wikipedia.org/> retrieved 2010/03/23

Rock Paintings

These are ancient or old paintings made by the Basarwa (see figure 3). These paintings are found at Tsodilo hills. These paintings are symbolic of Basarwa's lifestyle. You must understand that the Basarwa are not tourist attractions, but their paintings are.



Figure 3 : Rock paintings by the San

Source: http://www.botswanaturism.co.bw/attractions/tsodilo_hills.html retrieved 2010/03/23

Okavango Delta

This is unique scenery which is flooded with water. The delta covers an area of about 15 000 sq. km of swampland and Savanna (grassland). Study the photograph and map of the Okavango in figure 4. Locate Maun (known as the gateway town into the delta) on this map.





Figure 4: Okavango Delta

Source: <http://www.afrizim.com/images/maps/Okovango-Linyati.gif> - retrieved 2010/03/23

The water attracts a variety of wild animals including birds. This offers photographic opportunities and game viewing by vehicle or canoes. The Okavango delta as an unspoiled wilderness also fascinates tourists with its flood plains, pans, lagoons, grassland and the aquatic vegetation. The photograph (figure 5) shows part of the Okavango delta and some tourists on a canoe transport.



Figure 5: The Okavango delta

Source: http://www.botswanaturism.co.bw/photo_gallery/img/okavango_delta.jpg
retrieved 2010/03/23

You may visit these internet links to view photo slides showing the Okavango delta

http://www.afrizim.com/Pics/Slide_Shows/Botswana/Scenes/Okavango-2.asp

http://www.afrizim.com/Pics/Slide_Shows/Botswana/Scenes/Okavango.asp

http://www.afrizim.com/Pics/Slide_Shows/Botswana/Scenes/Okavango_Slideshow.asp

National Museum and Art Gallery

It is located at the centre of Gaborone city. Here, there are some displays of excellent art and craft collection. There are also some archaeological and ethnological exhibits. The picture (figure 6) shows the national museum and art gallery in Gaborone.

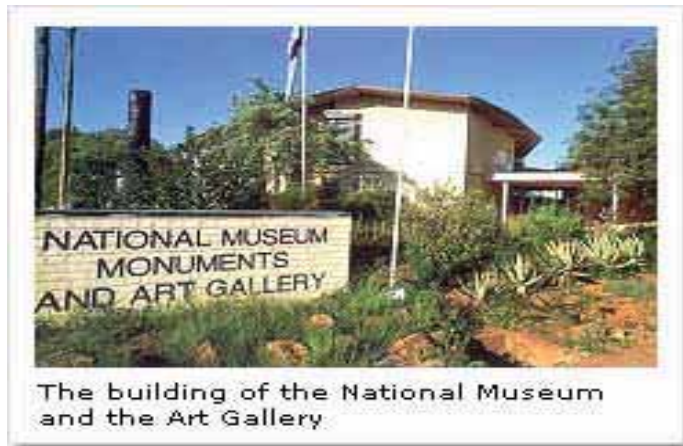


Figure 6: the national museum and art gallery

Source: Botswana Tourism Board

Hotels, Lodges and Casinos

Hotels and Casinos of great standards are located at different town and major villages. In addition to hotels, there are some lodges, motels and camps. The photo (figure 7) shows the Abu lodge which accommodates tourists.



Figure 7: Abu Camp

Source: <http://www.botswanatourism.co.bw/accommodation/facility.php?facilityID=79> - retrieved 2010/03/23

Services and Activities:

Restaurant, Game Drive, Walking Safaris, Fishing, Bar, Mokoro (Dug Canoe), Elephant-Back Safari, Swimming Pool, Boat Cruise and Airport Transfers are some of the services provided by Abu lodge. These services are typically provided by most lodges and hotels in Botswana.

Handicrafts

These are beautiful traditional baskets and woodcarvings. Batswana, especially in rural areas make baskets of high quality, which are very much sought after by tourists. Figure 8 show some of the baskets with excellent patterns and designs.



Fig. 8: Typical examples of Botswana basket

Source : http://www.botswanatourism.co.bw/photo_gallery/img/craft.jpg - retrieved 2010/03/23

Flora

One of the attractions in Botswana is the unique plants found in the country. Below in figure 9 are some of the plants. Do you recognise any of these plants?

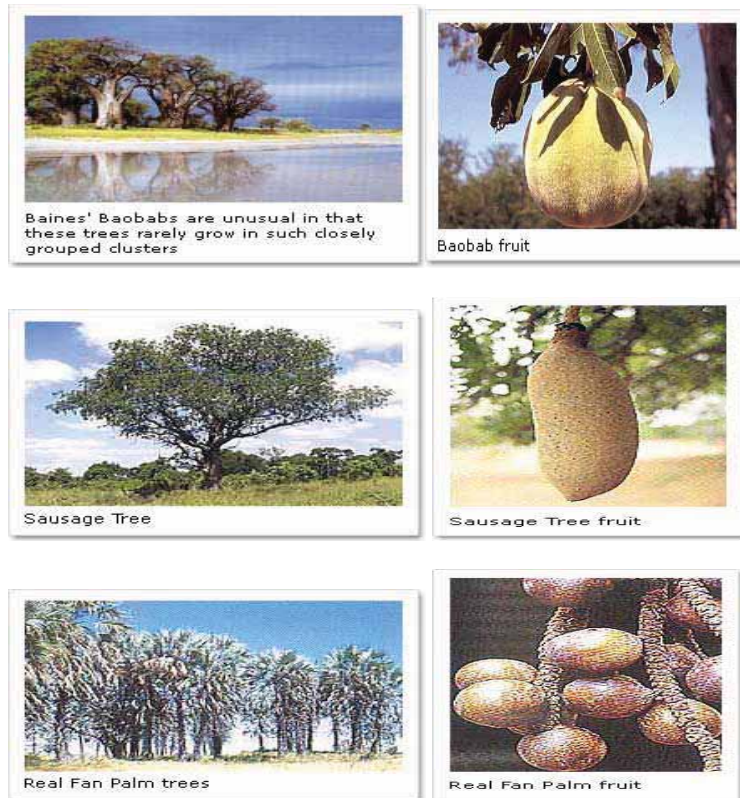


Fig. 9: Plants in Botswana

Source: Botswana Tourism Board

We have looked at Botswana's tourist attractions as a typical example of inland tourist attractions.

In relation to this, let us now look at the economic importance of tourism. Before we actually start the discussions on this sub topic, try activity 2 below.



Activity 2

From Botswana tourism attractions and activities we discussed so far, you may have related these to some benefits to the country, some of which are economic. Briefly explain the economic importance of tourism to Botswana?

Feedback

The following topic section provides an answer to this activity.

Economic Importance of Tourism in Botswana

- (a) Tourism provides employment for Botswana in both urban areas and rural areas. Many Botswana are employed in the following which are related to the tourist industry:
- safari companies
 - hotels and lodges
 - airlines
 - handicrafts, etc
- The number of people employed under tourism is estimated at 27 000.
- (b) It promotes development of remote areas by encouraging the provision of services such as roads, airports, hotels etc. The Maun-Nata road was developed as a way of promoting tourism. Both the Kasane and Maun airports were developed to promote tourism.
- (c) It is a source of foreign exchange. In 1989 tourism brought P107.9 million in foreign exchange. The latest estimation shows that tourism industry contributes about P 271.8 million per annum to the Gross Domestic Product.
- (d) Tourism promotes local arts and craft industries and this includes:
- carving
 - pottery
 - weaving
 - music
 - dancing
- (e) It introduces new ideas and cultures and promotes international understanding. Botswana receives many visitors from South Africa, Europe etc and these tourists come with new ideas and culture. They also learn and understand Botswana's culture.
- (f) Tourism encourages the conservation of natural resources such as wildlife. There are many national parks and game reserves in Botswana which are used to conserve wildlife.

You can refer to the responsibilities of the department of wildlife and national parks in this lesson.

Do you still remember the names and location of Botswana's national parks and game reserves?

(g) Tourism industry diversifies the economy of Botswana. Tourism industry is quickly growing. This means that the government of Botswana will gain money from tourism industry instead of relying on minerals and meat and meat by-products.

The above are some of the advantages of tourism. The major advantage can be said to be the one which deals with the government of Botswana gaining revenue or money. This is not to say that other advantages are not important, as they are very important as well.

In topic 1, we have noted that tourism is important because it is a source of income. In Botswana, millions of Pulas are received from tourism every year. Have you ever asked yourself how tourism generates or makes money? Attempt activity 3 to find out how much you already know about how tourism generates income for your country.



Activity 3

Use the following space to write down the ways through which tourism industry make money.

- (a)
- (b)
- (c)
- (d)
- (e)

Feedback

How far have you gone with the above activity? Most people know that tourism brings a lot of money to our country, but they do not know how. The ways of bringing money are as follows: Money paid to tour operators by tourists, money paid for licenses by tour operators, personal taxation by people working in the tourism industry, money paid in hotels and the entrance fees into national parks and game reserves.

Study the following Table 1 which shows the amount of money which was received by the government from different national parks and game reserves.

Table 1: Revenue collected by Government from Park Fees in 1996/97

Protected Area Collected	No of Tourists	Park Fees
Chobe National Park	48, 481	P 3,011,705.00
Moremi Game Reserve	23, 504	P 2,448,316.00
Nxai Pan National Park	915	P 95,559
Makgadikgadi Pans National Park	684	P 42,504
Central Khalahari Game Reserve	1,164	P 110,392
Kutse Game Reserve	1,249	P 71,421
Gemsbok National Park	745	P 53,152
Total	76,742	P 5,835,051

Source: National Development Plan 8/9

This table shows that the tourism industry brings a lot of money to Botswana. Tourism is growing from year to year. This means that the number of tourists who visit Botswana increases as time goes on.

If the number of tourists who visit Botswana increases, what do you think will happen to the money received from tourists? Yes, the money received from tourists will also increase. The larger the number of tourists, the higher the amount of money received by Botswana.

Study the table 1.2 which shows the number of tourists and the amount of money received by the government in 1993 and 1997.

Table 1.2: **Tourism contribution to Government Revenue in 1993 and 1997**

Year	No of Tourists	Revenue Generated
1993	607 000	US\$ 120 million
1997	750 000	US\$ 181 million

Source: National Development Plan 8/9

The table 1.2 shows that the number of tourists who visited Botswana in 1993 was 607 000 while in 1997 the number was 750 000. The amount of money generated from tourists also increased from US\$ 120 million in 1993 to US\$ 181 million in 1997. Try to find out the total number of tourists who visited Botswana from 1993 to 1997. You may note that the number is increasing and that means revenue generated from tourists is also increasing.

In this section you learnt about inland tourism, using Botswana as an example. You can now list example of inland tourist attractions and activities. These are not unique to Botswana but can also be found in areas experiencing inland tourism. In the next section of this topic we shall look at

coastal tourism. As we go through this section note the similarities and differences between coastal and inland tourism.

3.0 Coastal Tourism (Case study: Durban – South Africa and Mombasa - Kenya)

You learnt that coastal tourism is the type of tourism which takes place on the coast or coastal area. Our case studies are drawn from coastal South Africa (Durban) and Kenya (Mombasa). Durban in South Africa lies on the coast and it gets many tourists because of its beautiful coastal attractions. Mombasa is also a coastal town found in Kenya. Mombasa is also well known for its unique and attractive features.

Now let us look at coastal tourism in South Africa. Since South Africa has several areas of coastal tourism we shall only choose one area – **Durban**.

3.1 Location of Durban coastal area

Durban is one of the largest cities in South Africa. It is also among those cities which are located on the coastal area. Durban is therefore called a coastal city or town and therefore experiences coastal type of tourism because it has access to the Indian Ocean.

Apart from being a tourism attraction, Durban has important seaports or harbours. These sea ports or harbours are used by South Africa and its neighbouring countries for the exportation and importation of goods.

Durban is serviced by King Shaka International Airport. Many international and domestic flights offer their services. Durban can also be reached by rail and road from other cities of South Africa.

Durban as a coastal area provides one of the best coastal tourism in South Africa. WHY? To answer this question, let us look at Durban's coastal tourist attractions.

Durban Coastal Tourist Attractions

(a) Durban Forests and Animals

Durban is well known for its beautiful and luxurious coasts, namely the north and south coasts. These coasts are occupied by the warm water of the Mozambique current.

The coastal forests of the north coast and south coast of Durban are dense and tall. This is a very beautiful and attractive coastal vegetation. The coastal area is amazing because instead of expecting sea or water animals you will also see big animals if you visit the game lodges such as the Tala Game Reserve.

The following are examples of animals that you can see moving through the game lodges:

- Elephants
- Zebras
- Hartebeests
- Elands
- Antelopes.

What is strange about the animals listed above? Did you expect to see such animals when talking about coastal tourism? These animals are common in inland tourism. You will definitely see such animals under inland type of tourism.

(b) Marine Park

USHaka Marine World occupying almost 15 hectares is one of Durban's major tourist attractions. This is the largest marine park in Africa. It has:

- Salt and fresh water aquariums
- Restaurants and shops
- Fresh water entertainment
- Swimming pools
- River rides
- Variety of water games for adults and kids
- Oceanography Research Institute
- Coral Gardens
- Dolphin, Seal stadiums
- Penguin rockery
- Botanical garden
- Sandy beach
- Open sea

(c) Durban Beach Front

As a tourist you cannot talk of Durban and its coastal attractions without mentioning the Durban Beachfront. The Beachfront is a centre for many attractions. The Beachfront is really meant for those tourists who are "crazy" for pleasure or leisure. It is indeed a tourist paradise.

Study the photograph (figure 10) which shows some parts of the Durban Beachfront. What features of interest can you see from the photograph?



Figure 10: Durban Beach Front

Source: http://wikitravel.org/en/Image:Durban_Beach.jpg – retrieved 2010/03/24

What makes the Beach Front Attractive?

As a tourist once you are at the Beachfront you are at the right place. As a tourist your desire for pleasure and leisure will be satisfied due to the following range of attractions.

- Line of luxurious hotels
- Amusement parks
- Aquarium and Dolphinarium
- Marine shells and crayfish
- Octopus and corals
- Seals and sharks
- Scuba diving
- Snake park
- Amphitheater garden
- Swimming pools and fountains
- Boating – provided by the royal Natal yacht club.
- Cinemas and fun fair rides
- Sporting facilities e.g. golf, cricket, cycling, etc.
- Swimming and surfing as well as sun bathing.
- Beautiful features such as lagoon, harbour, bay etc.
- Picnic sites
- Camping and caravanning.

All of the above provide an atmosphere of excitement and fun.

You have learnt about Durban and its coastal areas as an example of South African coastal tourism. Note that other major tourist coastal areas in South Africa are Capetown, Port Elizabeth and East London. Most tourist activities in Durban are the same for these coastal resorts. Let us now look at Mombasa in Kenya and its coastal tourism.

4.0 Coastal Tourism (Case Study: Mombasa -Kenya)

Mombasa situated along the Indian Ocean coast, is a big beautiful Tropical city which act as the chief port and the centre of coastal tourism in Kenya. Mombasa is linked to other parts of Kenya by roads, railway line, air and sea. These major transport systems link the coastal area with the rest of Kenya and also with other international places.

Air transport, which is the fastest of them all provide international links i.e. Kenya is linked with several European countries. You must remember that most of the tourists who visit Kenya come from Europe. Kenyan airways play an important part in the promotion of tourism in Mombasa as it links Kenya with other parts of the world including the rest of Africa.

Some of Mombasa's coastal attractions include the following:

- A beautiful and unique coastal area. The coast is full of coral reefs which are found in the shallow lagoons and bays.
- Fort Jesus located along the coastline of Mombasa is one of the popular tourist attractions. This was built by the Portuguese in the 16th century.
- Gedi ruins built entirely from stones.
- Hindu Temples with idols and stone curvings displayed within temples.
- Mombasa Tusks built to commemorate Queen Elizabeth's visit in 1952, is a symbolic cultural entrance into Mombasa.
- Mamba village is the largest Crocodile farm in Africa.

- Haller Park with a variety of wildlife is the largest animal sanctuary.
- The coast made up of gentle curving bays such as Malindi bay, Sheshale bay, Formosa bay and others.
- Sheltered harbours such as Kilifi harbour, Mtwapa harbour and Kilindini harbour.
- Permanent rivers which flow from inland are also found on the coast e.g. Tana river and Galana river.
- Some hills on the coast which attract tourists such as the Kwale and Mwele hills.
- Mombasa's beautiful coastal islands such as the Sii island, Funzi island and Wassini island also attract tourists.
- Marine national parks such as Malindi marine national park and Watamu marine national park.
- Many hotels and bush lodges.
- Night clubs for providing entertainment.

Like other coasts, the coast of Mombasa provides the following sporting activities for tourists or holiday makers:

- deep sea diving
- big game fishing
- goggling
- swimming
- surfing
- sun bathing
- scuba diving
- boating

Note that Mombasa is not the only coastal tourist attraction in Kenya and they provide the same tourist activities. Other coastal towns include Watamu, Malindi and Kipini.

Now that we have gone through both inland and coastal tourism, let us now find out the differences. I hope you have noted them as advised earlier in the topic introduction. Some of the points you may have noted include:

- Inland tourism takes place in landlocked countries or the interior part of countries while coastal tourism takes place in the coastal areas. In other words, it takes place in the area between sea and land. Sandy beaches are very attractive to tourists.
- Coastal tourism attractions and activities are more related to the sea or ocean. These include surfing, beach sports, scuba diving and many others. Inland tourism attractions and activities include game reserves and parks in which camping, safari drives, game viewing, trophy hunting and game photo or video shooting are common.

We have looked at the difference between inland and coastal tourism. Let us now find out the economic importance of coastal tourism.

5.0 Economic Importance of Coastal Tourism

You may realise that the economic importance of coastal tourism is just the same as those of inland tourism. The economic importance of coastal tourism includes:

- Major source of government revenue which is earned through license, taxes or duties and other fees. Durban tourism contributes 2/3 of the Province GDP.

- Source of foreign exchange. Foreigners bring in the needed revenues which most countries use to pay for their imports. For example, in Botswana, we use the money for paying for food, clothing, machinery, medicine imports.
- Promotion of local industry like crafts. Examples of such crafts include baskets, pottery, jewellery, leather works and paintings.
- Promotes the growth of other economic sectors like Agriculture, Trade, Transport and Communication. These industries in turn provide the much needed products and services to the tourism industry.
- Source of employment. Durban tourism contributes 30% or 40% to the Province's employment. As mentioned earlier in the previous topics, many people are employed in hotels, game parks and reserves, airports and so on.
- Promotes development of infrastructure. This includes roads, railways, schools, health facilities, accommodation facilities.
- Provides a market for locally made goods. Tourists buy locally made goods and some come and establish business relationships leading to the creation of a big market for our goods.

You may want to carry out a mini research on both types of tourism, that is, coastal and inland. Name and locate the places and compare tourism in the two places you have named.

You are now enlightened about the economic benefits of tourism. The question now is that if tourism is so beneficial to most countries, regardless the type, what do most countries do to promote it? To answer this question let us see how Kenya promotes tourism.

5.1 How the Government of Kenya Promotes Tourism

Kenya is among those countries in the sub-Saharan Africa with the best developed tourism.

Kenya has been successful in promoting its tourism industry. Tourism is now the number two revenue earner for Kenya after agricultural products namely coffee and tea. The tourism industry has been successful due to the government of Kenya's policy on tourism. The following are some of the ways through which the government of Kenya is promoting tourism.

- The government established a Tourism ministry which looks into the development and growth of tourism.
- The tourism ministry established the Kenya Tourism Development Corporation which directly promotes the development of tourism.
- The Kenyan Government works in partnership with the private sector to promote tourism.
- The Government reduces travelling expenses or air transport costs.
- Improve hotel standards.
- Expand air services (international air links).
- The Government keeps or maintains political stable atmosphere.
- Protection and conservation of wildlife.
- Kenyan Tourism Marketing Board which advertise or promote tourism abroad especially in European countries.

The Marketing Board promotes tourism by:

- Setting up offices abroad especially in Europe.

- Advertise tourism in books, magazine, pamphlets, postcards etc.
- Advertise tourism through radio and television.

The Government of Kenya is spending a lot of money in developing tourism. Can you suggest the reasons why the Government of Kenya is spending a lot of money on tourism?

The government of Kenya is spending a lot of money in developing tourism because the government and the people of Kenya benefit a lot from tourism industry.

Go through the summary below and find out the main points you have covered in this topic.

6.0 Summary

In this topic you learnt that there are two types of tourism namely Inland tourism and Coastal tourism. Inland tourism takes place inside the country and away from the coast. Coastal tourism takes place on the coastal area or coast. Botswana has an inland type of tourism while Kenya and South Africa have both coastal tourism and inland tourism. In order to study coastal tourism in both countries we looked at their coastal cities of Mombasa and Durban. You have noted that some attractions found under inland tourism are different from those found under coastal tourism. Most of the coastal attractions are related to the sea and the strip of land along the sea, that is, the beach. You have also noted the economic benefits of coastal and inland tourism.

In Topic 4 we will learn about the impact of tourism. We have discussed some aspects of the impact of tourism when we dealt with its economic benefits. Before you move on to Topic 4 ensure that you understand what we have discussed in the first three topics and if you are unsure of some areas, please review them.

Topic 4: The Impact of Tourism

Introduction

Topic 4 is closely linked to the previous topic in which you learnt about which was inland and coastal tourism and the economic benefits of both types of tourism. The economic benefits that you learnt about in topic 3 are actually an example of an impact of tourism. Tourism has a huge impact on all tourist destinations or areas. The discussions in this, topic will give you a good understanding of both the positive and negative impact of tourism. You will also distinguish between the economic, social and environmental impact of tourism. Though the emphasis is on the economic impact, we will also look at the social and environmental impact of tourism. This will help you distinguish the economic impact from other types of impacts. Finally, you will learn ways of assessing the impact of tourism and also discuss the policies and frameworks designed to examine the impact of tourism.

Learning Objectives

On completion of this topic you will be able to

- distinguish between positive and negative impacts of tourism
- discuss the economic, social and environmental impact of tourism
- describe how the impacts of tourism can be assessed
- discuss policies and frameworks designed to examine the impact of tourism

1.0 Positive Impact of Tourism to Botswana

Here you are going to learn about the benefits which are gained from tourism. These are also known as advantages of tourism. We have already discussed some of the positive impacts of tourism when looking at the benefits of inland and coastal tourism.



Activity 1

From the benefits of both inland and coastal tourism you learnt in Topic 3, list the positive impacts of tourism.

Feedback

I trust that you were able to list the impacts of tourism. You can compare your list with mine below.

- (a) *Tourism industry diversifies the economy of a country, for example, the Botswana tourism industry is quickly growing. This means that the government of Botswana will gain money from tourism industry instead of relying mainly on minerals and beef exports.*
- (b) *Tourism provides employment as many people are employed in the tourism related industries like safari companies, hotels and lodges, airlines, handicrafts, etc*
- (c) *It promotes the development of remote areas by encouraging the provision of services such as roads, airports, hotels etc. The Maun-Nata road was developed as a way of promoting tourism. Both the Kasane and Maun airports were developed to promote tourism.*
- (d) *It is a source of foreign exchange. In 1989 tourism brought P107.9 million in foreign exchange. The latest estimation shows that the tourism industry contributes about P 271.8 million per annum to the Gross Domestic Product.*
- (e) *Tourism promotes local arts and craft industries and this includes:*
 - *carving*
 - *pottery*
 - *weaving*
 - *music*
 - *dancing*

You must have noted that the benefits of inland and coastal tourism you learnt about provide the positive economic advantages of tourism. There are other social and environmental positive impacts. The following are other positive impacts of tourism.

- It introduces new ideas and cultures and promotes international understanding. Botswana receives many visitors from South Africa, Europe etc and these tourists come with new ideas and culture. They also learn and understand Botswana's culture.
- Tourism encourages the conservation of natural resources such as wildlife. There are many national parks and game reserves in Botswana which are used to conserve wildlife.

After our discussion of positive impacts of tourism, let us now look at the negative impacts of tourism.

3.0 Negative Impacts of Tourism

Negative impacts can also be viewed as disadvantages or problems. The following negative impacts of tourism are common to Botswana and other countries in Africa including South Africa, Kenya, Malawi and Namibia. The negative impacts of tourism include;

- Foreign currency or a lot of money is spent on payment for imports especially food and machinery.
- The tourism industry is 100% run by the government but there are some private companies such as Safari companies which take a lot of profit from tourism.
- Tourism is an unreliable industry. The number of tourists can fluctuate from year to year due to different problems such as shortage of money to tour by tourists.
- Like other industries the tourism industry pays Botswana lower wages since most of the higher posts are in the hands of foreigners.
- Tourism disturbs wildlife e.g. animals including birds in the Okavango are disturbed by the noise made by motorboats and motor vehicles.
- Tourism can directly affect wildlife due to littering of the environment or protected areas. Some of the roads are littered along their sides, even some of the camping sites are sometimes left with a lot of litter.
- Some of the irresponsible tourists and poachers are involved in vandalism especially inside the parks. Trees are indiscriminately destroyed as well as fences.
- Tourists are said to be partly involved in the disruptions or changes in the culture of some of the local people.
- Local cultures could be looked down on as barbaric, outrageous or freak shows.
- Tourism is also blamed for the increase in prostitution as well as the spread of diseases including HIV-Aids.
- Tourism is occupying a large land due to the creation of national parks and game reserves.

Although Botswana is a large country with a small population, there is still a serious competition for land. Think of other areas in your country or local area that compete for land with tourism and attempt the following activity.



Activity 2

Which departments or sectors compete for land with the tourism industry?

What do they need land for?

- (a)
- (b)
- (c)
- (d)
- (e)

Feedback

Through this activity you learnt that not all sectors or government departments have conflicting interests on the same piece of land with the tourism industry. Some of the departments or sectors which would compete for land with tourism are as follows:

Pastoral farming – there is need for vast lands for grazing animals. This helps to avoid problems of overstocking leading to soil erosion.

Arable farming – farmers need land for crop cultivations. You may have seen large commercial farms like the Pandamatenga farms. These are essential for large outputs, in other words, to produce enough for the country and reduce agricultural imports.

Manufacturing and processing industries also need land for actual industrial activities and storage.

Settlements – as the population grows, the demand for residential and commercial land also increases

We have looked at both the positive and negative impacts of tourism. Remember in the topic introduction, we mentioned that another way of looking at impacts is by categorising them according to economic, social and environmental impacts. The next sub-topic deals with these impacts.

4.0 The Economic, Social and Environmental Impact of Tourism

We have classified the impacts of tourism as either positive or negative. We can also distinguish between economic, social and environmental impacts from the positive and negative impacts of tourism. Here we are looking at the changes on people and their lifestyle, their natural resources as well as their economic well-being.

Before we discuss further, try this activity. It will consolidate your understanding of all types of impacts on the environment.



Activity 3

In the table below, write down tourist activities which have an impact on the environment and make a tick to indicate if they have an economic (Eco), social (Soc) or environmental (Env) impact and also if they have a negative (-) or positive (+) impact.

Activity	Eco	Socl	Env	+	-

Feedback

Environmental Impacts

- *Pollution of land, water, air resources (-)*
- *Encroachment of roads and buildings into the coastline (-)*
- *Garbage disposal on land and in water resources(-)*
- *Encroachment of buildings, facilities and roads close to the coastline (-)*
- *Beach erosion due to building, dune removal and dredging(-)*
- *Excessive use and destruction of natural areas to accommodate tourism or other needs (-)*

- *Contribution to the conservation of fragile natural areas (+)*
- *Contribution to conservation and protection of wildlife (+)*
- *Depletion of scarce natural resources or land degradation (-)*
- *Vegetation destruction during construction of tourist facilities like roads, hotels, golf courses, airports (-)*

Social Impacts

- *Inter-sectoral competition and conflict over (marine and terrestrial) space (-)*
- *Exclusion of local communities from any role of significance in decision-making (-)*
- *The loss of natural and architectural heritage in the face of rapid expansion (-)*
- *Strain on public utilities and facilities due to over population (-)*
- *Displacement of local population (-)*
- *Creation of restricted exclusive zones that are off-limits to the local people (-)*
- *Creation of facilities like museums which help to preserve local culture (+)*

Economic Impacts

You have discussed the economic impacts of tourism earlier when assessing the economic benefits of both inland and coastal tourism. The following are examples of economic impacts:

- *Loss of business to the local enterprises as all-inclusive resorts supply all the needs of their guests (-)*
- *High prices of goods which the local people cannot afford (-)*
- *Creation of employment –local people get jobs from services given to tourists. (+)*
- *Infrastructural development – accessible roads built to tourist resorts(+)*
- *Source of income –earned directly from tourists or indirectly from related services or facilities. (+)*
- *Source of foreign exchange – used to pay for imports(+)*
- *Development of local industries to meet the needs of tourists(+)*
- *Contribution to government revenues from taxes, license issue (+)*

In this activity you learnt how to categorise the impact of tourism. Do you know how the impact of tourism is assessed? The next section will focus on how the impact of tourism is assessed.

5.0 Assessing the Impact of Tourism

There are many ways in which the impact of tourism can be assessed. Some of these ways are listed and explained below.

- Research e.g visitor surveys/ resident attitude towards tourists survey
- The use of secondary data e.g. statistics from other sources like government statistics, statistics on international arrivals
- Estimates and comparisons over a period of time
- Analysis methods e.g using lodging receipts, entrance fee records from game parks and reserves.
- Public meetings and stakeholder consultations
- Environmental Impact Assessment – meant to assess or to find out the positive and negative impact that a project may have on the environment. This is done by experts in this field.
- The use of Tourism Satellite Account – a system used by Botswana to analyse tourism data in order to assess the state and nature of tourism.

The mention of research and use of secondary data should remind you of what you covered in Unit 10 – Research Methods. The same research skills that you acquired from Unit 10 can be used to gather information on tourism and assess its economic, social and environmental impacts.

Tourism can be measured by tourism expenditures on goods and services. From the tourism benefits, activities and attractions that you learnt about in topic 2 and 3, you must have an idea of goods and services consumed by tourists. In case of goods, we can give an example of food, and for services we can give an example of guided tours. The rate at which goods and services are consumed in a tourist resort can tell us the economic importance of tourism. We can estimate the amount spent by tourists on food, crafts and other goods consumed by tourists. Examples of services used by tourists can be measured from receipts on lodgings, park activities and transport services.

We can also assess tourist activities by carrying our research surveys, For example, visitor surveys can be carried out in national parks to assess the impact of vehicles used by tourists in a game reserve. We can also use observation method to assess the environmental impact of tourists on certain natural resources.

Secondary data, like statistics collected by the Tourism Department can be used to assess tourism impacts. For example, statistical records from hotels, lodges, and guesthouses can give us an idea of how much tourists are spending on accommodation. Such expenditure is an example, of an economic impact.

Any tourist activity which impacts on the social life or way of life of the people is referred to as a social impact of tourism. Some of the social impacts of tourism may be negative while others may be positive.

Literature on tourism indicates that tourism is one of the most important sectors in the global economy, contributing more than 70% of the global income. This means that tourism contributes significantly to the economies of many countries in the world. In fact the economy of some countries is driven by the tourism industry. How much does tourism contribute to the economy of your country? Does it contribute negatively or positively? Either way, it has both economic positive and negative impact. To understand these questions you have to understand that economic issues refer to anything that deals with production, exchange and distribution of goods and services.

In many countries the environment, both natural and man-made is the mainstay of tourism. Many studies on tourism have revealed both negative and positive environmental impact of tourism on the environment.

In addition to the listed ways of assessing tourism, there are policies and frameworks examining the impacts of tourism.

6.0 Policies and frameworks examining the impacts of Tourism

Most countries developed their tourism policy after carefully assessing the impact of tourism. The policies continue to function as a way of examining the impacts of tourism. The development of Botswana's tourism policy is based on the assessment of the country's wildlife as well as other resources. The policy makes provision for the examination of the impact of tourism. This is done to provide the basis for better planning, developing and managing tourism.

Botswana government has passed a number of quality policy statements and development framework on tourism. We have listed some in topic 2, under a section discussing the political factors influencing tourism. The key frameworks of Botswana guiding tourism are as follows:

- **Master Plan** – evaluates tourism development options on marketing and maximise tourism product diversification.
- **Botswana Tourism Development Framework** – set up to assist the department of tourism in implementing the Tourism master plan.
- **Botswana National Eco-tourism strategy** – aims to ensure sustainable tourism, planning and management.

The frameworks are implemented and through them the impacts of tourism are examined. The reports from examining the environment are used to add value to the tourism industry. In other words, they are used to plan ahead, improve and manage the tourism industry.

6.0 Summary

You have learnt both the positive and negative impacts of tourism. The positive impacts include provision of employment, contribution to the country's economic developments, source of income and foreign exchange. The negative impacts include littering, disturbing wild animals in their natural environments and introducing undesirable cultural elements. You can also distinguish between social, economic and environmental impact of the tourism. To cement learning of this topic, it is very important to assess the impacts of tourism in your local area or country. You may use one of the methods you learnt about in this topic.

In the next topic you are going to learn about those common problems facing the tourism industry and the role of stakeholders in the development of tourism.

Topic 5: Problems Facing Tourism and the Role of Stakeholders in the Development of Tourism

Introduction

Congratulations for having reached this far. This is the last topic of the Unit 12. In this topic you are going to learn about problems facing tourism and the role of different stakeholders in the development of tourism. As we continue through the topic you will note that some of the problems discussed here are actually the negative impacts of tourism mentioned in the previous topic. Tourism like any other industry has challenges or problems.

Furthermore, we will also look at the role played by stakeholders in the development of tourism. Again it is worth noting that the stakeholders discussed in this topic are actually the same stakeholders discussed in Units 6 to 10 which dealt with the utilisation and management of resources. In these units we discussed the role of stakeholders in either managing or protecting the resources. In this topic we will look at key stakeholders such as the Botswana Government, the local community, the non-governmental organizations and private sectors. We will see how they contribute towards the development of tourism in Botswana.

Learning Objectives

On completion of this topic, you should be able to:

- Analyse problems facing the development of tourism in Botswana.
- Discuss possible solutions to problems facing the development of tourism in Botswana.
- Evaluate the stakeholders' role in the development of tourism in Botswana.

1.0 Problems Facing the Development of Tourism

How do you think problems facing the development of tourism were identified? You are absolutely correct if you said through research. Researchers have used various methods to analyse data provided or collected. Through data analysis they identified problems facing the development of tourism in Botswana as follows:

- Long distances travelled by tourists from North America and Europe to Botswana. Travelling long distances is very expensive.
- Tourism in Botswana is still at an infant stage. This means that tourism is still developing. Tourism in Botswana is therefore faced with serious competition from Zimbabwe, South Africa and other neighbouring countries with fully developed tourism.
- Tourism in Botswana is still growing and it is of little benefit to most of the Batswana. There are limited direct benefits that local people get from tourism.

- There is also little or insufficient publicity about tourism in Botswana. This means that there is little advertisement of Botswana's tourist industry in overseas countries, hence the small number of tourists.
- Most of Botswana's attractions are isolated. This is a problem because roads in Botswana are not fully developed. Most of the roads leading to the attractions are untarred and dirty, making tourist destinations inaccessible.
- There is also less variety of attractions. Botswana's tourism is mostly based on wildlife which is not good for tourism. What do you think is the danger for a country that depends on wildlife mostly for tourism? Yes, the tourist industry will be seriously affected if wildlife resources are exhausted.
- Botswana is sometimes faced by shortage of accommodation, shortage of food etc for tourists.
- Political instabilities and economic crisis in neighbouring countries also lead to a slow development of tourism industry. Some funds that could be used to develop tourism are now used to address such instabilities. For instance, taking back illegal immigrants or putting in place more security measures against poaching.
- Shortage of manpower in the department of tourism to implement and monitor tourist activities and policies.
- Poaching is also a serious threat to tourism in Botswana. Illegal killing of wild animals can lead to a reduction in the population of the animals that are killed.

You have earlier come across some of the above-mentioned problems, especially when we were discussing the impact of tourism in Topic 3 of this unit. Now let us look at the solutions to problems facing tourism. You must remember that the solutions mentioned are not applicable to all of the problems facing tourism.

2.0 Possible solutions of Problems Facing the Development of Tourism in Botswana

The following are some of the solutions to problems facing the development of tourism.

- Improvement of wildlife through the proper development and management of national parks and game reserves.
- Improvement of services such as accommodation as well as roads transport and communications.
- Improvement of tourism on a regional base. Botswana is a member of the Southern African Development Community (SADC). SADC has a tourism organization called the Regional Tourism of Southern Africa (RETOSA). This organization is responsible for the coordination, packaging and marketing of the regional tourism products.

- Improvement of tourism on the international scene. Botswana is also a member of the World Tourism Organisation. This is a United Nations agency or organization.
- Development of Infrastructure especially air links, e.g. the opening of the Sir Seretse Khama airport, Kasane airport, Maun airport, etc.
- Introduction of lower air transport fares as well as hotel accommodation.
- The department of tourism train and develop Botswana to deal directly with tourism.
- The Botswana Government is advertising the tourism industry in overseas countries. How is tourism advertised abroad? Advertisement is done through the establishment of tourism offices in overseas countries. Audio-visual cassettes, magazines, pamphlets, postcards etc are also used in the advertisement of tourism.
- An anti-poaching unit was established to combat poaching. The Botswana Defence Force (BDF) personnel are deployed to fight illegal killing or stealing of wild animals.
- The Botswana Government is also in the process of encouraging Eco-tourism.

We have looked at solutions of problems affecting the development of tourism in Botswana. There may be other solutions, not mentioned here, that can be applied or used in your area. Some of the solutions listed are provided by key stakeholders of tourism. Next, we will find out how these key stakeholders are involved in the development of tourism.

The Role of Stakeholders in the Development of Tourism

Earlier we have said that Botswana's tourism industry is still at an infancy stage. This means that tourism is still a small industry which is currently growing. You also learnt earlier on that tourism is a unique and a new kind of industry that is different from other types of industries. You also learnt that tourism experiences many challenges most of which are addressed by various stakeholders. In this section we will discuss the role of various stakeholders in the development of tourism in Botswana. As mentioned in the topic introduction, these stakeholders are Botswana Government, Non-Governmental Organisations. First we will look at the Botswana government as the key stakeholder.

3.1 Botswana Government

The tourism industry is being developed and promoted by the government of Botswana because of the benefits it brings to the country. The economy of Botswana is said to be diversified since the country does not rely on only minerals and beef to gain revenue.

The Botswana government is promoting the growth and development of tourism through some different ways. Can you think of a way through which the government is promoting the development of tourism in your country? Most of the people will think that the government promote tourism by spending a lot of money. Yes, it is true that the government spends a lot of money on tourism. But you must know that the Botswana government also promotes the development of tourism through departments such as wildlife and national parks, Department of

Environmental Affairs, Tourism department, Botswana Tourism Board and other departments. The above departments are more active than other government departments. Let us now look at how some of these government departments are responsible for promoting and developing tourism, starting with the Botswana Tourism Board.

- a) **Tourism Department** is mandated or charged with the responsibility of regulating the tourism industry and promoting sustainable tourism by facilitating the use of resources leading to national economic development. In addition the department is responsible for tourism policy formulation and implementation. Besides the tourism policy of 1990, the tourism act of 1992 provides guidance and regulates tourism in Botswana. The department of tourism is also responsible for regulating tourism through the following bodies:
- (i) **Botswana Tourism Board** This is a parastatal body set up by the government act in 2003 and it is charged with the responsibility of marketing, grading and classifying tourism facilities and promoting investment in Tourism.
 - (ii) **The Casino Control Board** – This is responsible for licensing and regulating the casino gambling sector. You must remember that most of the luxurious hotels in Botswana have casino gambling sections.
 - (iii) **Education on Wildlife Management and Tourism** – The tourism department in conjunction with wildlife department promotes education on wildlife management and tourism through the following means:
 - Establishment of wildlife clubs, particularly in schools
 - Observing world tourism day
 - Promotion and support of conservation awareness

Department of Environmental Affairs ensures the protection and conservation of the environment by managing the implementation of national environmental policies, programmes and legislation

Department of Wildlife and National Parks plays an important part in the development of tourism. You learnt about the Department of Wildlife and National Parks in Unit 6. Try the following activity as it will help you relate tourism to this department.



Activity 1

Briefly write the roles and responsibilities of the Department of Wildlife and National Parks and how they contribute to the development of tourism in Botswana

Feedback

This department works hand in hand with the Tourism Department and promotes tourism by protecting our wildlife. The department of wildlife and national parks is aimed at protecting natural resources, particularly wild animals, so that these natural resources can be used to benefit the country. The department is also interested in seeing that those natural resources are not completely depleted as they are used to benefit the country. According to the department of tourism, national parks and game reserves are the major tourist attractions.

The wildlife department also aims at enforcing laws and policies related to wildlife protection. The following are some examples of policies and laws related to wildlife resources:

- *National Conservation Strategy of 1990*
- *Wildlife Conservation Policy of 1986*
- *Wildlife and National Parks Act of 1992*

These laws and policies have played a major role in the conservation of wildlife. They have also lessened interference with wildlife inside these parks and game reserves. You must know that these national parks and game reserves provide a natural and suitable environment for the wild animals. Good management and further developments of games parks and reserves has resulted in the growth of the tourism industry.

We have seen that the government as the key stakeholder has a lot of responsibility in the development of tourism. To carry out such a huge task the government regulates tourism through various departments. Next we shall look at the private sector or private companies and Non-Governmental Organisations (NGOs) that are also putting a lot of effort in the promotion and development of tourism.

3.2 Private Sector and Non-Governmental Organisations (NGOs)

The private sector plays an important role in the development of tourism. It would be very expensive for Botswana government to run the tourism alone. The private sector helps in the development of tourism by providing special services and also by contributing to government income through taxes and donations.

The private companies gain money through the tourism industry. It is very important for you to know that the money which is obtained from tourism does not go to the Botswana government alone.

The most important category of companies which are helping in the development of tourism is as follows:

- Safari operators
- Safari hunters
- Lodge and hotel owners

Even though there are other private companies which promote tourism these companies are said to be the most active ones.

Non-governmental organisations and some developed countries also provide technical and financial assistance. For example, they give donations to some projects such as Mokolodi Nature Foundation and the Khama Rhino Sanctuary.

3.3 Local Communities

Local community participation in tourism planning and development is becoming increasingly important. This has led to the emergence of concepts like community based tourism or Community Based Natural Resource Management (CBNRM) in the case of Botswana. Examples of Botswana local tourism projects include:

- Nata Bird Sanctuary
- Mokolodi Nature reserve
- Nqwaa Khobe Xheya Trust
- Chobe Enclave Conservation Trust
- Khwai Community Trust



Activity 2

1. What role is played by the local community in developing tourism?
2. What do local communities benefit from participating in local tourism?

Feedback

1. *The communities can participate in developing local tourism in many ways including*

- *Conserving Natural Resources*
- *Providing the needed services by being employed*
- *Producing goods like local crafts and food*
- *Displaying some aspects of culture which might capture the interest of tourists*
- *Creating a friendly and welcoming environment for the tourists*
- *What about dancing and singing by the local people? Is this not another way of developing and promoting tourism industry?*

You must remember that traditional dancing and singing are regarded as some of the tourist attractions. Botswana are well known for the love of their cultural or traditional dance and singing. The traditional dancing and singing are part of entertainment for tourists. The traditional attire or dress also attracts tourists.

- *What about the local language spoken by the local people? Tourists would also be interested in knowing some words in the local language.*

- 2. You may know that the money earned from tourist activities is partly used for some village developments. Some tourist activities have created employment opportunities and promoted the development of local crafts. Local people can be employed as cooks, waiters in lodges, camps and hotels etc. From these activities, the community earn money to support themselves, hence reducing poverty.*

Some of the local communities work with and are assisted by Non-Governmental Organisations and other donors to run and sustain their projects.

We have now reached the end of our topic, go through the summary below.

3.0 Summary

There are some problems facing the development of tourism. These problems slow down the development of tourism. One example of these problems is that tourists travel long distances from their countries to tourist destinations. For example, tourists from North America and Europe travel great distances to Botswana. As a result, Botswana receives few tourists due to expenses of travelling.

Stakeholders play an important role in the development of tourism in Botswana. In Botswana, stakeholders include government stakeholders, some private companies, local authorities, foreign countries and other donor agencies. Some of the stakeholders directly finance tourism projects while others play an important role in the conservation of the environment and develop other tourist attractions.

Unit summary



Summary

In this unit you learned the following important points:

- Tourism is viewed as one of the largest industries and an important economic sector for most countries, contributing significantly to the generation of foreign exchange and employment.
- The **World Tourism Organization** defines tourists as people who "travel to and stay in places outside their usual environment for more than twenty-four hours and no more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited."
- Ecotourism is a category of tourism also known as nature based tourism or ecological tourism and refers to responsible travel that avoids damage and conserves the natural environment.
- Sustainable Tourism aims to lessen the impacts of tourism on the environment while benefiting the economic, social and cultural wellbeing of the local communities.
- The existence and development tourism in any particular area is influenced by the physical, economic, political and human factors.
- Inland tourism refers to tourism that takes place within the interior of a country or in landlocked countries like Botswana, Lesotho and Swaziland.
- Coastal tourism takes place along the coast or in small islands like Seychelles.
- Countries like South Africa, Kenya, Namibia and India experience both coastal and inland tourism. This is because they have access to the sea and vast lands far from the coast.
- Inland attractions include game reserves and parks, rivers, lakes, museums, waterfalls, crafts. Coastal tourism attractions include marine parks, sandy beaches, beach front shops, hotels and restaurants.
- Tourism has a great impact on people and their environments. Positive impacts include employment creation, foreign exchange, local industrial and infrastructural developments and conservation of wildlife. Negative impacts include disturbance of wildlife, littering, exploitation of local labour by foreigners, cultural changes and influence, land use conflicts.

- Tourism impacts can be distinguished according to economic, social and environmental categories. For instance, littering is more of an environmental problem.
- The development of tourism is faced by many problems such as political instability, poor infrastructure and long distances from tourist destinations
- Stakeholders play an important role in the development of tourism. The Government as a major stakeholder plays an important role and works alongside with other stakeholders such as Non-Governmental Organisations (NGOs), Private companies, local communities, donor agencies and countries. All of them provide educational skills development, technical expertise and financial assistance.

Congratulations again! You have now come to the end of unit 12. The following reference materials will help you get additional information; some of which is available in the internet and others, possibly in your local library. However, if you cannot find any of the recommended information, do not worry because this unit is loaded with relevant information.

Remember that immediately after the references is the assignment which you must do and mark. Low marks means that you should go over the unit until you are satisfied with your marks, at which time you may proceed to the assessment, which must be posted to your tutor for marking.

Before moving on, let's quickly check our understanding of the unit by asking our self this question: What is the importance of developing tourism in your country?

If you were able to come up some of the following, you are on the right track!

- creates jobs
- source of income
- foreign currency/ foreign exchange
- diversification of the economy
- development of new industries
- conservation of wildlife
- development of infrastructure

Assignment



Assignment

Note that this assignment is divided into five self-assessment exercises. As mentioned in the teaching and learning approach of the unit, each self-assessment exercise is for a certain topic. For example self – assessment 1 is for topic 1 in this unit.

Write your answers in the spaces provide. On completion of an exercise mark your own work, referring to answers at the end of the assignment.

You are advised to take **30 minutes** on each exercise.

Self-assessment Exercise 1

1. Define the following key terms

a) Tourism [2]

b) Tourist [2]

2. How is the tourism industry different from other industries? [2]

3. Which United Nations agency serves as a global forum for tourism policy issues and a practical source of sustainable and universally accessible tourism worldwide? [1]

4. List **three** tourism activities common in game parks and reserves.
[3]

5. What is the difference between domestic tourism and international tourism?
[2]

6. What is ecotourism? [2]

Total : 14 marks

Self-assessment Exercise 2

1. Match the major types of factors influencing tourism with the following examples: [4]

Tourism Act

Local cultures

Exchange rate

Waterfalls

<u>Major Factor</u>	<u>Example</u>
(a) Economic	_____
(b) Human	_____
(c) Political	_____
(d) Physical	_____

2. What is a honey pot? [1]

3. (i) Name any **two** physical factors in that influence tourism in your country. [2]

(ii) Explain how the **two** physical factors influence tourism. [2]

4. Technological developments are a major factor in the growth and development of tourism.

a) Give examples of technological developments in your country which have contributed to the growth and development of tourism. [3]

b) Explain how those technological developments contributed to

the growth of tourism in your country. [4]

Total: 16 Marks

Self- assessment Exercise 3

Answer the following questions in the spaces provided

1. What is the difference between inland tourism and coastal tourism? [2]

2. Write down **two** examples of inland tourism attractions and two examples of coastal tourism attractions and countries in which they are found in Africa. [4]

3. Name any **two** areas of tourist attractions in Botswana. [2]

4. List down **two** areas in Kenya of coastal tourist attractions. [2]

5. List down any **three** attractions which make tourists visit the Chobe National Park.

[3]

6. What is a marine national park? [2]

7. Name one area with coastal tourism in South Africa and list down any **three** attractions of the area. [4]

8. Name one area which provides coastal tourism in Kenya and list down any **three** attractions of the area. [4]

9. List down **four** reasons why the government of Kenya promotes the tourism industry. [4]

10. Write down **three** ways through which the government of Kenya is promoting tourism. [3]

Self-Assessment Exercise 4

1. One positive economic impact of tourism in Botswana is the creation of employment for local people. Give **four** examples of employment opportunities created by tourism in your country. [4]

2. Give any **five** negative impacts of tourism. [5]

3. Give any **five** positive impacts of tourism. [5]

4. Local communities and cultures have become a tourist attraction. Give an example of such a community and describe how they arouse visitors' interest and curiosity in their culture? [5]

5. Tourism generates money through many ways. Describe one way in which tourism generates money in your country. [3]

6. List down **four** disadvantages of tourism. [4]

Total: 26 Marks

Self-Assessment Exercise 5

1. What is a stakeholder? [1]

2. Give reasons why stakeholders are important in the development of tourism. [2]

3. Write down any **four** problems facing the development of tourism in Botswana. [4]

4. For the problems named above, suggest any possible solution for each.
[4]

5. Describe how tourism can improve the quality of life of rural communities in developing countries. [3]

6. Describe how local communities participate in the development of tourism. [4]

Total: 18 marks

Answers to Assignment Self-assessment Exercises

Self-Assessment Exercise 1

1. (a) Tourism is “the temporary, short-term movement of people to destination outside the places where they normally live and work and their activities and the facilities designed to cater for their needs during the stay at each destination. It includes movements for all purposes.”

(b) Tourists are people who "travel to and stay in places outside their usual environment for more than twenty-four hours and no more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited"

2. Tourism industry is invisible or intangible/cannot be seen physically/ does not directly produce any goods.

3. World Tourism Organisation

4. Tourism activities in game parks include game hunting/ trophy hunting, safari rides, photographing, bird watching, night safari rides, guided wilderness trails.

5. Domestic tourism involves travelling done by people within their country whereas international tourism involves travelling outside the country.

6. Responsible travel to natural areas, involving the conservation of the natural environment and improving the wellbeing of the local people.

Self-Assessment Exercise 2

1.	<u>Factor</u>	<u>Example</u>
	(a) Economic	Exchange Rate
	(b) Human	local cultures
	(c) Political	wars/conflicts
	(d) Physical	waterfalls

2. A honey pot is an area visited by a large number of tourists.

3. (i) In case of Botswana you can name the Okavango delta, Kalahari desert, Tsodile hills, Cwihabe caves, game reserves and parks.

(ii) Explain – scenic beauty, provide unique experience for tourists, enable tourists to study the environment and as a result the development of tourism in these physical resources has enabled tourism to grow.

4. a) Examples of technologies

- computer
- internet

- mobile phones
- fax
- telephones
- television
- radio

b) How technologies have contributed to the growth and development of tourism

- online sales/direct bookings
- online payments
- effective marketing
- information sharing
- reduced costs/time of processing information

Self-Assessment Exercise 3

1. Inland Tourism is the type of tourism which takes place inside a country. This type of tourism occurs away from the coast. Coastal tourism is a type of tourism which takes place on the coastal area. It does not occur inside a country.

2. Examples of attractions which follow under Inland tourism are mountains, wild animals, natural vegetation, valleys, gorges, waterfalls etc.

Examples of attractions which are common under coastal tourism are beach, sea animals i.e. dolphins, water sport i.e. surfing etc.

3. Areas of tourist attraction in Botswana are as follows: Tsodilo hills, Okavango delta, Chobe national park, Moremi wildlife reserve etc.

4. Areas of attractions in Kenya (coastal attractions) are as follows: Mombasa, Watamu, Malindi, Kipini etc.

5. Attractions of the Chobe National Park:

- (a) wild animals
- (b) lodges
- (c) campsites
- (d) tarred roads etc

6. A marine national park is an area on the coast or sea that is reserved for the protection of sea animals.

7. One area with coastal tourism in South Africa is Durban/Capetown/Port Elizabeth/East London.

The types of attractions are:

- beaches
- sea animals e.g. dolphins
- natural features e.g. lagoons
- man-made features e.g. hotels

8. One area with coastal tourism in Kenya is Mombasa.

The types of attractions are:

- beaches
- sea animals
- natural features e.g. bays, coral reefs
- man-made features e.g. hotels

9. Reasons why the government of Kenya promotes tourism:

- it creates employment
- it brings foreign currency
- creates market for agricultural products
- it encourages protection of natural resources
- it promotes rural development
- it promotes local culture.

10. The government of Kenya is promoting tourism by:

- advertisement by Tourism Board/ advertising overseas
- improvement of infrastructure e.g. roads
- conservation of wildlife
- Providing clean and safe environment

Self-assessment Exercise 4

1. Include jobs in the following
 - hotel and logging
 - cruises
 - casinos
 - restaurants
 - amusement parks
 - wildlife parks and reserves
 - other tourist attractions

2. Negative impact of tourism
 - Foreign currency or a lot of money is spent on payment for imports especially food and machinery.
 - Safari companies which take a lot of profit from tourism.
 - Tourism industry pays Batswana lower wages.
 - Tourism disturbs wildlife e.g. animals.
 - Littering of the environment or protected areas
 - Poaching.
 - Disruptions or changes in the culture of some of the local people.
 - Local cultures could be looked down on as barbaric, outrageous or freak shows.
 - Tourism is also blamed for the increase in prostitution as well as the spread of diseases including HIV-Aids.
 - Tourism is occupying a large land due to the creation of national parks and game reserves.

3. Negative impact of tourism
 - Tourism industry diversifies the economy of a country.
 - Tourism provides employment opportunities.
 - It promotes the development of remote areas by encouraging the provision of services such as roads, airports, hotels etc.
 - It is a source of foreign exchange.
 - Tourism promotes local arts and craft.
 - It introduces new ideas and cultures and promotes international understanding.
 - Tourism encourages the conservation of natural resources such as wildlife.

4. Name indigenous people like Masai in east Africa, Hausa in west Africa, Fulani in west Africa, Bendouin in Namibia, Basarwa in the Kalahari dessert.
 Arouse interest from their whole way of life
 - livestock herding
 - nomadic life
 - food
 - music and dance
 - clothing
 - shelter

5. Tourism generates money through:
 - Tax – companies involved in tourism business are taxed.
 - Tourism services – eg. accommodation, transport
 - Park fees – Money collected from the park entrance
 - Purchasing of local goods – eg. crafts

6. The disadvantages of tourism are:
- destruction of the natural environment
 - spread of diseases
 - increase in drug abuse
 - prostitution
 - exploitation of workers
 - foreign domination of the industry
 - it is costly
 - cultural breakdown, etc.

Self- assessment Exercise 5

1. A stakeholder is a person, group or organisation that has interests or stake in an organisation, a particular product or service.

2. Stakeholders are important because:

- can play an important role in the management of business
- conservation of natural resources
- designing/planning

3. Problems facing the development of tourism include [4]

- Little or insufficient publicity of tourism abroad
- Most of the attractions are isolated
- Long distances between Botswana and major tourist sources
- Political instabilities and economic crisis in neighbouring countries
- Tourism is still small/at an infant stage
- Poaching is also a threat to tourism
- Less variety of tourist attractions
- Shortage of manpower
- Shortage of accommodation, especially during the peak season

4. Possible solutions [4]

- Improvement of wildlife through the proper development and management of national parks and game reserves.
- Improvement of services such as accommodation as well as roads transport and communications.
- Improvement of tourism on a regional base.
- Improvement of tourism on the international scene.
- Development of Infrastructure especially air links, e.g. the opening of the Sir Seretse Khama airport, Kasane airport, Maun airport, etc.
- Introduction of lower air transport fares as well as hotel accommodation.
- The department of tourism train and development Batswana to deal directly with tourism.
- The Botswana Government is advertising the tourism industry in overseas countries.
- An anti-poaching unit was established to combat poaching
- The Botswana Government is also in the process of encouraging Eco-tourism.

5. Tourism can improve the life of rural communities

- provides income
- developments eg improvement of roads, health facilities
- can enhance/revive local culture
- encourages conservation of natural resources

6. Local communities participate in tourism by

- producing goods eg through craft industries
- providing services
- conservation of attractions

Total: 18 marks

Assessment



Instructions to Learners

Assessment

1. Answer all the questions in the space provided against each question
2. You may take 1 hour to do this assignment
3. Submit or post your work for marking

1. With specific examples explain the difference between inland and coastal tourism. [5]

2. What are the factors which promote tourism? [5]

3. How do countries in Africa south of the Sahara promote tourism?
[5]

4. Why do countries in Southern Africa receive few tourists than north African countries?
[5]

5. Why do countries in Africa south of the Sahara spend a lot of money in the development of tourism?
[5]

6. Study the following table, and **use arrows** to match each country with its national park or game reserve.

<u>Country</u>	<u>Game Reserve/National Park</u>	
(a) South Africa	Masai Mara Game Reserve	
(b) Botswana	Hwange National Park	
(c) Kenya	Kruger National Park	
(d) Zimbabwe	Kafue National Park	
(e) Zambia	Khutse Game Reserve	[5]

7. Explain how the political situation may affect the growth and development of tourism in a country. [5]

8. Explain why tourism is growing in Botswana. [5]

Total = [40 marks]

Answers to the Unit 12 Assessment

1. Coastal tourism occurs along the coast or coastal area.
 - Coastal tourism occurs in countries with access to the sea or ocean.
 - Examples of countries with coastal tourism are South Africa, Namibia, Kenya etc.
 - Attractions include swimming, fishing, boating, sea animals, etc.
 - Inland Tourism occurs away from the coast or in land.
 - Inland tourism occurs inside countries with or without the sea.
 - Examples of countries with inland tourism are South Africa, Botswana, Kenya, Zambia etc.
 - Attractions include wild animals, natural vegetation, hills, mountains, rivers, volcanoes etc.

2. The factors which promote tourism are as follows:
 - (a) Economic Factor - The government should have enough money to improve infrastructure such as roads, railway line, airports, hotels etc.
 - (b) Human Factor - The government should have skilled and unskilled labour to work in the tourism industry.
 - (c) Political Factor - Tourism operate or occurs in those countries which are politically stable. Politically unstable countries receive few tourists.
 - (d) Physical Factor - The physical conditions such as climatic conditions influence the number of tourists who visit a country. Tourists will consider whether the country they are visiting is very hot or very cold.
 - (e) Social Factor - The way people relate with tourists is also an important aspect. Tourists need a warm welcome from the society.

3. Countries in Africa south of the Sahara promote tourism through the following means:
 - Establishment of tourism ministries
 - Establishment of tourism boards
 - Development of infrastructure in the country
 - Protection and conservation of natural resources
 - Advertisement or publicity of tourism abroad
 - Involvement of parastatals and non-governmental organizations and other key stakeholders

- Allocation of some funds to tourism department

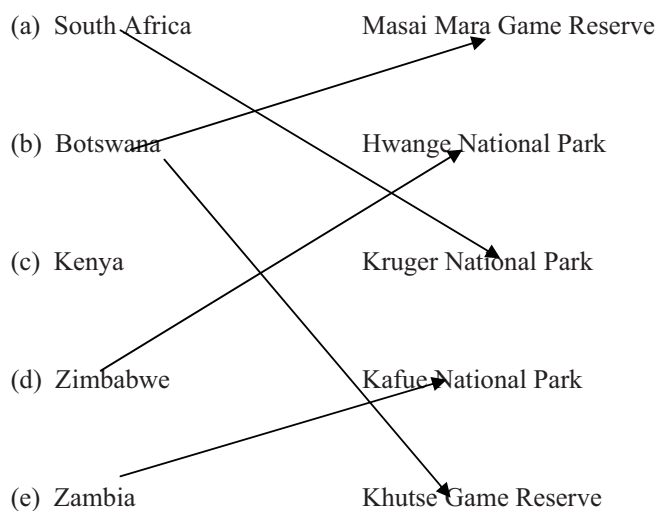
4. Countries in Africa south of the Sahara receive few tourists than those countries in North Africa because:

- Countries in Africa south of the Sahara are far from European countries.
- There is less publicity abroad concerning tourism in the sub-Saharan Africa.
- It is costly to travel from Europe to countries in Africa south of the Sahara.
- Tourism in some countries in Africa south of the Sahara is still growing and it is not fully developed.
- There is a lot of political instabilities in most countries in Africa south of the Sahara.

5. Countries in Africa south of the Sahara spend a lot of money in the development of tourism because:

- tourism creates employment
- tourism brings foreign exchange
- it promotes development of infrastructure
- it create some diplomatic relationships
- it places the country on the world map
- it helps or encourages protection and conservation of natural resources
- It helps to diversify the economy of the country

6. Country Game Reserve/National Park



7. Political instability affects tourism because tourists will be afraid to visit a country that is not peaceful. Tourists will think that may be they will be killed during the conflicts or wars. Tourists will not risk their lives visiting politically unstable countries.

Country laws may also be restrictive to some tourist activities, hence lessening the variety of tourist activities.

8. Tourism is growing in Botswana because of:

- great affluence
- increased mobility of local people
- improved accessibility to attractions
- increased variety of attractions
- more advertising overseas
- reduced travel and accommodation costs
- grants received to develop tourism

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Unit 13

Processing and Manufacturing Industries in Botswana and the SADC Region

Introduction

You have already learnt about wildlife resources in Unit 6 as well as veld products in Unit 7. Then in Unit 11, you learnt about agricultural products particularly processing of cotton and sugar. You also learnt that agriculture is a source of raw materials. But the question is, where do all these products or raw materials and many others go? Where are they processed? Well, that is the focus of this unit.

In this unit, you are going to learn about processing and manufacturing industries in Botswana and in the SADC region. I hope this topic will be of great interest to you since most of the things we use today are manufactured in various industries.

This topic is not totally new to you. Like tourism, it looks closely at what is happening in your surroundings. You must also know that this topic is related to tourism. Processing and manufacturing industries and tourism deal with how the Government of Botswana and other those of countries gain revenue or money. You must remember that tourism is an industry that benefits the Botswana Government and Botswana as a whole.

The topic, Processing and Manufacturing Industries is also related to other topics in the Botswana General Certificate of Secondary Education (BGSE) syllabus. Topics such as Agriculture, Mining, and Forestry are topics that are closely related to manufacturing and processing industries.

Like in many other topics in the BGCSE syllabus, you will also learn both the negative and positive impact of the processing and manufacturing industries.

Upon completion of this unit you will be able to:

- *classify* industries into primary, secondary and tertiary
- *explain* the importance of processing and manufacturing industries in Botswana
- *discuss* the economic role of Botswana in the context of the SADC region
- *assess* both the imports and exports commodities of Botswana
- *explain* the importance of protecting natural resources
- *discuss* sustainable utilisation of raw materials or natural resources in the manufacturing and processing industries
- *analyse* one small scale industry in Botswana in terms of location, processes, inputs and outputs, problems and their solutions, and its impact on the environment
- *analyse* one large scale industry in Botswana and another in South Africa in terms of location, processes, inputs and outputs, problems and their solution, and its impact on the environment



Outcomes

Teaching and Learning Approach

A learner-centred approach is used in teaching this course. This particular unit will incorporate that approach as well. In fact it will emphasise more on your own ability to work out things for yourself and consolidate the knowledge you acquire. As you will notice as you move along the unit, most of the information contained can easily be related to your day-to-day lives or at least things within your reach. To that end there will be case studies, hands on activities, reflection questions, rhetorical questions, group discussions, pair work and other activities employed in order to assist you to learn and understand better.

You will notice that content in this unit is predominantly theoretical and touches on things that you may already know or have noticed (except in cases where you may not have paid particular attention to them). As such, whenever possible, reference is made to your prior learning or experience as a way to assist you to reflect and consolidate knowledge. However, there are topics (particularly Topic 5) that contain content which is rather new to you. In such cases, you would note that I have adopted the transmission style of teaching with little reference made to your prior knowledge (except where you are required to reflect on what I have already discussed in the previous sections of the topic).

I hope you will find this unit interesting and informative.

Unit Contents

This unit has been made easier to study by dividing it into five topics as follows:

- Topic 1:** Definition of industries
- Topic 2:** Factors influencing location of industries in Botswana
- Topic 3:** Case study of a small-scale industry
- Topic 4:** Case study of a large-scale industry in Botswana
- Topic 5:** Case study of a large-scale industry in South Africa

Time

You are expected to take about two hours on each topic. In order to finish the unit, you need about ten hours. This translates to about two hours per topic. You must bear in mind that you are not restricted to the ten-hour period to complete all the five topics. In case you do not understand a topic, you are advised to give yourself more time. You can also finish or complete a topic in less than two hours.

You will also need to spare sometime to work on assignment and assessment items mentioned earlier. Each assignment should take you about 45 minutes while the assessment should take you about 1 hour 30 minutes. Even though you will not be supervised as you do these activities, try to pace yourself so that you get used to answering questions within a stipulated time. Remember your final examinations will

be written within a stipulated time. So, practice!

Resources

When studying this unit, you are advised to consult as many sources as possible. Use those resources that are relevant and easy for you to follow. You should not be disappointed if some of the resources or sources mentioned are not available in your area. This unit provides sufficient information to achieve the objectives of each topic.

However, the following efforts to look for information is encouraged on your part:

- A visit to any school nearest to you can help you with relevant information concerning processing and manufacturing industries.
- A visit to the Ministry of Commerce and Industry. From this Ministry you can obtain some magazines and books with information on Processing and Manufacturing Industries.
- A visit to a local public library where you can find books and other relevant resources

Activities

There are many activities for you to do in this unit. They are meant to help you understand the concepts given. Each topic consists of several of these activities which are relevant to the topic. These activities differ from one topic to the other. You are advised to go through all of them. They will help you understand the whole unit.

You must bear in mind that some of these activities are difficult. If you do not do well in one activity do not be discouraged because this does not always indicate that you do not understand the topic of concern. At the end of each activity, I have given you feedback. Compare the feedback with your responses to the activity.

At the end of each topic there is an exercise that you must do to check your understanding of the topic. Each exercise is provided with some short answers at the end of the Unit. Compare these answers with yours. Remember that your answers need not be similar to mine word for word.

Summary

A topic summary is given at the end of each topic. The summary covers the most important points or ideas of the topic. The summary is short or brief. You may use this summary for a quick review of the topic. There will also be a unit summary at the very end. This will summarise everything we have studied in this unit.

Glossary

The meaning of certain words or concepts which you may find difficult to understand is given in a glossary (named as Terminology) below. If you come across a word which is not in the glossary, I am advising you to use a dictionary. If you do not have a personal dictionary, please check for a copy at your study centre, mobile centre or your local library.



Terminology

Apartheid	Segregation laws
Bulky	Large, heavy and taking up a large space
Capital intensive	Heavy dependence on the use of more money and machines
Commodity	Goods or items
Consume	To utilize or eat
Demand	The desire or items
Democracy	Government of the people for the people and by the people
Dyed	Added colour or darkened
Factory shells	Large and open buildings used as factories
Goods	Finished products
Grant	Money given and not paid back
Imports	Goods bought from outside
Industrial Estate	Area used and reserved for industries
Infrastructure	Facilities such as roads, railway, hospitals etc.
Invest	To use money to gain profit
Labour intensive	Heavy dependence on manual work by using people instead of machines
Linkage	Connections or joints
Multi-national	Big international companies
Open Cast	Shallow method of digging up minerals
Ore	Unprocessed mineral-bearing rock
Pollution	Discharge of poisonous wastes or gases into the environment
Renewable	In a position to be reproduced or recycled
Rentals	Money paid for using a building
Revenue	Money received
Share holder	Partner in ownership of a business

Smelting	Heating at very high temperatures until material becomes a liquid
Stimulate	Encourage or to activate
Stripped	Removed the upper part or covering of a material
Subsidy	Assistance whereby one pay part and the Government pays the rest
Wages	Money paid to workers
Waste material	Less important material from processing raw materials or minerals

Topic 1: Definition of Industries

Introduction

In this topic, you will learn about the classification of Industries into primary, secondary and tertiary. You will also learn that there are many industries in Botswana and in the world at large. This topic will also differentiate between the types of industries that we have. The difference between Processing Industries and Manufacturing Industries will also be discussed and hopefully, you will also understand the meaning of the word industry. The topic will also provide you with good, relevant examples of the major classes of industries.

Topic Objectives

At the end of the topic you should be able to:

- list the major classes of industries found in Botswana and the rest of the world
- state the characteristics of each major class of industry
- give examples for each major class of industries given
- locate where these industries are found
- describe the type of goods and services produced by these industries.

Topic Contents List

1.0 Definition of Industries

2.0 Botswana's Manufacturing and Processing Industries

3.0 What are Botswana's Major Industries?

4.0 General Classification of Industries

5.0 The Major Classification of Industries

- 5.1 Primary Industries
- 5.2 Secondary Industries
- 5.3 Tertiary Industries
- 5.4 Quaternary Industries

6.0 Summary

7.0 Self-assessment Exercise 1

1.0 Definition of Industries

Let us first look at the classification of industries. Before we continue with this topic, we are going to look at the three most important words that appear in the unit title. The three key words are:

- Industry
- Processing Industry
- Manufacturing Industry.

It is very important that you understand the meaning of each of the above mentioned words as they will be used throughout the unit. The explanation of other words will be given throughout the topic or under the glossary section. Both the processing and manufacturing industries will be explained in detail later in this topic.

(a) What is an industry?

The word industry is a broad one. Industry can be defined differently by different people. Industry can be defined as **the means of producing goods and services.**

Industry can also be defined as **all the work that we do in order to gain a living or a group of activities that are of economic value.**

It can also be referred to as the **production that takes place inside a factory, whereby raw materials are turned into finished goods.**

The processing and manufacturing industries exploit their raw materials from the following sectors:

- Farming
- Forestry
- Fishing
- Mining

Given these diverse sources of raw materials, do you see why I said earlier on that most of the units you have studied so far are related to this one? Take note of that so that as I refer you to what you have studied earlier, you can easily relate to one of the units.

We have just defined an industry. Now, let us go further and define a processing industry.

(b) What is a processing industry?

Can you use the definition of industry given above to define processing industry?

In simple terms, this is an industry that prepares raw materials, so that they can be used to produce other goods or finished goods. These industries are also known as **Primary Industries**. A processing industry is involved in the preparation of raw materials or resources from the earth surface.

In Unit 11, we talked of cotton and sugar processing. Try to remember what we said the whole process entailed. You are free to review Unit 11 if you cannot remember.

Now that you know what a processing industry is, what about a manufacturing industry?

(c) What is a manufacturing industry?

A manufacturing industry is an industry that uses raw materials from a processing industry to turn them into finished goods or products.

The word manufacturing comes from the word "manufacto" which means to make by hand. In the olden days, manufacturing used to mean to produce goods by hands or using hands.

You must remember that these days manufacturing is more complicated because of the use of machines and computers in producing finished goods.

To try and consolidate our discussion, can you now mention at least one raw material, what it can be processed into in a processing industry and what further product can be made from it in a manufacturing industry?

Take skin or hide for example. The raw material will be skin/hide of course. This raw product can be processed into leather, which in turn can be used in a manufacturing industry to make a pair of shoes you are putting on right now or your school shoes you had in primary school! Or it can be cotton which results in the garment you are wearing. Right!

I hope you got the last scenario right. There are so many such industries all over the world. Now let us look specifically into what processing and manufacturing industries there are here in Botswana.

2.0 Botswana's Manufacturing and Processing Industries

Manufacturing Industries in Botswana are still few and light when compared to other countries. Botswana is a developing country and most of her industries started developing after independence. Botswana's processing and manufacturing industries are thus still at their infancy stage as most of them are still developing.

Manufacturing does not contribute much to the economic growth of Botswana. The manufacturing sector also employs only a few people under the formal sector. It is important to know that one of the reasons why the Botswana Government spends a lot of money in the development of industries is to create employment for Botswana. The manufacturing sector employs about 10% of the population under the formal sector. This is a small number.

Most of the industries in Botswana are light industries which produce goods of low economic value. Due to the fact that Botswana's manufacturing sector is small, Botswana therefore imports a lot of manufactured goods from other countries especially from South Africa.

Botswana also exports few goods or commodities to other countries. What does this mean to you? It means that Botswana spends a lot of money to import manufactured goods from other countries. It also means that Botswana get less profit or money as it exports few goods to other countries.



Activity 1

Use the following table to list examples of goods imported from outside Botswana and those that Botswana exports to other countries.

Import Goods (Goods from outside)

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Export Goods (Goods sent to other countries)

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

For the goods that are imported from other countries you will probably come up with a long list. You will realise that goods exported to other countries are very few.

For those goods which are imported you will come up with things like machines, food products, cars, clothes, cooking utensils, tools etc.

For goods that are exported to other countries, you will probably come up with goods like copper, nickel, diamonds, meat, meat products etc. Botswana however, does produce some few agricultural based products for export.

3.0 What are Botswana's Major Industries?

The Botswana Government is investing a lot of money towards the development and growth of industries in Botswana. So far, there are few major industries in Botswana. These industries are those which bring revenue to the country.

Mineral production and meat products are the leading industries in Botswana which make up for substantial revenue in the country. Do you know of the Botswana Meat Commission (BMC)? It is the largest meat producing industry in Botswana. To check whether you really know BMC, where are its three branches located? You can check with your study mates and tutor if you are not sure.

Diamond production alone accounts for more than two-thirds of the country's export revenue. The three mines employ a large number of the Batswana. The number of people employed under diamond mining is estimated to be about 5 000. The mining industry does not only contribute to the country's economy through the exportation of diamonds alone. There are also other minerals that are mined in Botswana.

The activity that follows aims to assess your current knowledge of the minerals found in Botswana.



Activity 2

List any four minerals of economic importance to Botswana and state where each mineral is mined.

Mineral(s)	Location/Place(s)
(a) _____	(a) _____
(b) _____	(b) _____
(c) _____	(c) _____
(d) _____	(d) _____

Feedback

From the above activity, you will realise that Botswana has a variety of minerals. Not all of the minerals found in Botswana are of any great economic importance. You must also remember that some of the minerals found in Botswana are not mined.

Minerals which are said to be of great economic importance to Botswana are diamonds, copper, nickel, coal, and soda ash. Diamonds are mined at three mining towns namely, Orapa, Letlhakane and Jwaneng.

Copper and Nickel are mined at SelebiPhikwe. Coal is mined at Morupule near Palapye while soda ash is mined at Sowa (Sua) town.

4.0 General Classification of Industries

Before we can discuss the three major categories or classification of industries, let us look at the general classification of industries. You must remember that the word industry is a broad term that includes a variety of activities.

The following are some examples of industries, which can be classified under general categories of industries:

- Extractive industries
- Manufacturing industries

- Construction industries
- Transport and communication industries
- Trading industries
- Services industries.

Now let us look at what each industry named above deals with. We will not discuss each industry in detail since we will be learning about the major classification of industries later on in this topic.

(a) Extractive Industries

These are industries that extract or **get raw materials from the earth**. These industries use natural resources from the earth or ground. You have to know that some of the natural resources extracted from the earth are renewable while others are non-renewable. (I hope you still remember from Units 5 and 6 what renewable and non-renewable resources are).

Examples of extractive industries are:

- Fishing
- Mining
- Forestry
- Agriculture

(b) Manufacturing Industries

These are industries **that process raw materials to create or to form new end products**. The creation of new end-products is made easier by the use of machines.

Manufacturing industries can also be subdivided into small divisions namely:

- Heavy manufacturing industries
- Light manufacturing industries.

What do you think is the difference between heavy manufacturing and light manufacturing industries?

Heavy manufacturing industries produce heavy, big and expensive goods while light manufacturing industries produce light, small and less expensive goods. The heavy and light manufacturing industries also differ according to size. Heavy manufacturing industries will occupy a larger space than light manufacturing industries.



Activity 3

Group the following types of industries into Heavy Manufacturing Industries and Light Manufacturing Industries.

Car assembly plant; Television manufacturing industry; Watch manufacturing industry; Shipbuilding industry; Calculator manufacturing industry; Locomotive building industry; Aircraft manufacturing; Bicycle manufacturing.

(a) Heavy Industries

1. _____
2. _____

3. _____

4. _____

(b) Light Industries

1. _____

2. _____

3. _____

4. _____

Feedback

I do hope the above activity was simple. Under heavy manufacturing industries we have car assembly plant, shipbuilding industry, locomotive building industry and aircraft manufacturing.

For light industries you must have television manufacturing, watch manufacturing, calculator and bicycle manufacturing.

(c) Construction Industries

These industries are concerned with the construction of houses, roads, dams and other features that are man-made. Figure 1 shows activities in a Construction Industry. What activities can you identify?



Figure 1: Activities in a construction industry

Yes, the figure shows some people building, some welding, and another compacting the soil. I hope this is a familiar site. Even in rural areas, you may have seen people constructing say a school or clinic. Right! As for urban areas, it is a common thing in Botswana.

Let us continue to discuss other types of industries.

(d) Transport and Communication

This industry is unique and totally different from other industries. Do you really think that this is a type of industry?

This is an industry in the sense that raw materials and finished goods have to be transported. Raw materials are transported to several industries or factories while finished goods are transported from factories to the consumers. Telephones also play a major part in the running of all industries. Communication links, involving the running of industries is made through telephones, fax, internet etc.

(e) Trading Industries

Trading industries are related to Transport Industry. Under these industries there is a middleman. The middleman is responsible for selling finished goods from factories or industries to the consumer or market. The middleman also sells products from one factory to another. Figure 2 shows activities in a trading industry.



Figure 2:Activities in a trading industry

Does this picture ring a bell?

In every corner of Botswana, there is something called *semausu* (tuckshop). These are places where you can find sweets, matches, candles, fruits, etc? Where do you think these items come from? Of course from processing and manufacturing industries which are closely linked to the consumers through traders (middlemen). All these traders, whether formal or informal (like the one above) form the trading industry.

(f) Service Industries

These are also unique industries because they do not deal with the production of goods. They deal with the provision of services. These industries provide services to all existing industries. This means that the operation of other industries would be difficult without service industries.

The following is a list of some service industries found in Botswana and other countries in the world:

- Banks
- Hospitals
- Shops
- Hotels
- Schools
- Transport and Communication

You must bear in mind that some of these industries are interrelated. For instance you learnt earlier on that transport and communication is another example of an industry. You have just learnt that

transport and communication is also an example of service industries.

You have just learnt about the general classification of industries. Now you are going to learn more about the major classification of industries. Some of the industries named under the general classification of industries will also appear under the major classification of industries. Such industries can also be used as examples of the major classes or categories of industries.

5.0 The Major Classification of Industries

Industries can be classified into three major classes namely:

- Primary Industries
- Secondary Industries
- Tertiary Industries

There is also a fourth level of industries, the quaternary industries, which we will discuss last in this section of the topic.

5.1 Primary industries

Under the general classification of industries you learnt about extractive industries. These extractive industries are also known as Primary Industries.

You must remember that Primary Industries are those industries which extract raw materials from the earth or from nature. Primary industries obtain raw materials which can be used to produce finished goods.

The extraction of raw material is made in such a way that nature can have a chance of reproducing them. This means that the extraction of raw materials is not made in such a way that the raw materials are exhausted or completely used up.

Can you suggest some examples of Primary Industries? To give examples of Primary Industries you must look at the examples given under extractive industries.



Activity 4

For the following examples of Primary Industries list the raw materials produced by each industry.

Type of Industry **Raw material produced**

(a) Mining _____

(b) Fishing _____

(c) Forestry _____

(d) Agriculture _____

Feedback

Raw materials are very important in the processing and manufacturing industries. The type of raw materials produced in mining is minerals, while for the fishing industry it is fish. For forestry the raw material is timber, wood or logs and for agriculture there are crops which are considered important raw materials.

An example of a Primary Industry is the sugarcane harvesting industry or a sugarcane cutting industry. Why is sugarcane harvesting considered a Primary Industry?

It is a Primary Industry because sugarcane is harvested or extracted from the soil which is a natural source. In this case, sugarcane is regarded as a raw material. The sugarcane can then be changed into a new form under other levels of production.

Primary Industries are also known as First Order Industries or Processing Industries. These industries involve simple processing operations. Usually there is little or no change in the original raw material. This means that the processing of raw materials add little value in terms of money to the final product.

Forestry is an example of a Primary Industry. Forests are extracted to obtain timber.

5.2 Secondary industries

These are also known as Second Order Industries. You must also know that these industries are also known as Manufacturing Industries because earlier on in this topic you learnt about manufacturing industries.

Secondary industries involve several stages of processing. They involve complex processing activities while primary industries involve simple and single operations. The end product in secondary industries is much more valuable than the raw materials. Each level of processing increases the value of the product.

Earlier on in this Unit, you learnt that manufacturing industries are divided into two sub-divisions. Do you still remember what the two sub-divisions are? The two sub-divisions are heavy manufacturing industries and light manufacturing industries. You must also remember examples of industries which fall under each sub-division.

Secondary industries are made of several stages of production or manufacturing. You must remember that each processing stage adds value to the end product.

Secondary industries can therefore be divided according to levels of manufacturing. Some of the secondary industries can be made up of two levels of production as follows:

- First level manufacturing
- Second level manufacturing

First level manufacturing deals with the processing of harvested raw materials from the earth or nature. The processing of pine logs to produce pulp or block boards and plywood is an example of

first level manufacturing.

Second level manufacturing deals with the processing of the end products from the first level manufacturing. When pulp is processed to produce paper in an industry it is second level manufacturing.

Study the following chart in Figure 3 which shows a secondary industry with both first level and second level manufacturing.

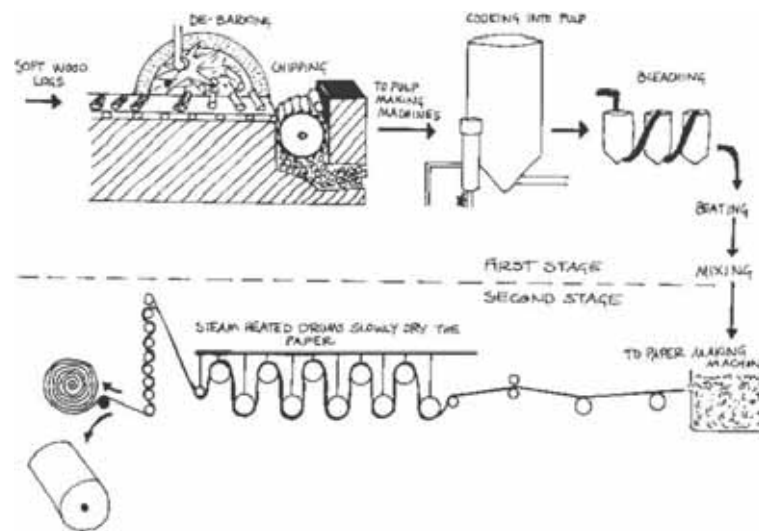


Figure 3: A secondary industry with two levels of manufacturing

From the above figure you would realise that in this particular industry, we have both primary and secondary levels of manufacturing in one industry. The first level starts with the soft wood being processed into pulp or plywood. Instead of ending there, this industry would then go further to turn the pulp into paper. That now becomes the second level manufacturing. Note the dotted line separating the two levels or stages.

There is a wide variety of secondary industries including food processing industries. Which food processing industries do you think fall under secondary industries?

Almost all of the food processing industries are examples of secondary industries. The following are examples of secondary industries that process food items:

- Meat packing
- Maize milling
- Sorghum milling
- Fruit and vegetable canning
- Brewing and soft drink bottling.

The most important thing that you have to know about secondary industries is that they use raw materials from primary industries to produce finished goods or end products.

Now you are going to learn about tertiary industries. You learnt earlier on that tertiary industries are related to both primary and secondary industries. Note that all major categories of industries are related to one another.

5.3 Tertiary industries

You learnt about service industries when we were dealing with the general classification of industries earlier in this topic. Service industries are tertiary industries.

Tertiary industries are different from both primary and secondary industries because they do not process or manufacture goods. This means that tertiary industries do not harvest raw materials from the earth or nature. Like primary industries, tertiary industries do not increase the value of raw materials by changing their form.

Do you still remember what we said earlier on about service industries? **Service industries provide services to both primary and secondary industries.**

Tertiary industries are also known as third order industries. These industries provide services which are beneficial to both primary and secondary industries. This means that tertiary industries provide services important to human beings and other industries. They provide a wide range of services to other industries such as:

- Banking
- Insurance
- Transport
- Telecommunications
- Health
- Education
- Panel beating
- Repairing of machinery in workshops.

As mentioned earlier, you must bear in mind that the major categories of industries are related. This means that primary, secondary and tertiary industries are related. Primary industries are **First Order Industries** while secondary industries are **Second Order Industries** and tertiary industries are **Third Order Industries**.

The relationship between primary industries, secondary industries and tertiary industries can be illustrated as shown in figure 4.

First Order Industries = Iron ore (extraction) (Primary) or mining

Second Order Industries = Manufacturing of iron (Secondary) ore into steel

= Manufacturing of cars from steel

Third Order Industries = Transportation of steel and finished Cars to the market

Figure 4: Developmental stages at different manufacturing levels

5.4 Quaternary Industries

By definition, quaternary industries are basically that part of the economy that deals with

information. They are the economic activities that involve the intellectual services (specialised skill or knowledge). Examples of these activities include scientific research, governance, libraries, culture, education, and information technology.

Using figure 4 above, you would realise that if we had to include quaternary industries, an example would be marketing of the steel and cars on the internet for example. By so doing, you are creating awareness about the products, or giving out information about the products. Try to figure out on your own how quaternary industries fit into the whole picture.

That brings us to the end of the first topic. We can now summarise what we have learnt.



6.0 Summary

The term industry is broad and includes a wide variety of activities. Most of the activities are those that we do to earn a living.

There are also a wide variety of both processing and manufacturing industries. Processing industries are those industries which prepare raw materials to be ready for the production of finished goods. Manufacturing industries are those industries that turn raw materials into finished goods.

There is a general classification of industries which includes a list of activities. The general classification of industries includes small activities or industries.

There is also a major classification of industries which only includes few industries. The major classification of industries only includes the major activities taking place in a country. The major classification of industries includes industries such as primary, secondary, tertiary, and quaternary.

The major classes of industries are related. Primary industries extract raw materials from nature while secondary industries use raw materials from primary industries to produce finished goods. Tertiary industries provide services such as transport to both primary and secondary industries. Quaternary industries are the knowledge or information industries. They include education and information technology.

You have come to the end of the first topic of the unit. Now check your level of understanding by doing Exercise 1 under the assignment section of the unit. Remember to answer questions without referring to the study unit. Once you have completed the exercise, check your answers with those provided at the end of the exercise. If all your answers are correct, congratulations! You can now move on to Topic 2. If some of your answers were incorrect, review the relevant sections before moving on to the next topic.

In Topic 2 we will discuss the factors influencing the location of industries including the importance of industries to Botswana.

Topic 2: Factors Influencing Location Industries and the Importance of Industries to Botswana

Introduction

You have learnt about the classification of industries in Topic 1. Now you know about the different categories of industries. In this topic you will learn about the factors which influence the location of industries. You will learn about what to consider when establishing an industry. The location of the different types of industries you learnt in Topic 1 is influenced by several factors.

This topic will also deal with the importance of industries to Botswana. You will learn about the benefits of industries that are found in Botswana. At the end of this topic you will be in a position to understand why the Government of Botswana is spending a lot of money in the development of industries.

Topic Objectives

At the end of this topic you should be able to:

- describe the major factors which influence the location industries
- explain the importance of the factors which influence the location of industries
- explain the importance of industries in Botswana
- list examples of industries which are of great economic importance to Botswana.

Topic Contents List

- 1.0 Factors influencing the location of industries in Botswana**
- 2.0 The impact of industries in Botswana**
- 3.0 Economic growth**
- 4.0 Summary**

1.0 Factors Influencing the Location of Industries in Botswana

Factors that influence the location of industries are very important because they determine the establishment of an industry. Before an industry is constructed, these factors have to be considered. There is no single factor, which can influence the location of an industry alone. There is a wide variety of factors which, in combination, influence the location of an industry. This section will look at the major factors only, which influence the location and existence of an industry.

One thing that you have to know is that without these factors, the establishment of an industry will be very difficult or impossible. The major factors influencing the location of industries that we are going to look at are as follows:

- Raw materials
- Capital/Finance/Money
- Telecommunications
- Management
- Market
- Transport
- Power/Electricity
- Water
- Skilled manpower
- Land
- Site
- Labour supply
- Politics

(a) Raw materials

These, as you already know, are unfinished goods that are processed to produce finished goods or new end products. Raw materials form the basis of the production of goods.

Can you imagine an industry that can produce goods without raw materials? All of the industries both processing and manufacturing require raw materials to produce finished goods. There must be enough raw materials before one can establish an industry.

In order to start an industry one has to look at raw materials and how the raw materials will be transported to the factories. Transportation of raw materials is very important as well as the cost of transporting raw materials.

You must remember that raw materials are usually heavy and bulky. This means that it is expensive to carry raw materials from one area to another. What do you think should be done to reduce the cost of transporting raw materials to factories? Industries which process heavy and bulky raw materials are located closer to the source of raw materials.

(b) Markets

You learnt earlier on that industries process raw materials to produce new end products. These new end products or goods have to be sold to the market. In this case, by the term market we mean **the number of people who are in a position to buy goods from industries.**

In order to start an industry one has to consider those people who will buy the goods produced by industries. The **market size** can be big or small. We can also talk of **a local market** or **an international market.**

Botswana is a developing country with a small market size. The international or world market is far from Botswana and other developing countries. Most of the goods from developing countries are sold in the world market. Developing countries also sell goods to several trading organisations in the world.

Botswana and other developing countries pay high transport costs for selling their goods outside. When selling goods an efficient and reliable transport system is very important. Why do you think goods are not sold locally? It is because there are few people who are willing and are able to buy the goods. Most people from developing countries receive low cash incomes.

Which one of the following areas do you think has a bigger market, a village or town? A town has a bigger market because it has more people who also receive high cash incomes. There are some industries which produce milk, fruits and vegetables located near towns. This is because people in towns have enough money to buy the goods. Such industries are also closer to towns so that milk, fruits and vegetables are consumed while they are still fresh.



Activity 1

List any **three** organisations which provide market for goods produced in Botswana.

- (a) _____
- (b) _____
- (c) _____

Feedback

There are several organisations which provide a market for goods produced in Botswana. The following are some of the organisations that have trading relations with Botswana:

- *Southern African Customs Union (SACU)*
- *European Union (EU)*
- *Commonwealth of Nations etc.*

These are not the only ones; there are many others.

(c) Labour supply

Labour supply is very important in the location of industries. Labour supply or manpower is very important in the production of goods or new end products. You must remember that by labour or manpower we are referring to those people who **are employed to produce goods in industries.**

Some industries are situated in areas with easy availability of labour. There is enough labour supply in towns than in villages. When we consider labour or manpower we must also consider the transportation of labour to the industrial areas. The accommodation of the people employed in industries should also be considered. It is common to find companies that provide their workers with accommodation. Some private companies also have their own transport to carry workers to and from industrial areas.

Industries can be classified as **labour intensive or capital intensive industries.** There is a difference between these two types of industries.

- Labour intensive industries are industries which employ more people and use few machines
- Capital intensive industries employ few people and use more machines.



Activity 2

Use the following statements to complete the table below:

- It encourages unemployment
- Production is slow
- Production is fast
- It creates employment.

	Advantage	Disadvantage
Labour Intensive		
Capital Intensive		

Feedback

It is very important to know the advantages and disadvantages of both labour intensive and capital intensive industries. Labour intensive industries are said to be good because they create employment for many people. Labour intensive industries are also generally slow compared to capital intensive industries when producing new end products. Capital intensive industries encourage unemployment since they use many machines in the production of goods. The production of goods by machines tends to be faster.

Skilled manpower is part of labour supply. People with skills or technical skills are important in every industry e.g. engineers. This means that both skilled and unskilled labour is very important in the production of goods.

Developing countries have less skilled manpower than developed countries. They invest a lot of money in the training of manpower and at times rely on developed countries for skilled manpower.

(d) Transport and communication

You have learnt a lot about the importance of transportation in the location of industries. Transport is important for carrying raw materials to the factories or industries. Transport is also important for carrying finished goods to the consumers and for carrying both machines and workers to and from industrial areas.

There are different transport systems that are used.



Activity 3

List at least four types of transport systems that can be used to carry raw materials, finished goods etc., to and from an industry.

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Feedback

The transport system used depends on the type of goods or commodities that are to be carried to or from an industry. The following are types of transport systems that are usually used: railway transport (trains or locomotives), water transport (ships), air transport (aeroplanes) and finally road transport (cars, lorries, trucks etc).

Today's industries need adequate communication links in order to develop. Most of the activities taking place inside industries require the use of telephone and telex services.

(e) Politics

This factor is an important one which must also be considered when locating an industry. The political stability of a country is to be considered before one can establish an industry in such a country.

Politically stable countries attract more foreign companies or investors than politically unstable countries. Few industries will be located in politically unstable countries. Can you think of a country which is politically unstable and how its instability has discouraged the establishment of industries in the country?

During apartheid times South Africa had many foreign companies withdrawing and stopping investment. Such companies moved elsewhere especially to the politically stable neighbouring countries such as Botswana.

(f) Power

Can you imagine what life would be like without power or electricity? Without electricity life would be difficult and dull. Without electricity the rate of production would also be slow.

Electricity or power is very important in the location of industries. Industries develop quickly in an area with a lot of electricity. What do you think is the use of electricity in an industry?

Electricity is used to drive machines that produce goods or new end-products.

Electricity is very expensive and some countries especially developing countries, Botswana

included do not produce enough electricity. Botswana and her sister countries such as Lesotho and Swaziland depend on South Africa for electricity.

The Botswana Government established a thermal power station at Morupule to meet the high demand for electricity in the country. The Morupule power station now provides electricity to many industries in the eastern part of Botswana. Some of the electricity is from Zimbabwe and South Africa. The map (Figure 2) shows Botswana Power Corporation - National Distribution Grid and the Cross Boarder Supply.



Figure 2: Botswana Power Corporation – National Distribution Grid

Source: NDP 8

(g) Water

Water is another factor which is very important in the manufacturing and processing of goods. Industries cannot grow or develop if there is no adequate water supply. Some industries are located near sources of water such as dams. Water is used for cooling machines which are used by industries and for washing raw materials. There are many other uses of water. Can you think of other uses of water in an industry?

(h) Capital

Capital is another important factor that must be considered before establishing an industry. Money

forms the foundation of industries. Industries cannot develop without money. Most of the developing countries depend on rich countries or big organisations or companies to develop their own industries. In Botswana there are many industries which were helped to grow by foreign companies. For example, the diamond mining industry in Botswana is being developed with the help of De Beers Mining Company.



Activity 4

Give **five** reasons for the importance of money in an industry

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

There are many uses of money in an industry. The most important uses of money in an industry are to buy raw materials, to pay transport costs, to build factories or warehouses, to pay labour or workers and also to buy machines and pay for their maintenance.

(i) Physical factors

It is also very important to consider some site factors. Site factors are physical factors and they affect the place where the manufacturing and processing industry is to be established. Some of the physical factors which are to be considered are:

- Soils
- Water
- Relief
- Climate

The location and distribution of industries is determined by several factors. The major factors are the ones which you have just learnt about. A combination of these factors makes the development of industries easier. These major factors must work together as a system or a unit to make the establishment and development of processing of industries more simple.

You have learnt about the factors which influence the location of industries. Now you know which major factors are to be considered to start an industry in any given area. You are now going to learn about the importance of industries to Botswana. You are going to learn about why the Botswana Government is spending a lot of money in the development of industries. Industries are being developed due to certain reasons.

2.0 The Importance of Industries to Botswana

There are many reasons why countries spend a lot of money in the development of industries. Let us take an example of a farmer who keeps livestock. A farmer can spend a lot of money in caring for his livestock in order to get milk, meat, money etc from these domestic animals.

The following are some of the major advantages resulting from processing and manufacturing industries in Botswana:

- They bring money to the country
- They give the country prestige
- They encourage development of other industries
- They create employment
- Local people gain skills and training
- They encourage development of infrastructure
- They reduce the importation of goods
- They encourage exportation of goods
- Industries promote economic growth and bring foreign currency.

These advantages are discussed in the section that follows.

(a) Income generation

Processing and manufacturing industries bring money to the Botswana Government. Money is obtained through the selling of goods produced in the industries. The government also gains money by making industries pay tax. The government also sells pieces of land or plots to companies which build warehouses and factories. There are also some warehouses or factory buildings which are owned by the government which are rented out on a monthly basis.

(b) Prestige

Processing and manufacturing industries give a country a lot of prestige. Countries which have well developed processing and manufacturing industries have a lot of prestige and are well known all over the world. Developed countries are said to be developed because they have well developed and organized processing and manufacturing industries. Countries such as the United States of America are well known because of their industries and multinational companies. You must remember that a country with many well-developed industries is also a rich a country.

(c) Development of other industries

The existence of industries in a country will also stimulate the growth or development of other industries in that country. It is easy for other industries to grow where there are already existing industries. Industries easily develop where there are already existing industries because the important facilities will be available and cheap.

What types of facilities do you think will be available in an area already occupied by industries? Facilities such as water and electricity will be shared by industries located in one area. The area which is reserved and occupied by a group of industries is called an industrial area or an industrial estate. Towns in Botswana have some groups of industries built in one area to form industrial areas. Can you think of any town in Botswana and one industrial area found in that town? If you cannot, ask your friends, tutor or members of your family.

(d) Employment creation

Industries create employment opportunities for Botswana. The industrial sector employs a number of people even if it is a small percentage of the population. Industries are said to be very important in the sense that they employ people. Some people migrate from rural areas to towns to look for employment. People know that there are many industries in towns than in villages.

(e) Skills and training

Botswana is a developing country. Most of her industries are still developing. You learnt earlier on in this topic that some Botswana are not skilled and that the government is spending a lot of money to educate and train them on various skills. The existence of processing and manufacturing industries give some of the employees some skills and training. Those who are employed in the industrial sector gain technical and managerial skills.

(f) Development of infrastructure

Processing and manufacturing industries encourage the development of infrastructure such as roads and railway lines. Roads and railway lines are built to make the transportation of finished goods and raw materials easier. Better roads are built leading to different industries. Roads are developed in rural areas if processing and manufacturing industries are located in such areas.

(g) Reduction in imports

Botswana and other developing countries do not produce finished goods of their own. The developing countries import or buy goods from outside. The developing countries buy goods made from outside because they do not have well developed processing and manufacturing industries. Botswana and other developing countries spend a lot of money to pay for the goods which come from outside. The development of industries in Botswana will mean an increase in the production of goods and a reduction in importation of such goods.

Developed countries import few goods because they produce most of the goods they need. If a country imports few goods its expenditure will be lower.

(h) Increase in exports

An increase in the number of industries in a country means that there will be more goods and new end-products in that country. Countries in the world create industries so as to produce goods to be exported or used inside the countries.

Development of many industries in a country means that the country will have many goods which can be sold to other countries. A country which sells many goods outside, that is to other countries, gains a lot of money (foreign exchange). A country which exports more goods gains more money than the one which imports a lot of goods. Figure 3 shows the composition of Botswana's exports and imports of Goods in 1995.

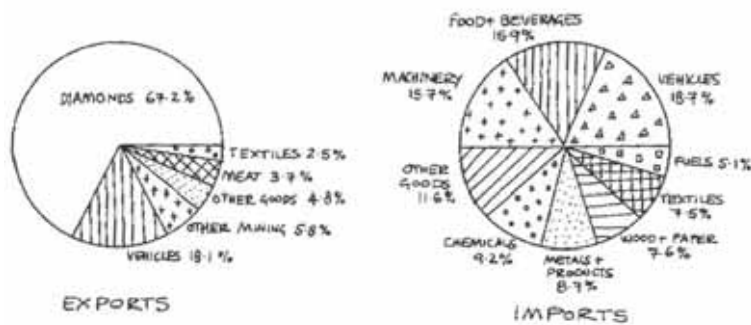


Figure 3: Composition of Botswana’s exports and imports of goods in 1995 Source: NDP 8 – Central Statistics

From the above figure, what is Botswana’s major export? Also note that Botswana imports almost everything required for the country to keep running. All the same, the few export commodities do contribute to the economic growth of the country. But, what does economic growth mean?

3.0 Economic Growth

The existence of processing and manufacturing industries promotes economic growth. The economy of the country will grow due to the goods which are sold to other countries. Foreign exchange or money is obtained when the country sells its products to foreign countries. An increase in foreign exchange means that the country’s economy will grow and the country will become rich.

You have learnt about the importance of processing and manufacturing industries to Botswana. It is important to know that industries encourage economic growth. Every industrialised country has a well developed economy. Botswana is promoting industrial growth as a way of improving the country’s economy.



4.0 Summary

The establishment and location of industries is determined by many factors such as water, labour, land, capital, power/electricity, transport and communications. You must remember that these factors act as a group or unit in the location of industries. One single factor alone cannot influence the location of an industry.

There is an increase in the number of industries found in Botswana because of the existence of most of the factors which influence the location of industries. Botswana benefits from the increase in the number industries.

There are many ways in which Botswana benefits from her industries including the creation of employment for Botswana, bringing in foreign exchange to the country, encouraging development of infrastructure and getting skills and training by Botswana working in the industries. The establishment of many industries in Botswana also contributes to the country’s economic growth.

Now work on Self-assessment Exercise 2 which you will find at the end of the unit. Follow the steps as recommended at the end of Topic 1 to check your answers and decide whether and what needs to be revised before moving on to the next topic.

Topic 3: A Case study of a Small Scale Industry in Botswana

Introduction

In Topic 1 you learnt about the classification of industries and the differences between the various categories. In Topic 2 you learnt about the factors influencing the location of industries. This topic is related to both Topics 1 and 2. In this topic you will do a case study of a small scale industry. You will also learn about the factors which influence the location of the selected industry.

In addition, you will learn how the chosen industry processes goods and the type of goods produced at the end of manufacturing. This topic will also focus on the problems facing the small scale industry, the solutions and government policies regarding the development of processing and manufacturing. Finally, you will also study the impact of the small-scale industry on the environment.

Topic Objectives

At the end of this topic you should be able to:

- locate Everest Mills on a map of Botswana
- state the factors which influenced the location of the Everest Mills
- discuss the inputs and outputs of the Everest Mills
- discuss the problems and solutions of the Everest Mills.

Topic Contents List

- 1.0 Everest Mills**
- 2.0 Factors influencing the location of Everest Mills**
- 3.0 Production at Everest Mills**
- 4.0 Urban/rural location of industries**
- 5.0 Why there are few Industries in rural areas**
 - 5.1 Benefits from the development of rural industries
- 6.0 Problems facing Everest Mills**
- 7.0 Government policies on manufacturing**
 - 7.1 Botswana Development Corporation
 - 7.2 The Botswana Enterprise Development Unit
 - 7.3 The impact of industrial development on the environment
- 8.0 Summary**
- 9.0 Self-assessment exercise 3**

1.0 Everest Mills

Everest Mills is a textile manufacturing company situated in Francistown. At first, it was known as Shashe River Textiles. It is an example of a small scale industry. The Botswana Government is promoting the development and growth of both small scale and large scale industries.

Small scale industries like large scale industries are widely distributed in many towns of Botswana. There are more industries in towns than in villages. You must also bear in mind that the Botswana Government is encouraging the development of industries in rural areas.

Most of the industries, both small scale and large scale are located in the major towns of Botswana. The following are the major towns of Botswana which have many industries:

- Lobatse
- Gaborone
- Francistown
- SelebiPhikwe

Before we can learn more about Everest Mills, let us look at the differences between large-scale industries and small scale industries. It is important that you know the difference between these two major categories. Remember that you will learn about large scale industries in a different topic.



Activity 1

Use the following table to list down the differences between small scale industries and large scale industries.

Small Scale Industries	Large Scale Industries
• _____	• _____
• _____	• _____
• _____	• _____
• _____	• _____

Feedback

The following are some of the major differences that you have to consider:

- *Small-scale industries produce few goods while large-scale industries produce goods in large quantities.*
- *There is less money used or invested in the development of small scale industries while large-scale industries use a lot of money.*

- Most of the small-scale industries use few machines while large-scale industries use a lot of machines.
- Large-scale industries are of great economic importance, while small scale industries are of less economic importance. This means that large-scale industries bring a lot of foreign exchange than small scale industries.
- Goods produced under small scale industries are cheap compared to those produced under large scale industries.

You may be asking yourself where all these industries are located in Botswana. Figure 1 shows major towns in Botswana where different industries are situated.



Figure 1: Major industrial towns in Botswana

From the above figure, I hope you realised that major industrial towns are located along the eastern part of Botswana. Would you guess one of the reasons why this is so? I hope amongst other things, you mentioned population and infrastructural development like the railway line.

You now know the difference between small scale and large scale industries. You also know that the major industrial towns are located on the eastern part of the country. The above discussion has provided a background for the discussion of the case study of the Everest Mill which as we have already mentioned is a small scale industry.

2.0 Factors Influencing the Location of Everest Mills

Now let us look at the factors which influenced the location of Everest Mills. These are specific factors that you will learn about. Do you generally still remember those factors we discussed in Topic 2? You must remember that we said that these factors play an important role in the development of industries. These factors must be there in order to establish an industry.

There are many factors which influenced the location of Everest Mills in Francistown. The following are some of the factors that contributed to the location of Everest Mills:

(a) Land

Everest Mills were established in the early 1970s. The mills were established where there was enough land or space for expansion.

(b) Power

Everest Mills get electricity from the Botswana Power Corporation. The mills also use coal from the Morupule Coal Mine.

(c) Money

The establishment of the Everest Mills received financial support from the Botswana Government, through such projects as FAP which you learned about in Unit 11.

(d) Labour

Francistown city is the second largest city in Botswana after Gaborone. It provides skilled and unskilled labour to the Everest Mills. Thus, Everest Mills employ about 300 workers and the majority of the workers are Batswana. Settlements around Francistown also provide labour to Everest Mills.

(e) Water

This is another important factor which influenced the establishment of Everest Mills. The Shashe Dam is the major source of water for most of the industries located in Francistown including Everest Mills.

(f) Raw materials

Francistown is located near Zimbabwe. The basic raw material used in this industry is cotton which is imported from Zimbabwe. The mills are not located far from the source of raw materials. This also means that the cost of transporting cotton to the mills is lower.

(g) Transport

Everest Mills are located near the major railway line. The railway line links Everest Mills to the source of raw materials. Cotton is transported using railway lines from Zimbabwe to Botswana.

(h) Market

Everest Mills sell their products to local and external markets. There are clothing textiles which buy materials from Everest Mills. It produces 100% cotton indigo dyed denim. The factory sells its fabrics to the European Union and South Africa.

Look back at section 1.0 of Topic 2. How do those factors compare with the ones you have just read about? Discuss this question with your peers at your learning centre or with friends. It should be easy to answer this question as you merely have to do a comparison of what we have discussed above regarding Everest Mills and what was said in Topic 2, Section 1.0.

Let us now discuss the actual production at Everest Mills.

3.0 Production at Everest Mills

Everest Mills produces high quality products. The textile mills produce both woven and knitted fabrics which are competitive in the world market. The total production per year is estimated at over 5 million metres of fabric.

Everest Mills started as a small industry and has developed to a large industry. The mills use machines in the weaving and knitting of cotton to make denim fabrics. In the weaving of denim about 48 F2001 rapier looms are used. The pre-shrinking of the cloth is done in a Greenville finishing plant using a Morrison Sanfoviser. Everest Mills provides training for its workers.

There is a linkage between Everest Mills and other industries. There are other industries which are built in the same area as Everest Mills. Some of these industries buy fabrics from Everest Mills to produce different types of clothing.



Activity 2

List **four** items which can be made from the denim cloth produced at the Everest Mills.

Feedback

There are many uses of the denim cloth. The following are examples of items that are made from the dyed denim cloth:

- *bags*
- *jeans*
- *jackets*

- shirts
- skirts
- dresses

4.0 Urban/Rural Location of Industries

Earlier in this topic you learnt that most of the industries are located in towns. It is estimated that about 90% of all the industries in Botswana are located in towns and only 10% are situated in rural areas.

Figure 2 shows that there are very few industries which are built in rural areas. It also shows that the distribution of industries is uneven. Rural areas or villages are less attractive for the development of industries.

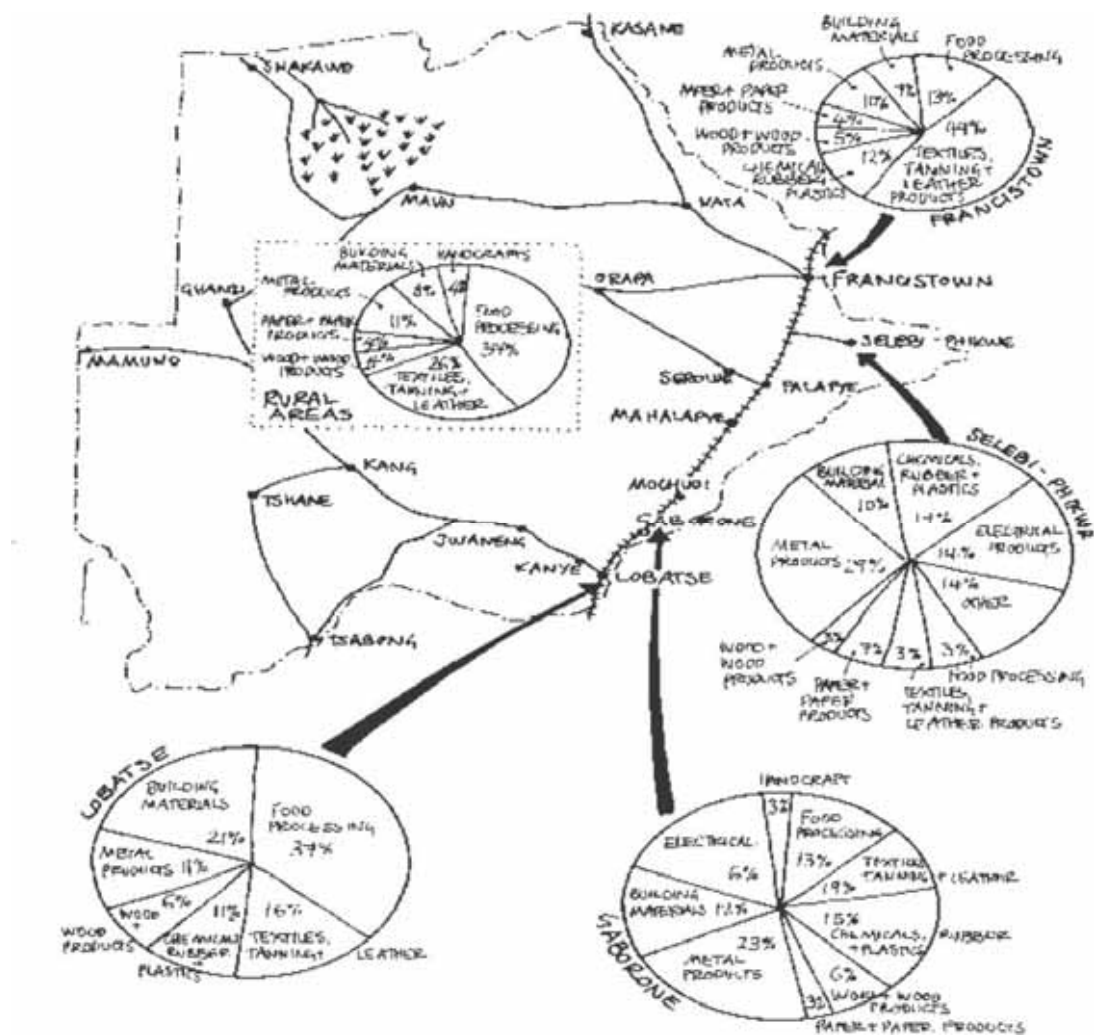


Figure 2: A pie-chart representation of industrial distribution in Botswana

Source: Silitshena R.M.K. and McLeod G. (1998) Botswana: a Physical, Social and Economic Geography

5.0 Why there are few Industries in Rural Areas

Why do you think there are few industries in rural areas? Most of the rural areas favour very few industries because of the following reasons:

- Most of the rural areas are far from the sources of raw materials
- Rural areas have poor transport and communications such as roads which are very poor.
Some rural areas are linked by poor or dirty and gravel roads
- Rural areas lack proper sources of power such as electricity. Those industries found in rural areas sometimes use small power generators
- There is also a serious shortage of water in the rural areas
- Most of the skilled labour is found in towns instead of rural areas
- Most of the people in rural areas do not have money to buy goods, therefore, lack of markets in rural areas discourage industries to locate in rural areas.

If rural areas seem so unattractive for industrial development what then would be the benefits of locating industries there?

5.1 Benefits from the Development of Rural Industries

The government is encouraging the development of industries in rural areas. What do you think are the advantages of creating industries in rural areas? When industries are built in rural areas, the local people as well as the Botswana Government will benefit.

The following are some ways through which Botswana and the government can benefit from the development of industries in rural areas:

- The rural population will be employed and they will have some wages and their living standards will be improved.
- Development of industries in rural areas will also encourage the development of infrastructure such as roads and railway lines for the transportation of raw materials and finished goods.
- The development of industries in rural areas will reduce the rate at which people migrate to towns from rural areas which is known as rural-urban migration.

You must bear in mind that rural to urban migration is one of the serious problems facing many countries nowadays. This means that if there are some industries in rural areas the rate at which people move to urban areas will be reduced. In other words, the majority of the people who move to urban areas from rural areas do so because of lack of jobs or employment opportunities in rural areas.



Activity 3

What are the problems caused by rural-urban migration?

(a) _____

- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

Rural-urban migration is a problem because of the following reasons:

- *It leads to unemployment in urban areas.*
- *Lack of accommodation in urban areas.*
- *An increase in crime in urban areas.*
- *Overcrowding in urban areas.*
- *Rural areas will be left with few able-bodied people who can be involved in the production of crops and rearing of livestock (only children and the elderly people are left in the rural areas).*
- *Rural areas will become less developed and also become depopulated.*

Now let us look at the problems facing the Everest Mills or small scale industries.

6.0 Problems Facing Everest Mills

(a) Competition

Everest Mills face competition from overseas companies. In other countries there are well established textiles mills which also produce high quality goods.

(b) High transport costs

The cost of transporting raw materials from Zimbabwe is high. A lot of money is used to pay for transportation of raw materials. A lot of money is also used to pay transport for the finished goods to the market. The major market for the produced cloth is the European Union.

(c) Low prices

Despite the fact that prices for the denim cloth is competitive, there are certain times when the European Union buys the cloth at very low prices. The prices in the world market go up and down.

(d) Growth of the industry

Every industry needs to grow from a small scale into a large scale. This is not always easy because of shortage of money. A lot of money is used to change a small scale industry into a large scale industry. The reason why most industries remain at the same level is that they do not have money to grow into another stage or level of growth.

(e) Shortage of skilled labour

Most of the people who are hired lack some skills. Everest Mills and some other small scale industries or textiles have to hire people and train them. Training people on the site requires a lot of time and money.

These are some of the problems which are facing the development of small scale industries. These problems are common to many small scale industries. They are also common to large scale industries.

Now you are going to learn about the ways through which the Botswana Government is trying to solve some of the problems facing the development of small scale industries. The Botswana Government established some policies to encourage the development industries.

7.0 Government Policies on Manufacturing

The government encourages industrial development through:

- protecting property rights and recognising the existence of industries
- the development of the private sector
- the existence of competition among industries
- the provision of infrastructure such as:
 - transport and communication
 - water
 - power supply
- provision of serviced land and plots with the following:
 - water
 - electricity
 - telephone connections
- provision of factory shells for rentals such as those provided by Botswana Development Corporation (BDC)
- financial support in the form of provision of:
 - loans
 - grants
 - subsidies
- technical facilities
- establishment of some training centres
- provision of technical education to provide skills or skilled labour
- protection of local industries from foreign industries through taxing goods which enter Botswana from other countries
- not charging custom duty on goods produced in Botswana and exported to other countries.

In order to encourage the development of manufacturing industries, the government also established two major agents. These two agents or bodies which are responsible for developing the processing and manufacturing industries are:

- Botswana Development Corporation (BDC)
- Botswana Enterprises Development Unit (BEDU)

Let us discuss what these agents do in order to assist in the development of industries in Botswana.

7.1 Botswana Development Corporation (BDC)

This agent was established about thirty years ago. It was aimed at developing the following sectors of the economy:

- commercial sector
- industrial sector
- agricultural sector

The Botswana Development Corporation attempts to attract foreign investors to open industries in Botswana. It owns several small companies or industries. It is also a share holder in many large companies.

Examples of small companies or properties owned by the Botswana Development Corporation are:

- The President Hotel
- Broadhurst Industrial Estate
- SelebiPhikwe Mall
- Botswana Craft Marketing Company (Pty) Ltd.

7.2 The Botswana Enterprises Development Unit (BEDU)

It was established in 1974. Its main purpose is to help Botswana who want to start their own businesses or industries. The Botswana Enterprises Development Unit provides the following services:

- Financial services
- Technical services
- Management services

Like the Botswana Development Corporation, the Botswana Enterprises Development Unit has established small scale industrial estates throughout the country. The Botswana Enterprises Development Unit has several projects including the production of:

- | | |
|--------------------|--------------------|
| • garments | • pottery |
| • leather products | • school furniture |
| • knitwear | • office furniture |
| • jewellery | |

Both the Botswana Development Corporation and the Botswana Enterprises Development Unit are said to have contributed a lot towards the development and growth of industries in recent years.

7.3 The impact of industrial development on the environment

In Topic 2, you learnt about the importance of industries in Botswana. You learnt about why the government invests a lot of money in the development of industries. Go back to Topic 2 and find out the reasons why the government is encouraging industrial development.

In Topic 2 you learnt that industries create employment for Batswana. You also learnt that industries promote economic growth and give a country prestige etc.

Industries promote economic growth, but they affect the environment negatively. There are many ways through which industrial development can affect the environment. Small scale industries and large scale industries affect the environment through the following ways:

(a) Pollution

During the processing and manufacturing, industries release substances into the air. The air will then become polluted. The burning or use of coal by many industries release gases such as carbon monoxide into the atmosphere. Apart from air pollution, there is also water pollution by industries. Water is polluted when industries release chemicals into the water. The polluted water affects vegetation and animals which normally live in water.

(b) Clearing

The clearing of vegetation to create space for the construction of industrial buildings is also another problem caused by industries. When the trees or the vegetation is cleared off, the trees are not replaced.

(c) Untidy environment

Industries are also associated with ugly, untidy and a dirty environment. Some industries usually leave the ground surface with some waste heaps or waste dumps. Industries will pile up waste material at one point. Apart from creating some waste heaps there are sometimes unnecessary digging of the ground which leaves the ground surface with many holes.

The above are some of the ways through which the environment is affected by industries. That also brings us to the end of the topic. Let us now summarise it.



8.0 Summary

Small scale industries are industries which produce less goods compared to large scale industries which produce goods in bulk. Small scale industries are of less economic importance while large scale industries are industries of great economic importance. Most of the small scale industries are located in major towns. Some of the industries which are listed under small scale industries category include craft industries, bakery, textiles etc. The government of Botswana is also encouraging the development of industries in rural areas to create employment for Batswana and also reduce the rural-urban migration.

The Everest Mills in Francistown is an example of a small scale industry. Everest Mills are located in Francistown because of the availability of water from the Shashe dam. Everest Mills get raw materials in the form of cotton from Zimbabwe. The Mills produce fabrics or denim cloth which is used to make shirts, skirts, jeans etc. These small scale industries are faced with several problems such as competition from other well established textile mills in other countries. The government of Botswana developed some strategies for protecting small scale industries from competition with products from large well-established foreign industries.

Do not forget to work on self-assessment 3. Remember also to assess your understanding by checking your answers against those provided and then taking the necessary remedial action where necessary.

Topic 4: Botswana Meat Commission: A case Study of a Large Scale Industry in Botswana

Introduction

In Topic 3 you learnt about a small-scale industry in Botswana, namely the Everest Mills. You should also remember that we said industries can be grouped into small-scale industry and large-scale industries. In this topic you are going to learn about an example of a large-scale industry.

You will learn specific factors which influence the location of the Botswana Meat Commission abattoirs. Furthermore, you will study the processing of meat products.

You will also study the problems encountered by the Botswana Meat Commission and how the Botswana Government is trying to solve those problems.

Topic Objectives

At the end of this topic you should be able to:

- list factors which influence the location of the Botswana Meat Commission abattoir in Lobatse
- explain how meat and meat products are processed into end products
- discuss the problems facing the Botswana Meat Commission
- explain how the Botswana Government is trying to solve the problems facing the Botswana Meat Commission.

Topic Contents List

- 1.0 The Botswana Meat Commission (BMC)
- 2.0 Livestock farming in Botswana
- 3.0 Subsistence and commercial farming
- 4.0 Transportation of livestock to the BMC
- 5.0 Factors which contributed to the selection of Lobatse as a site for BMC
- 6.0 Meat processing at BMC
- 7.0 Problems in the beef industry
- 8.0 Summary
- 9.0 Self-assessment exercise 4

1.0 The Botswana Meat Commission (BMC)

The Botswana Meat Commission contributes a lot to the economy of Botswana. Sometimes it is known as the **beef industry** and it is the second largest revenue earner for the Botswana Government after the Mining Industry.

The Botswana Meat Commission has three abattoirs in the country. The largest of these is the **Lobatse abattoir**. The second largest is the **Francistown abattoir** and finally there is the **Maun abattoir**.

These three abattoirs are well distributed throughout the country. You must remember that Botswana is a big and wide country. The factors influencing the location of one of these abattoirs will be discussed later in this topic.

Before you look at these factors which influence the location of abattoirs, study the Map of Botswana in figure 1 showing the distribution of abattoirs in Botswana.

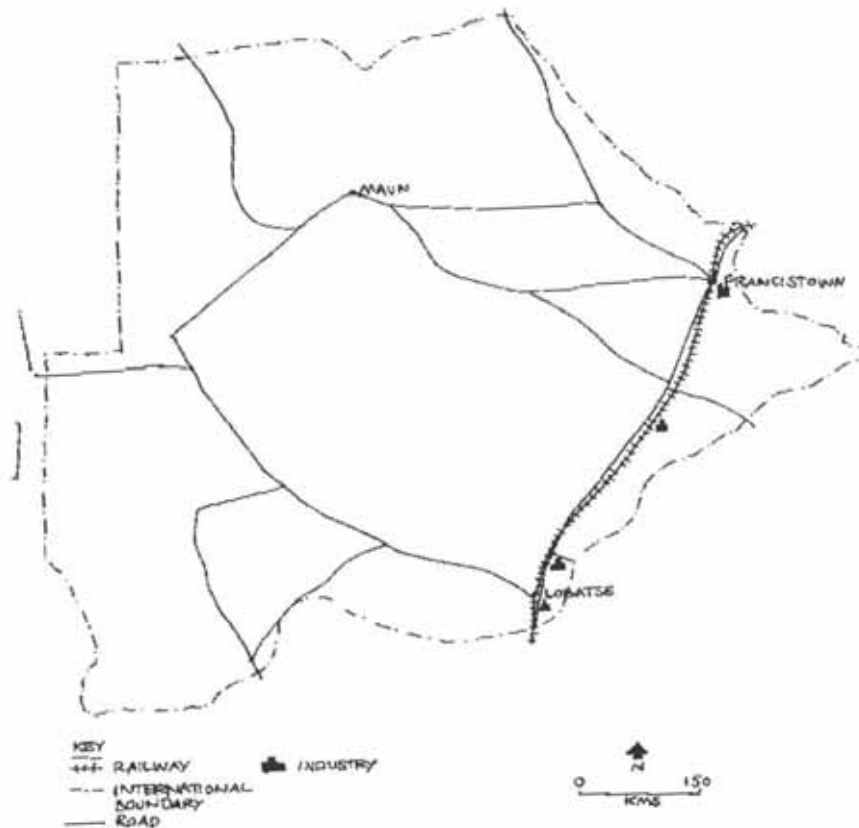


Figure 1: Map of Botswana showing the distribution of Botswana Meat Commission abattoirs

By studying the map above, what do you think the major advantages of having abattoirs at three different parts of the country? The major advantage is that farmers from different parts of the country will take their livestock or cattle to abattoirs easily and the cost of transporting their cattle will be lower. The abattoirs are also closer to different sources of raw materials – mainly cattle. You must remember that there used to be only one abattoir in Botswana – The Lobatse abattoir.

Now let us quickly go back to the factors that influence the location of processing and manufacturing industries. Could you quickly list down those factors that influence the location of industries? The factors are as follows:

- Site
- Management
- Land
- Telecommunications
- Water
- Electricity
- Political stability
- Transport

- Labour or manpower
- Money
- Market
- Raw materials

The above factors are said to be general factors. These factors can apply to any industry. Later on in this topic you will learn about specific factors which influenced the location of the Lobatse abattoir.

Remember that you are not going to learn about all the three abattoirs in detail. You will learn more about the Lobatse abattoir, which is the major abattoir.

There are many factors that influence the beef industry. When dealing with the beef industry which factor do you think forms the foundation for this industry? Raw materials are said to be important in any type of industry. What type of raw material is used under the beef industry?

The beef industry is greatly influenced by the presence of raw materials namely **livestock such as cattle, sheep and goats**. This means that without livestock, it would be difficult to have the beef industry in Botswana. The livestock sector therefore plays a very important role in the beef industry.

Let us quickly look at livestock keeping in Botswana.

2.0 Livestock Farming in Botswana

Livestock is the major raw material in the beef industry. Livestock refers to cattle, sheep, and goats. Most Batswana live in rural areas where they keep livestock and grow crops.

Livestock, especially cattle, play an important role in the lives of Batswana. Both the government and individual farmers benefit a lot from keeping livestock.



Activity 1

Explain why most Batswana keep cattle.

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

Remember that livestock is kept at both commercial and subsistence levels. Most Batswana keep livestock at subsistence level unlike commercial farmers who keep livestock in order to make profit. The following are some of the reasons why most of the traditional farmers keep livestock:

- to provide draught power
- for payment of bride

wealth (bogadi)

- as a source of milk
- to provide meat
- as a source of income
- for prestige.

Botswana is a semi-arid country that is better suited for the rearing of livestock than the production of crops. The Ministry of Agriculture spends a lot of money in the development of the livestock sector. You must bear in mind that cattle are the basis of the beef industry. The beef industry is said to be more advantageous than the rest of the industries in Botswana especially the mining industry. Cattle are a renewable resource compared to minerals, which can be used up or exhausted.

Cattle, unlike minerals benefit both the individual farmers directly as well as the government. Activity 1 of this topic explains how individual farmers benefit from keeping livestock. The Government of Botswana gains revenue through the selling of cattle to the Botswana Meat Commission.

3.0 Subsistence and Commercial Farming

Let us now look at the two systems of livestock keeping. These systems are the **commercial or freehold system** and the **Traditional or Communal System**. These two systems produce raw materials for the Botswana beef industry.



Activity 2

Complete the table showing the characteristics of commercial and traditional farming systems.

Commercial Farming	Traditional Farming
(a) High or large number of cattle.	(a) _____
(b) _____	(b) Livestock not produced for profit.
(c) Skilled labour employed.	(c) _____
(d) _____	(d) Land is open or not fenced.
(e) Supplementary feeding.	(e) _____
(f) _____	(f) No regular disease control.

Feedback

The above activity shows that the two systems of keeping livestock are different. Traditional farmers keep few cattle compared to the commercial farmers. Commercial farmers keep livestock for profit making. Usually under the traditional system no skilled labour is employed to manage the cattle. Commercial farmers use fenced land, which is also divided, into paddocks. Traditional farmers do not give supplementary feeding. Commercial farmers apply some disease control methods.

You must remember that the above are not the only differences between the commercial livestock farming and the traditional livestock farming. The two systems of livestock rearing also differ in terms of the type of animal breeds they keep. There are a wide variety of breeds kept by farmers in Botswana. Some of the cattle breeds originate from outside Botswana.

Study the drawings showing two different breeds of cattle in figure1. Which breed of cattle do you think is mostly kept by traditional farmers? Which breed do you think is commonly kept by commercial farmers?

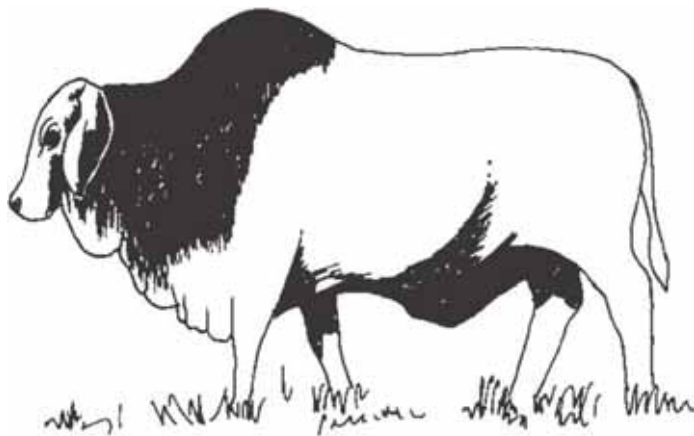


Figure 1: (a) Brahman Bull

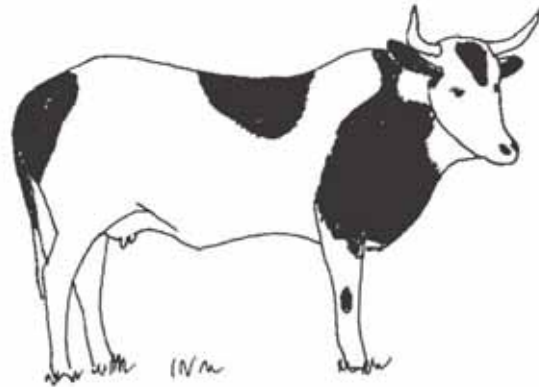


Figure 1: (b) Tswana Cow

The Tswana breed accounts for about 80% of the cattle kept in Botswana. The remaining 20% comprises of breeds developed outside Botswana. The following are examples of breeds developed outside Botswana:

- Brahman
- Africander
- Tuli

Now you are going to learn about the ways through which both commercial farmers and traditional farmers sell their cattle to the market. You must bear in mind that the major market for the livestock sector is the Botswana Meat Commission. Farmers can also sell their livestock to other farmers or to the local butcheries.

4.0 Transportation of Livestock to Botswana Meat Commission

Earlier on in this topic we mentioned that there are only three abattoirs in Botswana. This means that not every village or district has an abattoir. The question is, how do farmers take their cattle to the Botswana Meat Commission? You must remember that we said that both commercial farmers and traditional farmers provide raw materials to the Botswana Meat Commission industry.

The commercial livestock farmers sell a large number of cattle at one time than the traditional livestock farmers. The commercial farmers as well as the traditional farmers send many cattle to the Botswana Meat Commission abattoirs in order to meet the killing capacity of these abattoirs.

Study Table 1 which shows the estimated number of cattle slaughtered by each abattoir in a single day.

Table 1: Number of cattle slaughtered per day at each of the BMC abattoirs

Name of Abattoir	Number of Cattle per day
Lobatse	1200
Francistown	700

There are three major ways of transporting cattle to the Botswana Meat Commission abattoirs. The methods used are as follows:

- Road transport
- Rail transport
- Trekking method

Which method is commonly used in your area? Which abattoir is closer to your home area? All of the above methods are important in their own way. This is to say that each method has both advantages and disadvantages.

Both road transport and rail transport are quicker but more expensive. The trekking method is slower but cheaper. The trekking method has a major disadvantage since animals are made to travel long distances to abattoirs and thus lose weight.

The organisation of selling cattle to the Botswana Meat Commission varies from one farmer to another. Generally speaking there are three ways through which farmers sell their cattle to the Botswana Meat Commission.

- **Through marketing co-operative societies**

It is mainly made up of small-scale farmers. Farmers sell their cattle through co-operatives. The co-operatives charge farmers a small percentage.

- **Through registered BMC (Producers) agents**

The selling is done through an agent who also charges farmers a certain percentage of the gross value of the cattle.

- **Direct sales**

Large commercial farmers who sell their cattle in bulk use this method.

The Lobatse abattoir is, as already mentioned, the largest of the three abattoirs and it was the first abattoir to be established in Botswana. You are going to learn about the factors, which influence the location of the Lobatse abattoir. You must remember that these factors are specific to the Lobatse abattoir.

Like we have said earlier, we are going to use the Lobatse abattoir in particular as an example of a large scale industry. Let us start by discussing why Lobatse and not Ghanzi for example as the site for the Botswana Meat Commission.

5.0 Factors which Contributed to the Selection of Lobatse as the Site for Botswana Meat Commission

There are several factors, which contributed to the selection of Lobatse as the site for the Botswana Meat Commission. The following are some of the factors that influenced the selection:

- (a) Labour supply

Lobatse is a town with both skilled and unskilled labour. The town as well as other surrounding towns and villages provide the abattoir with workers.

(b) Adequate water supply

The abattoir gets water from the Nnywane Dam in Lobatse. The abattoir also gets emergency water supply from Gaborone dam.

(c) Money

The Lobatse abattoir gets financial support from the Botswana Government.

(d) Power

Electricity is obtained from the Botswana Power Corporation. Coal is also obtained from Morupule Coal Mine. The abattoir used to get coal from the Republic of South Africa.

(e) Market

Lobatse is close to South Africa which consumes a lot of beef from the abattoir. South Africa also provides facilities for exporting meat and meat products from Botswana to European markets.

(f) Land

The abattoir is situated in an area that can allow the abattoir to expand and become bigger.

(g) Politics

Botswana is a politically stable country. Remember that in Topic 2 we mentioned that politically stable countries favour the growth of industries.

(h) Transport

The abattoir is located near the railway line. Meat is transported by rail line to South Africa.

Study the sketch map in figure 2 which shows the site of Lobatse and some of the factors influencing the location of the abattoir. As you study the map, locate the factors discussed above and ensure that you understand them all.

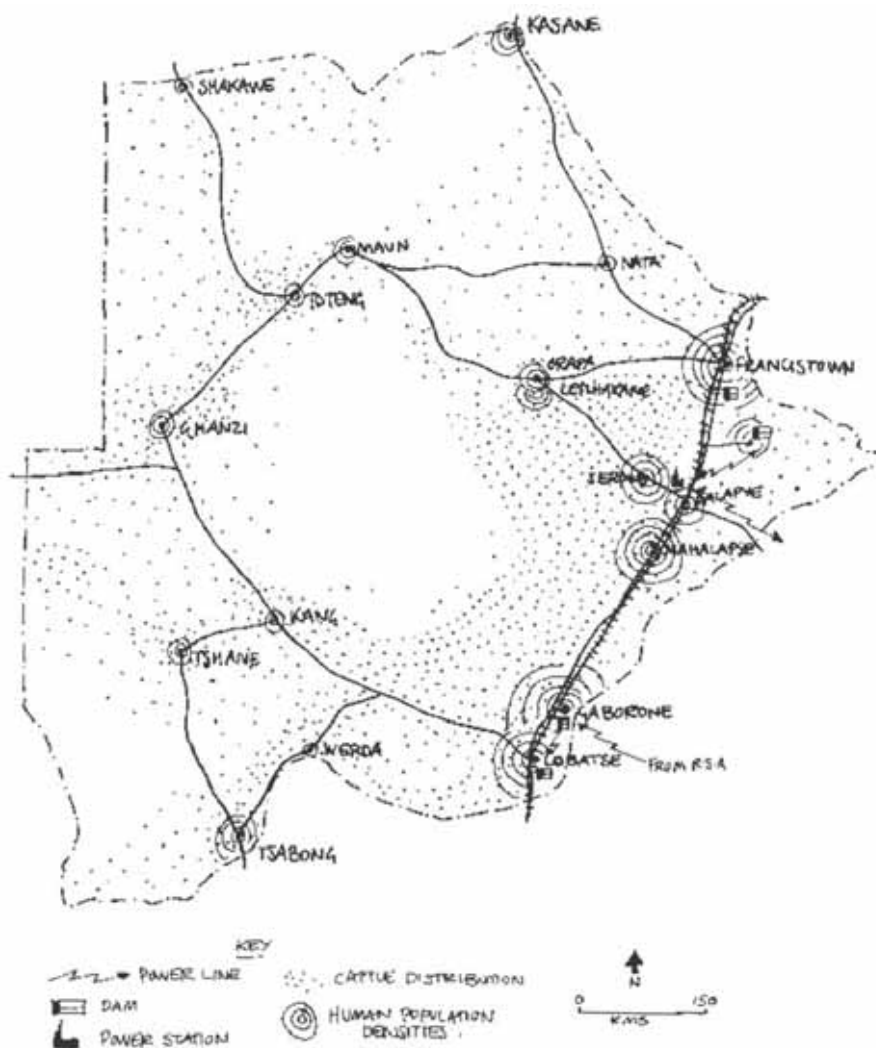


Figure 2: The location of Lobatse

The Lobatse abattoir gets raw materials or cattle mainly from Ngwaketse district, Kgalagadi district, Kweneng district, and Molopo areas. The abattoir was used to receive cattle from the northern parts of the country as well before the establishment of the Francistown and the Maun abattoirs.

Now let us look at the processing of meat and meat products.

6.0 Meat Processing at the Botswana Meat Commission

The processing of cattle like any other raw material or industrial products is in the form of stages. Each stage of processing adds monetary value to the product being processed.

The following are the stages of processing at the factory.

- the cattle are washed using sprays of water and then knocked down unconscious using a

special gun

- throats are slit
- carcasses are lifted by hind legs to drain blood
- carcasses hang from an overhead moving chain
- horns, heads & skins are removed
- internal organs are removed
- internal organs are put on a conveyor belt and moved parallel to the carcass.
- carcasses are examined by veterinary officers and graded.
- carcasses are split into two halves, washed and put into a chilling room for 24 hours.
- internal organs are washed, graded, packed and made ready for exportation or local markets.

The following day the chilled carcasses are exported to the Republic of South Africa and other countries. Apart from South Africa, Botswana's meat goes to several countries such as Mauritius, Hong Kong, Mozambique, Angola as well as the European Union.

A carcass that is found with a disease is destroyed. The internal organs are also destroyed. The farmer does not get anything in return or they are given a small compensation for these animals.

Not all the carcasses are exported to other countries. From the factory, some carcasses proceed along the overhead chain to the deboning room. What do you think happens to the carcasses inside the de-boning room? Inside this room workers remove pieces of meat until only bones are left.

Let us briefly discuss what exactly happens to carcasses that are taken to the de-boning room.

(a) De-boning

- various parts of the carcasses are removed
- each worker removes one piece of meat of a certain type (top side, silverside etc.)
- each worker specialises in removing one type of meat
- pieces are removed and then packed in plastic bags
- the packing of meat into plastic bags is done by packers
- the bags are then weighed, scaled and put into a cardboard box
- boxes are tied up and frozen as boneless meat
- the boneless meat will then be ready for export to the European Union
- the remaining bones are scrapped to get every piece of meat
- the scrapped meat is sold in Botswana as minced meat.

(b) Canning

- some scrapped meat is sent to the cannery
- other cuts of meat are also sent to the cannery
- meat is packed into tins and sold as corned beef.

The Lobatse Cannery is said to be capable of processing more than 300 tonnes of beef per week.

(c) By-products plant

At this plant different parts of the cattle are “cooked”. You must note that every part of the animal is important. There is nothing that is thrown away.

- bones are washed, heated and crushed to make bone meal
- blood is cooked and made into blood meal
- condemned carcasses and heads are cooked and ground into small pieces to make carcass meal
- tallow and dripping fat are collected
- bile from gall bladder is extracted to be used in medicine.

Products from bones are sold mostly inside the country.

(d) Tannery

At the tannery:

- hides/skins are treated and preserved
- there is a leather processing industry in Lobatse – many skins are processed at this tannery.

It is very important to know that small livestock such as sheep and goats are also sold to the Botswana Meat Commission. The number of small livestock sent to the Botswana Meat Commission is lower than the number of cattle sent to the three abattoirs.

The flow chart in figure 3 shows the processing of meat and meat products.

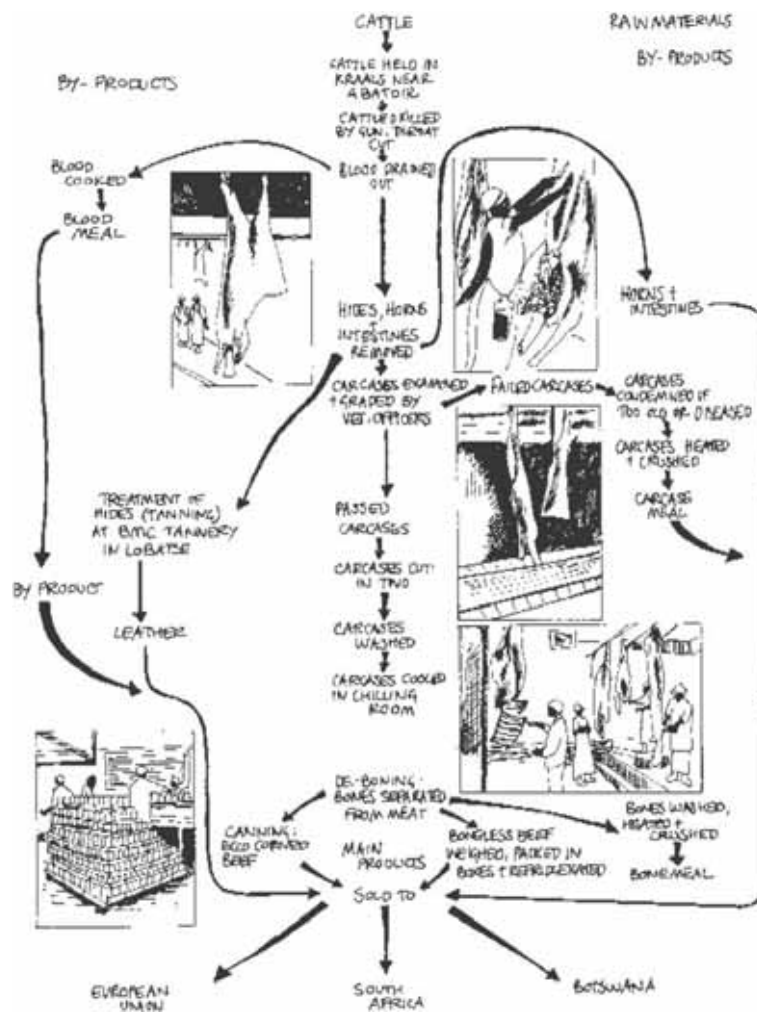


Figure 3: Meat Processing
 (Source: May, D. (1998): Geography of Botswana; page 174)

7.0 Problems in the Beef Industry

The following are some of the problems, which are facing the livestock sector and the beef industry:

- cattle diseases, e.g. foot and mouth
- external parasites, e.g. ticks
- internal parasites, e.g. tapeworms
- scarcity of water
- poor pastures
- drought
- long distances covered by trekked cattle

- overgrazing.

The above problems directly affect the Botswana Meat Commission, the individual farmer as well as the government as fewer cattle are sent to the abattoirs.

These are serious problems which can cause a reduction of meat and meat products resulting in a reduced economic growth. The European Union does not buy meat that is infected with foot and mouth disease. The Botswana Meat Commission also condemns animals infected with internal parasites.

Due to the fact that livestock plays a major role in the beef industry, the government introduced some measures to solve some of the problems facing the livestock sector. The following are some of the solutions to the problems:

- cordon fences are used to control the spread of diseases
- veterinary assistants use quarantine camps to inspect cattle
- farmers are given loans to develop their livestock
- research projects are established to improve the quality of livestock
- the government provides artificial insemination (AI) services
- farmers are assisted to purchase bulls under the Bull Subsidy Scheme
- farmers are advised to sell their livestock at the youngest profitable age
- development of ranches
- compulsory and free vaccination of livestock against diseases.

These are not the only solutions that the Botswana government has introduced to encourage the development of the livestock sector. If the problems facing the livestock sector are solved, the beef industry will also grow or develop. The Botswana Government is therefore investing a lot of money in the development of livestock production.

The livestock sector causes a serious environmental problem of overgrazing. Overgrazing is no longer a problem caused by traditional livestock farming only. Commercial farming also causes serious overgrazing due to poor management of ranches.

Overgrazing will leave the land bare without vegetation cover. If the land is left bare erosion will take place easily. The end result of soil erosion is desertification or the development of desert areas.

Other problems facing the beef industry include rising costs of transporting meat and meat products to the market overseas. There are also fluctuations in prices in the world market. The meat supply to the market is sometimes low due to the fact that farmers send a few cattle for slaughter to the Botswana Meat Commission.

Now let us summarise what you have learnt in this topic.



8.0 Summary

In this topic you learned that the Botswana Meat Commission is the second largest revenue earner for the Botswana Government after the Mining Industry. The Botswana Meat Commission established three abattoirs at Lobatse, Francistown and Maun. The Lobatse abattoir was the first to

be established and is the largest abattoir in the country.

You also learned that the meat and meat products industry is influenced by several factors. The following are some of the factors, which influence the beef industry: water, labour, electricity, land, capital and raw materials.

The Lobatse abattoir was established due to specific factors such as:

- labour supply from Lobatse town and the surrounding areas.
- water from Nnywane dam and Gaborone dam.
- railway transport closer to the abattoir.
- coal from Morupule and electricity from Botswana Power Corporation.

Meat is processed and sent to the market. Inside organs are also cleaned and sold locally. The beef industry also produces by-products such as bone meal and carcass meal. Skins are treated and preserved and later processed into leather in a tannery.

Lastly, you learned that the industry is faced by problems such as diseases and drought. To solve some of the problems, the Botswana Government gives compulsory and free vaccination and farmers are also assisted with loans to develop livestock production.

Again, it is time to do the end of topic self-assessment exercise. Follow the steps recommended in the previous topics before moving on to the last topic of this unit.

Topic 5: Vanderbijl Park Integrated Steel Works: A Case Study of a Large Scale Industry in the Republic of South Africa

Introduction

In Topic 4 you learnt about a large-scale industry in Botswana. In this topic you will do a case study of a large-scale industry in South Africa. You will learn about the factors that influence the location of the steel works in South Africa. You will also learn about the specific factors which have influenced the iron and steel works at Vereeniging–Vanderbijl Park, South Africa.

This topic also deals with the processing of iron from iron ore. You will also learn about the raw materials that are used in the processing of iron ore. At the end of the topic you will know about the problems facing the iron and steel industries of South Africa. You will also be in a position to assess the impact of the iron and steel works on the environment.

This case study and the one discussed in Topic 4 give you an opportunity to compare two large scale industries; one in Botswana and another in South Africa. When you compare these two with the Everest Mills case study that you studied in Topic 3, you should be better able to distinguish

between small and large scale industries. We encourage you to make your own notes of such comparisons and to discuss these with other learners and/or your tutor at the learning centre.

Topic Objectives

At the end of the topic you should be able to:

- discuss factors which influenced the location of the South African iron and steel works at Vanderbijl Park
- explain how iron ore is processed to obtain iron
- explain the importance of raw materials needed to process iron ore
- list specific factors influencing the location of the Vanderbijl iron and steel works
- explain the problems facing the iron and steel works and how the problems can be solved.

Topic Contents List

1.0 Vanderbijl Park Integrated Steel Works

2.0 The mining and transportation of iron ore

3.0 Factors that influence the location of Vanderbijl Steel Works

4.0 Processing iron ore

- 4.1 Organisation of the processing of iron ore
- 4.2 The making of iron from iron ore
- 4.3 The making of steel from pig iron
- 4.5 An integrated iron and steel plant
- 4.6 Uses of Iron and Steel

5.0 Problems facing iron and steel works

- 5.1 Possible solutions to problems facing iron and steel works

6.0 Summary

1.0 Vanderbijl Park Integrated Steel Works

South Africa and Zimbabwe are among the largest producers of iron and steel in Southern Africa. Iron and steel play a major role in the manufacturing process. Iron and steel are the basis for the processing and manufacturing industries. The importance of iron and steel will be covered later on in this topic.

South Africa has four major iron and steel processing centers. This iron and steel is not consumed only in South Africa but is also exported to other countries which do not produce iron and steel. The major iron and steel producing centres in South Africa are:

- Pretoria

- The Rand or Witwatersrand
- Vereeniging – Vanderbijl Park
- Newcastle

The largest of the South African iron and steel works is the Vereeniging – Vanderbijl Park Centre and it produces more iron and steel than the other centres.

Study the map given in figure 1 which shows South Africa’s iron and steel works.



Figure 1: The distribution of iron and steel works in South Africa

The South African iron and steel works were influenced by a wide variety of factors. You learnt about some of these factors in the previous topics. You must remember what we said about these factors. These factors make the establishment of industries possible. This means that without these factors, it will be very difficult to start the processing and manufacturing industries. We are not going to talk about the general factors since you have dealt with them in the previous topic. Later on in this topic you are going to learn about specific factors which influence the Vereeniging – Vanderbijl Park steel works.

Before you learn about the specific factors you must know that iron ore is a mineral which is extracted from below the ground surface. South Africa has a wide variety of minerals. You probably have heard people talking about South Africa and her rich mineral deposits. The following are some of the minerals found in South Africa:

- | | |
|----------|------------|
| • Coal | • Diamonds |
| • Gold | • Asbestos |
| • Copper | • Uranium |

- Iron ore
- Platinum

Let us continue this general discussion of iron ore and mining by focusing on methods of iron ore mining, the types of iron ore and how iron ore is transported from its source.

2.0 The Mining and Transportation of Iron Ore

The mining method used for mining iron ore is the **open cast**. This is the most common method although the shaft method is sometimes also used.

When the open cast method is used, the surface rocks are stripped off. Ore is then exposed and then dug out using diesel powered shovels.

Thereafter, iron ore is transported to the blast furnaces using the cheapest means of transport such as railway transport. At the blast furnace the iron ore is smelted.

Since iron ore is bulky and heavy, the iron ore of low grade is not transported but instead, blast furnaces are built closer to the ore mine. There are different types of iron ore and these iron ores differ according to quality and the geological occurrence. The four types of iron ore are as follows:

- Haematite - contains about 70% iron
- Limonite - contains about 60% iron
- Magnetite - contains about 50% iron
- Siderite - contains about 30%.

Now, let us look at the specific factors which have influenced the Vanderbijl steel works.

3.0 Factors That Influence the Location of Vanderbijl Steel Works

There are many specific factors which have influenced the location and existence of the Vanderbijl steel works. Study Figure 2 which shows operations at the Vanderbijl Integrated Steel Works.

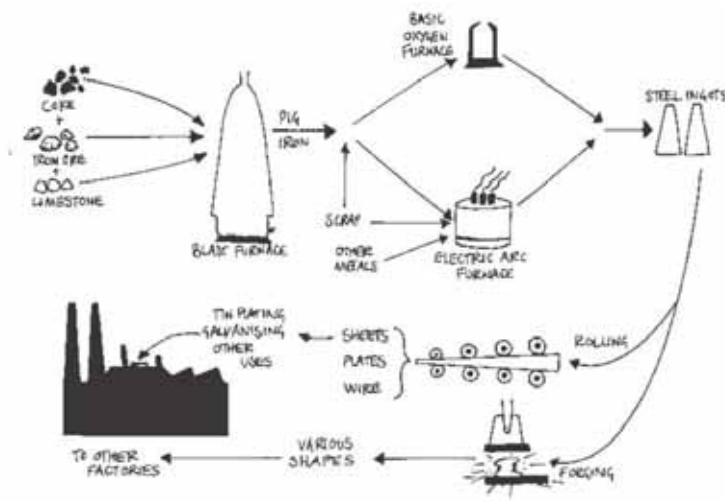


Figure 2: Integrated Process of producing iron and steel at Vanderbijl Integrated Steel Works

The following are some of the factors which have influenced the Vereeniging – Vanderbijl steel works:

- **Iron Ore**
This is the basic raw material needed for iron and steel processing. Iron ore is obtained from Sishen iron field in Cape Town and Thabazimbi.
- **Scrap Iron**
It is obtained from the mines and railways.
- **Pig Iron**
It is obtained from Newcastle.
- **Limestone**
It is obtained from Vereeniging which is near to Vanderbijl Park.
- **Cooking Coal**
It is obtained from Newcastle and also from Witbank.
- **Water Supply**
A lot of water is obtained from the Vaal river.
- **Electricity**
It is generated from the Vaal river.
- **Manganese**
It is mined at Postmasburg.

4.0 Processing Iron Ore

Now you are going to learn about the processing of iron ore. You must remember that each stage of processing adds monetary value to the end product.

Processing of iron ore is a complicated process. The major aim of processing iron ore is to separate waste material or rock from the real mineral which is iron. Iron ore is an unprocessed rock. Iron ore is only extracted or mined if the iron content of the ore is more than 20%.



Activity 1

What are the major factors that one has to consider before digging iron ore or any other mineral from the ground?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

Before mining, mineral deposits factors that you must consider include the following:

- *mineral content in the ore*
- *mineral quality*
- *depth of the mineral*
- *market*
- *environmental impact.*

4.1 Organisation of the processing of iron ore

The South African iron and steel works are owned and controlled by the South African Iron and Steel Corporation (ISCOR). ISCOR is responsible for the processing of iron ore in association with the African Metals Corporation (AMCOR).

All of the processes of extracting iron from iron ore are carried out in one operation known as the Integrated Steelworks. This means that all of the processes take place under one “roof”. The production of both iron and steel, thus, takes place at the same point. The first stage of processing involves the making of iron from iron ore while the second stage involves the making of steel from molten pig iron.

4.2 The making of iron from iron ore

For smelting iron from iron ore, a large structure called a **blast furnace** is used. The blast furnace gets its name from the blast of hot air that goes in at the bottom.

Study the blast furnace below. It is used in the heating or smelting of iron ore in order to produce iron.

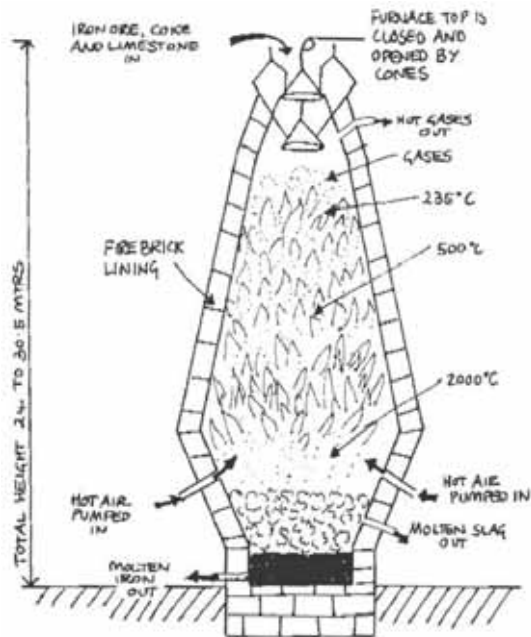


Figure 3: A Blast Furnace

- Iron ore is mixed with coke and limestone
- The mixture is fired in a blast furnace
- Hot air full of oxygen is blown into the blast furnace
- The furnace is heated at very high temperatures, i.e. about 1650°C
- Molten iron (iron in liquid form) called pig iron is produced
- The molten pig iron remains at the bottom of the blast furnace
- The molten pig iron is then removed from the furnace.

You must remember that we mentioned earlier on that iron and steel works need a lot of water. What do you think is the importance of the water? Water is needed to cool the blast furnace. Blast furnaces are therefore located near sources of water. The Vanderbijl steel works get water from the Vaal dam.



Activity 2

Complete the following table which shows some of the raw materials placed inside the blast furnace and their importance.

Raw Material	Importance
(a) Iron ore	_____
(b) Coke	_____
(c) Limestone	_____
(d) Hot air	_____

Feedback

Iron ore, coke and limestone are major raw materials in the smelting of iron ore. Hot air full of oxygen is also important in the smelting of iron ore. Iron ore is important in the sense that iron is made from iron ore and this means that iron ore is the basic raw material. Coke is important because it supports the weight of iron ore since coke is very hard. Coke also produces a lot of heat which makes the smelting process quicker. Limestone is used to remove impurities or waste material from the ore. Lastly, the hot air full of oxygen helps to increase the temperature inside the blast furnace.

4.3 The making of steel from pig iron

Now let us look at the making of steel. Steel is made from the molten iron which is known as pig iron. The molten pig iron is produced from smelting of iron ore inside the blast furnace. Steel is produced because steel is used widely by many industries. Steel is stronger than iron. It is also easy to work with steel or to shape steel into different shapes.

Steel is not the only product produced from molten pig iron. The other products or types of iron produced from pig iron are:

- cast iron
- wrought iron

We are more interested in steel production because of the important uses of steel.

In making steel from molten pig iron a furnace called the Bessemer Converter Furnace is used.

The Bessemer Converter Furnace works like the blast furnace and:

- molten pig iron is poured into the furnace
- air is blown into the furnace
- impurities such as carbon and sulphur are removed
- anthracite is added to make steel hard
- temperature inside the Bessemer Converter furnace is higher than that inside the blast furnace. (temperatures rise up to 1700°C).

Study the diagram in figure 4 which shows a Bessemer Converter Furnace.

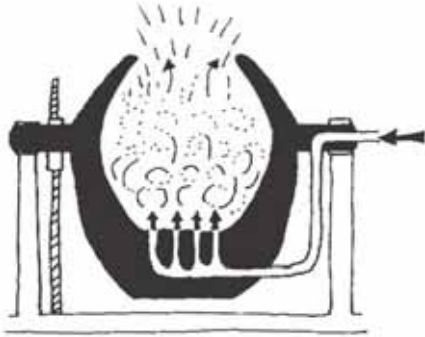


Figure 4: A Bessemer Converter Furnace

4.5 An integrated iron and steel plant

You must bear in mind that under the integrated iron and steel plants all raw materials necessary for the making of iron and steel are brought together at one site. An integrated iron and steel plant is made up of:

- coke ovens
- blast furnaces
- steel furnaces
- rolling mills

When using the integrated iron and steel plants money and time are not wasted, i.e. gases from coke ovens are used to heat the blast furnaces. Molten pig iron from the blast furnaces is poured directly into the steel furnaces. Molten steel then passes to the rolling mills.

4.6 Uses of iron and steel

What do you think are the uses of iron and steel? Iron and steel are the two most commonly used metals. These metals have more uses than other metals because they are strong and also cheap.

The following are some of the uses of steel:

- It can be made into bars
- It can be made into plates
- It can be made into sheets
- It can be made into wire, etc.

Iron and steel are important in many types of industries. The following are some of the industries which use the iron and steel from Vereeniging – Vanderbijl Park iron and steel works:

- Engineering
- Locomotive manufacturing

- Car manufacturing
- Railway lines manufacturing
- Rolling stock
- Shipbuilding industries.

The iron and steel produced are used by several industries to produce new end products or finished goods. You have just learnt about the industries which buy iron and steel in order to produce finished goods.

Let us look at the Motor Vehicle Industry which is one of the industries in South Africa which uses a lot of iron and steel from the Vanderbijl Park iron and steel works.

South Africa has many motor vehicle industries which rely on iron and steel to manufacture or to produce different parts of a car. The different components of a car are then used to build or to assemble a complete car.

Port Elizabeth is one of those centers with a wide variety of car assembly plants. Some of the motor vehicle assembly plants directly import different car parts from overseas countries such as:

- | | | |
|-----------------|---|---------------|
| • Britain | - | Rover cars |
| • West Germany | - | Mercedes Benz |
| • France | - | Peugeot |
| • Italy | - | Alfa Romeo |
| • United States | - | Ford |
| • Japan | - | Suzuki |

There are several parts of a car which are made from the iron and steel produced in the iron and steel works. The following are some of the parts made from iron and steel.

- | | |
|----------------|----------------|
| • Engines | • Wheels |
| • Shafts | • Door Handles |
| • Gearboxes | • Car Bodies |
| • Brake Pedals | |

You must bear in mind that there are some mills (Vanderbijl mills) which specialise in the production of the following items:

- | | |
|------------------|-----------------------|
| • steel plates | • strips |
| • sheets | • hollow drill steels |
| • castings, etc. | |

You learnt earlier on in this topic that South Africa has a wide range of industries which are directly linked. These industries range from the mining of iron ore to the manufacturing of new end products using iron and steel, e.g. the car manufacturing industries.



Activity 3

Suggest at least five advantages of having many industries in South Africa.

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Feedback

The advantages which are enjoyed by South Africa are due to an increase in the development of industries and are as follows:

- *Employment opportunities are made available for the citizens of South Africa.*
- *Rural areas have well development infrastructure due to the existence of industries in such areas.*
- *South Africa gains foreign exchange through the exportation of finished goods which are produced locally. You must remember that South Africa sells many of her manufactured goods to most countries in Southern Africa and the rest of the continent.*
- *South Africa imports very few goods and this means that she pays little money for the goods she imports from outside.*
- *Raw materials are available for many industries in the country, e.g. iron ore mining provide the iron and steel works of South Africa with iron ore.*

There are many more advantages which are enjoyed by South Africa due to a wide variety of industries found in the country. South Africa is one of the most industrialised countries in Africa.

Despite the fact that South Africa is a developed country, there are some problems which are facing its iron and steel works and the rest of the processing and manufacturing industries. The country has more advantages than disadvantages concerning industrial development.

5.0 Problems Facing Iron and Steel Works

Some of the problems which are facing the development of the iron and steel industries and other industries in South Africa are as follows:

- Transport costs for selling or exporting goods outside the country.
- Fluctuations in prices of finished goods in the world market.

- Political instability which exists in the country disturbs the development of processing and manufacturing industries. The political situation was worse some few years ago because of apartheid policies.
- Competitions from the developed European countries. There are countries which are leading in the production of iron and steel worldwide, e.g. Russia.
- Most of the industries use a lot of land. This means that some sectors will be left with little land. For example, an integrated iron and steel plant requires a large piece of land.
- Industries also cause a lot of pollution. Some poisonous gases are released into the atmosphere causing air or atmospheric pollution. Some industries also dump some waste materials into rivers, streams and other water bodies, thus causing serious water pollution.
- When locating or establishing industries, vegetation is destroyed to create an open space for industries.
- Even though South Africa is a rich country, some industries still lack money to develop or increase in size.

5.1 Possible solutions to problems facing iron and steel works

The South African Government has come up with policies and strategies aimed at improving industrial development. The following are some of the solutions to the problems:

- Provision of loans
- Unproductive land is spared for industrial development or industrial estates
- The government emphasises improvement of the environment
- The South African government supports and protects local industries against bigger industries or multi-national companies
- The government encourages the existence of democracy in the country.



6.0 Summary

South Africa is rich in mineral deposits. Iron ore is one of the minerals mined in South Africa and is used in the production of iron and steel. South Africa is the largest producer of iron and steel in Africa. The largest producer of iron and steel in South Africa is the Vanderbijl Park iron and steel works.

In the production of iron from iron ore, a blast furnace is very important. The furnace is used to heat iron ore together with coke and limestone. Iron ore, coke and limestone are important raw materials used in the production of iron.

To produce steel from iron or molten pig, an iron ore furnace called the Bessemer Converter is used. The furnace is used to further heat pig iron at a very high temperature.

The integrated iron and steel works at Vanderbijl Park process iron and steel at the same time at one place. Steel and iron are produced at one station. The integrated steel works is advantageous

as it saves time and money.

The iron and steel play an important role in the manufacturing of finished goods. Iron and steel are used widely in industries such as agriculture, locomotive manufacturing, motor vehicle manufacturing, shipbuilding and other industries.

The iron and steel industries as well as other industries in South Africa are faced with many problems such as fluctuation in prices in the world market. To fight some of the problems facing manufacturing, the South African Government introduced some new policies to try and address the problems.

We have now come to the end of Unit 13. Let us reflect on what the unit was all about.

Unit Summary



In this unit, you learnt about processing and manufacturing industries in Botswana and in the SADC region particularly in South Africa. I hope this unit was of great interest to you since most of the things we use today are manufactured in various industries in Botswana or other countries.

We started by defining both manufacturing and processing industries and mentioned that manufacturing industries turn products of processing industries into finished products. We also looked at the general classification of industries including extractive, manufacturing, construction etc. as well as major classes of industries namely primary, secondary, and tertiary. The second topic then discussed the importance of industries in Botswana and gave a brief discussion of factors that influence the location of industries.

In Topic 3, we then focused at a small scale industry in Botswana. Here we looked at the factors influencing the location of the industry, the actual production as well as problems faced by such an industry. To further our discussions, Topics 4 and 5 focused on case studies of large scale industries; one in Botswana and the other in South Africa. Just like in the case of a small scale industry, we looked at location of the industry, the actual production as well as problems faced by such industries. All in all we have learnt that industries are critical for the economic growth of any country.

We have now completed Unit 13 and it is your time to do the assessment. Remember this is a tutor-marked assessment and have to be handed in at your study centre.

Good luck with your assessment

Assignment

Self-assessment Exercise 1

1. Discuss the difference between processing and manufacturing industries?

[4 marks]

2. Name any **three** major classifications of industries.

[3 marks]

3. Give at least **one** function of each major industry.

[3 marks]

4. Give **one** example of each major industry.

[3 marks]

5. Explain the difference between light industries and heavy industries.

[2 marks]

Total = [15 marks]

Self-assessment Exercise 2

1. List any **five** factors which influence the location of industries in Botswana.

[5 marks]

2. For the factors you have named above explain how these factors are important to industries?

[5 marks]

3. State **five** reasons why the Botswana Government is spending a lot of money in the development of industries.

[5 marks]

Total [=15 marks]

Self-assessment Exercise 3

1. What is rural development?

[1 mark]

2. What s the meaning of:

[2 marks]

(a) BDC

(b) BEDU

3. Discuss the difference between small scale industries and large scale industries?

[4 marks]

4. List any **four** factors which influence the location of Everest Mills.

[4 marks]

5. How does the Government of Botswana encourage industrial development?

[4 marks]

Total = [15 marks]

Self-assessment Exercise 4

1. Name the **three** abattoirs, which are found in Botswana.

[3 marks]

(a) _____

(b) _____

(c) _____

2. What **three** factors influenced the location of the Lobatse abattoir?
[3 marks]

(a) _____

(b) _____

(c) _____

3. List any **three** problems which face livestock production in Botswana. [3 marks]

(a) _____

(b) _____

(c) _____

4. What are the methods used to transport cattle to BMC? [3 marks]

(a) _____

(b) _____

(c) _____

5. List down any **three** by-products of meat.
[3 marks]

(a) _____

(b) _____

(c) _____

Total = [15 marks]

Self-assessment Exercise 5

1. Name **three** minerals which are produced in South Africa.
[3 marks]

(a) _____

(b) _____

(c) _____

2. Name any **three** centers in South Africa where iron and steel are produced.

[3 marks]

(a) _____

(b) _____

(c) _____

3. What are **three** important raw materials used in the production of iron from iron ore?

[3 marks]

(a) _____

(b) _____

(c) _____

4. What are the furnaces used for in the production of iron from iron ore and steel from molten pig iron?

[2 marks]

(a) _____

(b) _____

5. Name any **four** industries which use iron and steel to produce finished products.

[4 marks]

(a) _____

(b) _____

(c) _____

(d) _____

Total = [15 marks]

Answers to Assignments

Exercise 1

1. Processing industries are industries which prepare raw materials so that these raw materials can be ready to be used in the production of consumable goods.

Manufacturing industries are industries which use raw materials to produce finished goods or end products.

2. The three major classes of industries are:
 - Primary industries
 - Secondary industries
 - Tertiary industries
3. Primary industries extract raw materials from the earth or from nature.
 - Secondary industries use raw materials from primary industries to produce finished goods.
 - Tertiary industries provide services to both primary and secondary industries.
4.
 - An example of a primary industry is mining of diamonds
 - An example of a secondary industry is making of jewellery
 - An example of a tertiary industry is transportation of diamonds and finished jewellery.
5. Light industries produce small goods which are less expensive. Production is on a small scale.
Heavy industries produce large goods which are expensive. Production is on a large scale.

Exercise 2

1. The five factors which can influence the location of industries in Botswana are:
 - Land
 - Money
 - Water
 - Electricity
 - Labour etc.
2. These factors are important because:
 - Land - industries need space where manufacturing will take place. Land is needed to build factories.
 - Money - Money is needed to buy raw materials, buy machines, pay workers, build factories etc.
 - Water - The processing or washing of raw materials need water. Water is also used to cool machines.
 - Electricity - It is important because it is used to drive machines.
 - Labour - Workers are involved in the processing and manufacturing of goods with the help of machines.
3. Five reasons why the Government is spending a lot of money in developing industries are:
 - Development of infrastructure
 - Brings foreign exchange
 - Locals gain skills and training

- Creates employment
- Reduce importation and increase exportation of goods.

Exercise 3

1. Rural development is a way by which the government provide basic facilities such as water, electricity, better roads etc. and also encourage the development of industries in rural areas.
2. BDC = Botswana Development Corporation.
BEDU = Botswana Enterprises Development Unit.
3. - Small scale industries produce few goods while large scale industries produce in bulk.
-Small scale industries are of less economic importance while large scale industries are of great economic importance.
-Small scale industries produce less quantity of cheap goods while large scale industries produce more quantity of expensive goods.
4. Factors:
 - Water - from Shashe dam
 - Raw materials - from Zimbabwe
 - Transport - factory closer to the main railway line
 - Labour - from within Francistown and surrounding areas.
5. The government of Botswana provides:
 - Loans/grants/subsidies
 - Serviced land
 - Infrastructure
 - Factory shells for rentals
 - Technical training
 - Technical schools, etc.

Exercise 4

1. The three abattoirs are:
 - Lobatse abattoir
 - Francistown abattoir
 - Maun abattoir
2. Three factors influencing location of Lobatse abattoir are:
 - water from Nnywane dam
 - labour supply from Lobatse and surrounding areas
 - coal from Morupule
 - cattle from farmers around Lobatse, i.e. Ngwaketse district, Kwenengdistrict,etc.
3. Three problems facing livestock production are:

- diseases
 - drought
 - overgrazing/lack of pastures
 - internal and external parasites.
4. The three methods of transport are:
- railway transport
 - road transport
 - trekking method.
5. Three by-products of meat are:
- carcass meat
 - skins or hides
 - blood meal, etc.

Exercise 5

1. Three minerals which are mined in South Africa are:
- Gold
 - Diamond
 - Iron Ore
 - Coal, etc
2. Three centers where iron & steel are produced:
- Pretoria
 - The Rand
 - New Castle
 - Vanderbijl Park
3. Three important raw materials used:
- Iron Ore
 - Coke
 - Limestone
4. Types of furnaces are:
- Blast furnace - iron from iron ore.
 - Bessemer Converter Furnace -steel from molten pig iron
5. Four industries which use iron and steel:
- Shipbuilding industries
 - Locomotive building industries

- Motor vehicle manufacturing
- Agricultural implement manufacturing
- Railway and buildings construction industries.

Assessment

Instructions to students

1. Answer all the questions.
2. Write all your answers in the spaces provided.
3. Marks for each question are shown in brackets.
4. You may spend no more than 30 minutes to do this assignment
5. Submit or post your work for marking

-
1. Describe any **three** factors which influence the location of industries.

[6

marks]

2. Explain the difference between primary, secondary, and tertiary industries.

[6

marks]

3. Discuss the problems facing processing and manufacturing industries in Botswana.

[6

marks]

4. What are the advantages of processing and manufacturing industries?

[6

marks]

Geography

Grade 12

COL Open Schools Initiative

Botswana

Unit 14

Mining

Introduction

Welcome to Unit 14 of the BGCSE Geography programme. In this unit you will learn about mining. You probably learnt some aspects of mining in your JC Social Studies topics. You may even come from near or around areas where some form of mining activity is practised such as S/Phikwe, Orapa, Jwaneng or Letlhakane. In Unit 13, we also touched on mining when we talked about extraction of mineral resources.

If you look around you, you are likely to find things made of different types of metals such as steel or iron, aluminium. Copper etc. You also use salt in your homes. You certainly have heard about diamonds and how they are used to develop the lives of Botswana. Where do you think all these metals and or minerals come from? Well, that is what we are going to discuss in this unit.

Unit Contents

This unit has been made easier by dividing it into four topics as follows:

- Topic 1:** Introduction to mining
- Topic 2:** Factors influencing extraction of mineral resources
- Topic 3:** Diamond and copper-nickel mining in Botswana
- Topic 4:** Copper mining in Zambia

Teaching and Learning Approach

Like the preceding units, this unit takes the learner-centred approach of teaching this course. To that end there will be case studies, hands on activities, reflection questions, rhetorical questions, group discussions, pair work and other activities employed in order to assist you to learn and understand better. There are also a lot of illustrations that you are required to interpret and even use to answer questions. All these are meant to present the content in a more user-friendly way.

You will notice that content in this unit is predominantly

theoretical. Whenever possible, reference is made to your prior learning as a way to assist you reflect and consolidate knowledge. However, Topic 4 contains content that is new to you. In that case, you would note that I have adopted the transmission style of teaching with little reference made to your prior knowledge (except where you are required to reflect on what I have already discussed in the previous sections of the topic or make reference to similar situations in Botswana).

Time

This unit will be dealt with in 4 topics. Each topic will probably require 2 hours of studying and doing exercises. Depending on your work pace you may take longer or even less time to complete each topic.

Activities

There are activities for you to do in each topic. The feedback to each activity is provided immediately after the activity. In order for you to understand the unit's content, you are required to do these activities. Furthermore, there is a practice exercise that you should do at the end of each topic. Do these exercises before you look at the answers provided after these exercises. Remember, the exercises are meant to familiarise you with examination tasks; so, do not cheat yourself.

To be able to do well in the examinations, do a lot of exercises from different books in addition to those in this unit. Once you have completed all the topics there is a test for you called assessment at the end of the unit. Like you have done in the previous topics, work on the assessment and hand it in for marking by your tutor.

Upon completion of this unit you should be able to:

- describe the distribution of major rock types in Botswana
- match rock type with mineral occurrence
- describe and explain factors influencing the exploitation of minerals
- analyse and present data in the form of chart and graphs to determine the importance of the mining sector to the economy of a country
- discuss the problems of a mineral led economy
- evaluate the impact of mining on the environment
- discuss problems of a mineral economy.



Outcomes

Time

Each topic in this Unit should take you about 2 hours to complete. This Unit has 4 topics only. You will therefore probably need eight hours to complete it. Remember this though, that the time allocated should not stop you from learning at your own pace. Depending on how fast you learn you may finish it quicker or later than what has been prescribed. You will still need to be time conscious though, and please proceed to the next topic as soon as you have completely understood the previous one.

In addition to the hours mentioned above, you will need 1 hour 30 minutes to complete the Unit Assessment. This assessment should be sent to your tutor for marking.

Resources

In this Unit you will need; an economic map of Botswana, and one of another SADC countries especially Zambia. An Atlas of Africa will do just as well. Reference books have also been included at the end of the unit. You can refer to them if you have them, as this will help you understand the topic better. In case you do not have any of the text books, do not worry since each topic has enough details, included in the form of maps and charts to adequately address the needs of your course content.



Terminology

Copper matte	A type of copper, which comes from the blast furnace. It still contains many impurities
Diamondi-ferous Kimberlite	These are Kimberlite rocks which certainly contain diamond deposits.
Environmental Impact Assessment Study (EIA)	A study undertaken to find out the degree of damage that an economic activity (operation) may cause to the environment of the areas around where it will be done.
Geological occurrence	The manner in which minerals occur or are found within a certain type of rock.
Geology	The way the rocks in an area are made up.

Government policy	The laws that are made to regulate or govern how things are to be done in a country.
Grading	This is an advanced stage of sorting. Where the minerals (diamonds) are given a move through inspection before they are finally grouped in according to their purity, colour, and shapes.
Gross Domestic Product	The total cost of goods produced in the country.
Hydro electric power	This is electricity which is produced using water pumped down from a dam and used on turbines which generate electricity.
Import Substitution	Replacing imported goods with locally manufactured goods.
Inputs	Anything used by the mining company (miners) directly to extract a mineral.
Kimberlite	A type of rock which may contain diamonds.
Market forces	All the things which one considers in deciding the price of a commodity like, cost of transport, cost of production and demand.
Mineral ore	The rock which contains the mineral in its unprocessed state.
Mining	the act of digging up the ground to obtain minerals.
Multi-sectoral economy	An economy that well developed in many sectors, which
Open pit /open cast	A method of mining whereby the surface overbid is removed as a large exposed hole is made to get at a mineral deposit.
Overburden	The layer of soil found overlying (on top) of a mineral deposit.
Quality	How expensive a product may be sold for and how much less impurities it may contain.
Rock type	The nature of rock or the geological structure of a rock.
Shaft mine	The act of digging deep vertical shafts intersped at intervals along their length by horizontal tunnels below

Slag	The impurities that come out from a copper smelter
Smelting	When minerals ore's are burnt at a very high temperature in an big oven called a blast furnace to change them into a semi -solid or molten rock.
Sorting	This involves arranging the diamond (minerals) into two groups depending on such things as quality, size or shape.
Stability	How stable a rock is in terms of how much the faults and folds in it may make it collapse easily.

Topic 1: Introduction to Mining

Introduction

In this topic you are going to learn about mining. You will first learn the meaning of the term mining. This will be followed by the distribution of rock types in Botswana and the minerals they may contain. You will learn more about where different types of rocks are found. This will include a brief look at Zambia, a mining country found in the SADC Region.

Topic Objectives

After the completion of this topic, you should be able to:

- discuss what mining is and what is involved in mining
- locate the distribution of different rock types (or systems) in Botswana
- match rock types with the minerals that are known to occur in them
- identify an area in Zambia where the mining of copper is done.

Topic Contents List

1.0 Mining

1.1 Mineral exploration

1.2 Various ways in which minerals occur

1.3 Different ways of extracting minerals

1.4 Uses of minerals

1.5 What is involved in mining?

2.0 The distribution of different rock types of Botswana

2.1 General description of some of the rocks found in Botswana

2.2 Matching rock types with minerals known to occur in them

3.0 Summary

4.0 Self-assessment exercise 1

5.0 Glossary

1.0 Mining

You have heard someone talk of a mine. You may even have read about this in some of your books. Moreover, you may have a relative or someone you know working at a mine. Have you ever asked yourself what a mine is? And from the word mine, can you guess what mining is all about?

Mining is the process whereby important raw materials (mineral ores) are obtained mechanically or through the use of manpower from the earth's surface or below the earth. They are sometimes found on the surface of the earth but most of the times they are found below the surface of the earth. The minerals or mineral ores that we are referring to include Diamonds, Gold, Nickel, Copper, Silver, Coal, Tin, Iron, Petroleum oil, Natural Gas, and many more. These minerals are later processed to make different things you see around us. That gas that you cook with is extracted from the earth through the process referred to as mining. That fuel you see being poured into the car's tank to enable it to move is also mined. Does that help you see the point? I hope it does.

We have just talked about mining of minerals. Now let us discuss how we get to know exactly where to mine these minerals. This is referred to as mineral exploration.

1.1 Mineral exploration

For man to obtain these minerals, it must be emphasised here that he must look for them and find them first. The systematic approach that is involved in searching or looking for minerals is called mineral exploration. Exploration involves many things such as:

- Searching for a suitable type of rock distribution where certain minerals are known to occur. For example, if you are looking for diamonds you will look at an area where Kimberlite (a type of rock distribution) is known to occur.
- Mapping an area using air photographs, electro magnetic mapping techniques and others which help the exploration by geologists (people who work to find suitable areas where minerals can be found), to decide if any minerals can be obtained in that area.

- Drilling an area to obtain core samples of the rock for analysis, a process known as prospecting.

Once the rock samples obtained are confirmed in laboratories by other geologists, the area can be considered for mining. All the processes mentioned here make up what is known as the mineral exploration stage.

From the exploration stage, if adequate deposits of minerals have been discovered in an area, then we proceed to the mineral extraction stage.

For you to be able to follow the discussions that follow, take some time to do the following activity.



Activity 1

1. How do people find minerals?

2. Do you think they stumble on them by accident or luck?

Feedback

I hope you were able to answer the questions with ease. If not, refer to the answers given below.

1. *They use exploration techniques which involve those such as aerial photography, remote sensing, seismic mapping, field exploration and magnetic, electrical and gravity mapping techniques.*

2. *Not often, especially in modern times, because they usually start off looking for minerals with a well planned approach as to where to start looking using data obtained by some of the methods mentioned above and also what to look for.*

Surely we would not have so much mining exploration and extraction activity going on today if people did not know where to look and what to look for in a country.

The method of extracting a mineral ore depends on how the mineral occur and relative ease of getting or accessing the mineral ore. Thus, before we move on to mineral extraction, we will discuss the different ways in which minerals occur.

1.2 Various ways in which minerals occur

It is important to also describe different ways in which minerals occur on earth.

- Minerals may occur at the surface of the earth or very close to the surface of the earth.
- They may also occur very deep underground.
- Some may be found as tracer deposits (small deposits) along the bed of river flood plains.
- Others may be found in liquid form. Many minerals are believed to be present at the floor of the oceans and seas.

In all respects to the examples mentioned above, a different method of extraction may be required to mine or dig them up.

Now that you know the different ways in which the minerals occur, let us explore the different methods of extracting minerals.

1.4 Different ways of extracting minerals

The methods of extracting minerals depend much on the way the minerals occur. Looking at the ways of occurrence of minerals listed above, would you guess how each type could possibly be extracted. Below is a discussion of ways to extract minerals depending on how they occur.

(a) Minerals that occur at the surface

For these minerals, usually found in the form of alluvial (river deposits) deposits along river flood plains; a simple method can be used. The technique involves using a pan to scoop out mud from the river then sifting it out carefully until only a small residue remains at the bottom of the pan. The residue is collected and later analysed or checked for mineral deposits. It can be used for minerals such as diamonds, gold, or tin. The method mentioned above is called **panning** (see Figure 1).



Figure 1: Panning Method

(b) Those occurring close to the surface

In some instances the mineral may occur below the surface but at levels not exceeding 50 – 80m. For these minerals a technique called open pit or open cast mining is used.

Open pit mining involves having to remove the overburden soil and vegetation from where the mineral occurs at the surface. Once the mineral ore has been reached, it is drilled and blasted into fragments using explosives. The fragmented rock is loaded into heavy-duty trucks and onto conveyor belt to the crushing section and to the refinery. An illustration of open pit mining is shown in Figure 2 (b). Note how closer to the surface the mineral ore is extracted as compared to the left side of the figure.

(c) Those occurring deep underground

For such minerals a vertical tunnel is dug up into the ground. When the mineral ore is reached, horizontal tunnels are cut into the rock to extract it easily. This is referred to as shaft mining.

An example shaft mining can be seen in Fig 2(a). Many horizontal tunnels can be drilled along the vertical shaft.

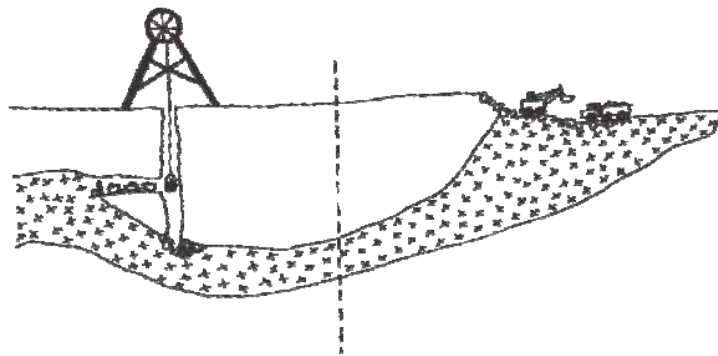


Figure 2a: Shaft mining **Figure 2b:** Open pit mining

(d) Minerals which appear as liquids (petroleum and natural gas)

Minerals that occur in liquid form are drilled and pumped out from below the ground. The processes involved are similar to those you see when people drill for ground water around your villages. Huge oil derricks are used. These are metal structures used to support the drill bit and later the pumping station gear; (See Figure 2c). The example shown is the kind used for ocean or off shore drilling operations.

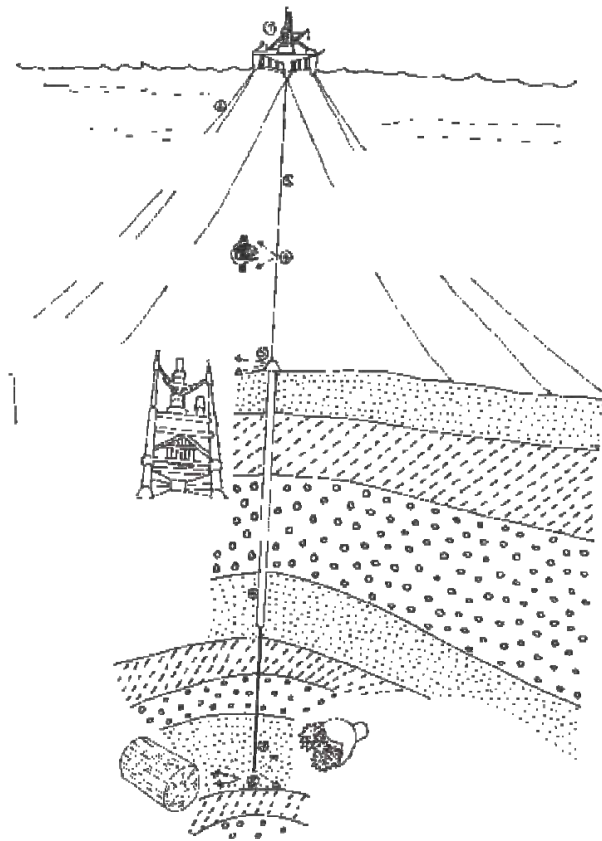


Figure 2c: Off shore drilling operations

1.4 Uses of minerals

Like I said in the unit introduction, wherever you are at this point in time, you can look around and see things that are processed from minerals. You may even be putting on a ring, necklace, earring/earknob etc that is made of one mineral or the other. So let us discuss further and see what minerals are used for.

Minerals are used in making many things that we love and use in our day-to-day activities. Metals such as iron and tin may be used to make steel for example. This is then used for a variety of purposes such as components in the manufacture of motor vehicles and in the building construction industry as door and window frames. Gold is mainly used for making expensive jewellery and as a form of currency (money). Other non-metals such as diamonds are also used in the manufacture of Jewellery. Coal can be used for heating and in very specialised circumstances it can be broken down chemically to extract petroleum, which is different from the other minerals

mentioned above as it is a liquid mineral. It is pumped out of the ground like water and later processed into various things such as paraffin, diesel, petrol, and machine lubricants like grease.

As we have already said, minerals are used in our day-to-day lives. As proof of that, do the following activity and then check my feedback below.



Activity 2

Look around you carefully; observe things made by people, and those they use to decorate themselves with.

1. What do you see?

2. What do people wear for decoration?

3. What do they drive?

4. Where do you think the metals and plants come from?

5. Do you know where the fuel for your lamps and motor vehicles comes from?

Feedback

I expect such things as:

- 1. Metal objects, buildings and plastic objects.*
- 2. Jewellery such as diamond earrings, gold necklaces and plastic hairpins.*
- 3. Motorcars, vans, motorcycles, buses, lorries, and trains.*
- 4. From extraction and processing of ores and petroleum.*
- 5. From petroleum distillation.*

From what you said when answering the questions as well as my feedback, I hope you were able to conclude that indeed minerals are used in our daily lives.

We have talked about mining and mineral extraction. But how does one get to mine these minerals? What needs to be done before the actual mining commences. Let us discuss these requirements in detail.

1.5 What is involved in mining?

Mining involves the following:

- Application for exploration lease
- Exploration and when successful application for a mining lease
- Exploitation of mining discovery
- Processing of the mineral
- Marketing of the mineral
- Use of the mineral.

(a) Application for exploration lease

As has already been mentioned, mining involves the extraction of minerals or mineral ores from the surface of the earth. Before mining can start in an area, land ownership has to be established first. Secondly it has to be determined how much of the land will be required for surface development and how deep below the surface of that land you may use for personal development. All citizens of Botswana may own a piece of land called a surface right but they do not own what is found below that piece of land called below surface right –

particularly if this has mineral potential of national significance. The government also reserves the right to take over a place and displace person(s) and any infrastructural development made therein if the area on which they are found has significant national value.

Once one has been given an exploration lease they can have a designated piece of land for five years after which it would go back to government. All the exploration findings are sent confidentially to the Ministry of Minerals, Energy and Water Resources. The minister grants mining leases using advice from government parastatals such as the Department of Mines and Geological Information Services (GIS), and other experts who may act on a consultancy basis.

When the mining lease is obtained, an agreement is signed between the government and the mining company to share the profits. Usually the company provides most of the money and expertise with the government providing land rights, some money and incentives in the form of tax holidays and reduced import/export tariffs.

The company may then proceed to extract the raw material, process, and change it into useful things that are used to provide goods for markets. The raw materials may also provide a cash flow for the establishment of other industries and help in the creation of jobs.

One such company in Botswana is Debeers Botswana (Debswana) whilst the other is Bamangwato Concession Limited (BCL).

Now that you know generally what happens from the time when a company wishes to explore for minerals until the minerals are excavated from the ground and put to their various uses, let us look at our country Botswana more closely and find out where minerals may occur.

2.0 The Distribution of Different Rock Types of Botswana

As you may already be aware, when we talk of minerals we are referring to substances that are found either on the earth's crust or below it.

The Geology of a country can be likened to the foundations of a house. When you study Geology you look closely at the rocks

and other structures below the surface of the earth. The geology of a country may help to explain what happens on its surface such as the occurrence and distribution of minerals in an area.

Geologists are people who are specially trained to study and analyse rocks and to say how the rocks are made up. This involves learning about the individual rock particles. In conducting such studies, Geologists eventually realised that certain types of rock or a geological formation tend to have certain mineral properties.

Remember in section 1.1 above we said that mineral discoveries are not a result of haphazard findings but involve detailed studies of rocks. This is done first by visual analysis, then by area mappings, and lastly by laboratory techniques to determine the type of rock and their mineral content, if they contain any. It is from these discoveries that we now find people carrying out prospecting through out the country looking for minerals.

The recent information that we have on the geological studies of our country indicates that Botswana has a lot of potential for the discovery of many minerals other than those being mined today.

It is true that in Botswana when we speak of mining many people think of diamonds. It is again natural that in recent years much of the mining exploration has tended to focus on diamonds. There are, however, many other minerals like copper, nickel, coal, soda ash, and salt which are already being mined. Others include gold, which was previously exploited by Tati Mining Company in the Francistown area. There are many others of considerable value which are yet to be found such as platinum and chrome.

Look at the map (Fig 3) which shows an outline of the rock formation (geology) of Botswana and the probable period when they were formed.

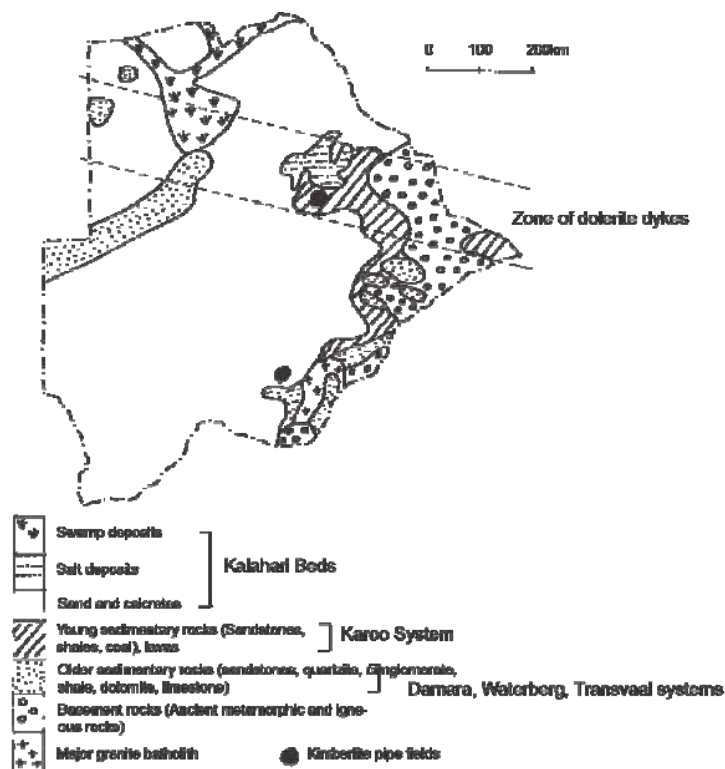


Figure 3: The geology of Botswana

The rocks in Botswana comprise mainly of two categories and these are:

- Igneous and Metamorphic rock. (Also known as Basement rocks)
- Sedimentary rocks

The rocks in Botswana can also be grouped into systems. Systems are broad categories or groupings of rock in an area. They usually have certain age and are named after the geographic area in which they occur.

The following systems have been identified in Botswana. Refer to the figure 3 which shows where these systems may be found. The oldest of these rocks which are mostly Granite and Basalt are supposed to have been formed about 3000 million years ago and make up most of what is referred to as Basement rock. Another layer or system of rock found on top of the Basement rock comprises mainly of metamorphic rock, such as Quartzite and was formed about 700 to 2200 million years ago. These form the group known as the Damara, Waterberg and Transvaal

systems. The Damara, Waterberg, and Transvaal systems are very old sedimentary rocks, though now changed to become metamorphic rocks. On top of the above mentioned systems of rock we again find a further layer or deposit of more sandstone, clays and coal known as the Karoo system. This system is estimated to have been laid about 200 – 300 million years ago. Finally on top of all these other systems of rock we have yet another layer of sedimentary rocks comprising mainly of loose sand, several metres deep of salt deposits and swamp deposits known as the Kalahari beds or Kgalagadi sands.

The extensive depth of the Kgalagadi sands has obscured other systems of rock which have greater mineral bearing potential. The eastern side of the country where Basement rocks are found has so far been the most economical in terms of the number of mineral discoveries found in the area. Many of our discoveries are found at surface protrusions of either igneous or metamorphic origin where expensive metal ores such as gold traces, copper nickel, cobalt, and Kimberlite ore pipes have been discovered.

The only notable discoveries of mineral in the Kgalagadi sands system of rock has so far been the Mmamabule coal fields and the Sua pan soda and salt deposits. The possibility of other minerals such as Petroleum and Natural gas are thought to exist but so far little prospecting evidence has been established as to their validity.

The layer of igneous rock found in the southern part of the country extending from Lobatse to the North Western Province of South Africa is expected to contain some deposits of chromium and vanadium but again test exploration for the mineral traces are so far inconclusive.

Below is a list of examples showing the different systems of rock and some minerals that may be found in them.

(a) Basement rock

Examples: Basalt, Granite

Minerals: Gold, Copper, Nickel, Chromium,
Silver, Iron, and Diamonds

(b) Metamorphic rocks (also known as the Damara, Waterberg, and Transvaal system)

Examples: Shists from Shales, Clays and Sand stones.
Gneises from (impure sandstones and granites)
Marble from Limestone
Quartzite from Sandstone

Minerals: Agate, Amethysts, and Traces of Gold

(c) Sedimentary Rocks (Karoo and Kgalagadi sands)

Examples: Sandstones
Shales
Conglomerates
Quartzites
Dolomite
Limestone

Minerals: Coal, Soda ash

So far, we have only named the different rock types found in Botswana. We will now go further and give a description of the rock types. That is, how can you differentiate the rock types from each other? We shall just pick some of the rock types.

2.1 General description of some of the rocks found in Botswana

Granite is also known as an extrusive igneous rock because it was formed when magma reached the surface. The lava cooled very rapidly to produce fine-grained rocks.

Basalt is also known as intrusive igneous rock because magma cooled below the surface. The magma cooled slowly allowing the rock to grow large coarse-grained crystals. (Both can be found in many areas of Eastern Botswana, that is, Tswamong Hills, Gaborone and Francistown areas.

Conglomerates are large pebbles cemented together with finer materials. They are quite hard and can be found in the Otse peak on the eastern part of the country.

Sandstones and quartzites have a finer grain and are made up of sand particles that have been compacted and cemented together. These may be seen in Ramotswa.

Shales are reddish or grey-black and have fine grains with closely spaced bedding planes. The dark colour indicates a high occurrence of organic material whilst the red indicates the presence of iron oxides.

Dolomites are greenish black in colour and were chemically formed from the precipitation of minerals in shallow water. Limestone was formed similarly and is more whitish in colour.

Coal is black in colour and was organically formed from deposits of lush tropical forest vegetation a long time ago (about 200-300 million years).

Other rocks found in Botswana include manganese near Kanye, asbestos in Moshaneng; west of Kanye, copper at Selibe/Phikwe, and the Ghanzi veld that we believe may be a Southwest extension of the Zambian copper belt. Gypsum is found near Foley and Topisi, uranium traces in the rest of Kanye and clay at Lobatse near Makoro.

Check your understanding of what we have just discussed by doing the following activity.



Activity 3

Using the map provided on the geological formation of Botswana (fig 3)

1. Where are most of the Basement rocks exposed at the surface?

2. What system of rock covers a greater part of the surface of Botswana.

3. Name the type of rocks this system is made up.

4. State in order of formation the 6 systems of rock types found in Botswana. (Start with the oldest)

i.

ii.

iii.

iv.

v.

vi.

Feedback

I am sure that you found this activity relatively easy to do because the information required was available on the map. Below are the answers you should have given.

- (1) The western part of the country.*
- (2) The Kalahari beds.*
- (3) Swamp deposits, salt deposits, sand and calcrete deposits.*
- (4) Basement rock, Transvaal system, waterberg system, Damara system, Karoo system and Kalahari beds.*

It can be said therefore that Botswana has generally about 3 main geological systems, namely the **Kalahari sand beds** that extend from the North to the South along the western margins

of the country. They occupy 70% of the country. They are said to extend from the Orange River in SA to the Congo Basin in the North; a distance of about 3000 km. The sands are said to be more than 100m deep in some places, such as in the Kalahari Basin in western Botswana. Few minerals have been discovered in these areas.

The other system of rocks is **the Karoo system** that is found below the shallow parts of the Kalahari sands. These rocks extend from the area around Francistown closely bordering the other formation of much older rocks found in the eastern part of the country. They may also be found in the extreme eastern parts of the country around the Tuli Block area. Minerals such as coal and gold may be found here.

The other system of rock comprises of **very old rocks** that have many faults and folds. They also contain many important minerals. In Botswana many of these rock out-crops which are of igneous origin can be as high as 400m thick. They contain minerals such as diamond from Kimberlite pipes of volcanic origin, gold, chromium and copper-nickel plus semi-precious stones such as agate, and amethyst.

Prospecting for other minerals such as Petroleum Oil and Gas is ongoing. Other minerals such as Chromium are also expected to show in promising quantity especially around the Molopo (Borolong Farms) area.

Finally you should remember the following.

- In Botswana, minerals are considered a national asset and cannot be extracted without official consent by Government.
- When a company or individual wishes to look for minerals in a country they are given an exploration and mining lease which normally elapses after a period of 5 (five) years.
- All citizens and other residents of Botswana have a right to land but they have surface rights only. Below the surface of all land areas in Botswana this right is held as a prerogative of Government.

2.2 Matching rock types with minerals known to occur in them

As has already been mentioned in our previous discussion

certain rocks are known to contain minerals of some kind. The map below (fig. 4) shows a general overview of broad geological areas of Botswana and the type of minerals they contain.

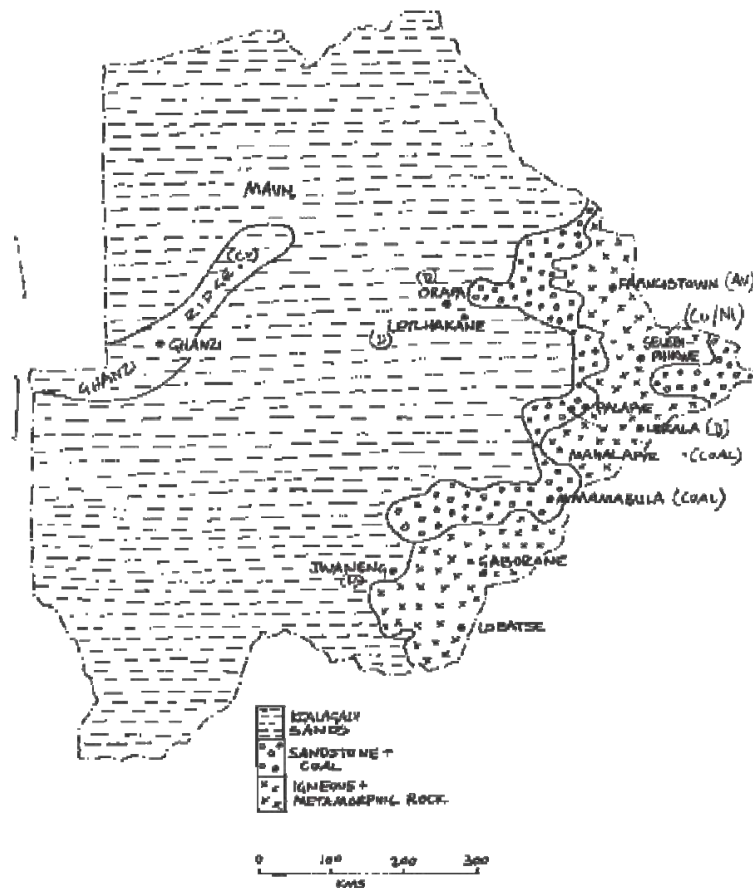


Figure 4: Broad geological areas of Botswana

Fig. 4 shows a broad geological mapping of rocks in Botswana and some minerals which may be found in the map shows us that much of the gold, copper, and diamonds are found in the basement rock intrusions and sedimentary rock in the eastern part of the country probably originating in the period between 200 million to 3 500 million years ago.

The coal is found in sedimentary rock formed around 260 million to 570 million years ago.

The minerals such as soda ash are found in most sedimentary rocks and these are formed recently around 570 million years to present era. These are in the delta marshes of Northern Botswana such as the Makgadikgadi Pans and Okavango Delta.

The area is called Protorezoic platform and is still under investigation. Minerals such as chromium, vanadium and iron are expected to be found in the future since most of these minerals have been discovered in a similar bedrock which extends into South Africa.

The area where we find the copper in Selibi-Phikwe forms part of a large basaltic rock outcrop known as the Zimbabwe craton.

The activity below will help you check whether you really know where and which minerals are found in Botswana. Ensure you do it before you read my feedback.



Activity 4

1. In which areas of Botswana do we find more mineral deposit (discoveries).

2. Which areas of the country have so far shown the least productivity in prospecting for minerals.

3. Other than metal and non metal minerals name one other mineral which was looked for but was not found in the South western part of the country.

3. Name the chief mineral that is being extracted in many parts of the country.

Feedback

I hope it is easy for you to answer these questions as the map shows them clearly. Otherwise compare your answers with mine below. If you did not do well, try to study the map (Figure 4) again.

1. *Eastern or South eastern to North eastern part.*
2. *South western to North western or western part of Botswana.*
3. *Oil and gas*
4. *Diamonds.*

It was mentioned earlier that much of the rock formations in Botswana extend into other countries around us, such as the Kaapval craton which extends into South Africa – we also have another notable example previously mentioned the; Damara belt or the Ghanzi ridge which we believe may be part of the rock which make up the Zambia copper belt. We will look closely at the *Zambian copper belt* later. For now take a look at the maps below and find where it is located.

Look at Figure 5(a) showing the Copper-Belt in Southern and Central Africa. Figure 5(b) is a more detailed map of the copper belt.



Figure 5a: Location of the Copper-belt

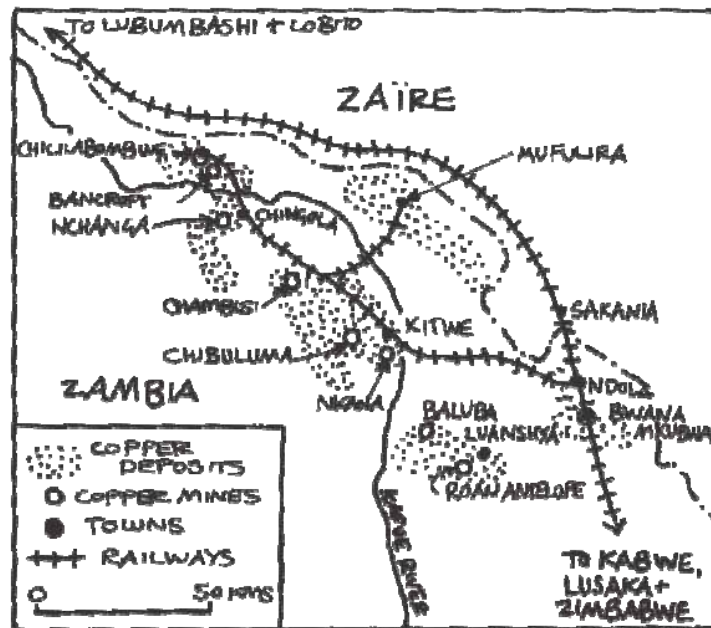


Figure 5b: The Copper-Belt

From these two maps, you would realise that the copper-belt stretches from Zambia into Zaïre.

3.0 Summary

In this topic you have learnt about rock types, and mineral types. You have also learnt that apart from agricultural products, almost everything we use in modern society is extracted from the earth. This includes all the metals and their alloys and thousands of other products made from chemical refinement which are often from natural resources such as crude oil.

Furthermore, you learnt that when mineral discoveries are made they are a result of a well planned approach using scientific equipment such as aerial photography, seismic mapping, and magnetic, electrical, and gravity mapping techniques.

The other thing to note is that much of the mineral discoveries are found on the eastern parts of Botswana where Basement rocks are exposed at the surface. In the western parts of the country there are very deep sands which make prospecting difficult. They have so far yielded nothing much except where we find basaltic intrusions of Kimberlite which contain diamonds such as at Jwaneng and Orapa.

That brings us to the end of Topic 1. We shall now move on to Topic 2 where we continue our discussion on extraction of minerals. Remember in section 1.3 above, you learnt about ways of extracting minerals. Now we need to discuss how people come to a conclusion that they have to extract minerals in a particular place.

But before you move on to Topic 2, do the exercise that follows. Remember to work on the exercise without referring to your study unit and then mark your work using the answers at the end of the unit. Make sure you revise any work that you are not sure about before you move on.

Topic 2: Factors Influencing Extraction of Mineral Resources

Introduction

In the previous topic you learnt about the rock types of Botswana. You also learnt where certain minerals occur in Botswana. In this topic you are going to find out about the various factors which a miner or mining company should consider before they can start mining operations.

Topic Objectives

At the end of the topic you should be able to:

- identify rock types and their stability in terms of whether they are fractured or folded since this can determine if a mineral discovery can be mined or not
- explain how the depth of a mineral ore can determine the method used for extracting the ore
- explain how the quantity and quality of the ore can influence mining and determine the length of mining in an area
- explain how the market contributes to mining at a profit
- describe how policy ultimately governs when, where and how much extraction activity may be undertaken in a country.

Topic Contents List

1.0 Starting a mining activity

1.1 The geology of the area where the mineral or mineral ore was discovered

1.2 Rock types and minerals, and the geological occurrence

1.3 The depth of the mineral

1.4 Quantity and quality of the ore

1.5 Markets

1.6 Government policy

2.0 Summary

1.0 Starting a Mining Activity

There are several factors to consider before starting mining activity of a newly discovered mineral or mineral ore. These factors include:

1.1 The geology of the area where the mineral or mineral ore was discovered

You are already aware that the term geology means types of rock found in an area. Rocks are the solid compounds or substances that we find making up our earth's crust. They are found everywhere on earth, in different types and concentrations.

For you to understand the geology of your area better, do the following activity. Remember you do not have to do it as you are studying. But create time to go around and do as required in the activity.



Activity 1

Think very carefully of your home area, more especially of the ground surfaces.

Try to remember the kinds of rocks that you normally see in your home area. Compare the rocks in your home area with any other place you have travelled to. If you have never travelled outside your home area, try to find another location on the map of Botswana (Fig 2) in Topic 1. This will help you to answer the following questions.

1. Name the common rock (groups) in your area.

2. Have you seen other rocks elsewhere which are either similar or different from the ones in your area?

3. What has this observation made you aware of regarding the distribution of rocks in your country.

Feedback

I cannot identify exactly the common rocks in your area because I do not know where you live. However the following feedback should help you to understand what was required in this activity.

1. *Common rocks in your area could be sandstones, clays, limestone Quartz, Granite and Basalt or more generalised descriptions such as dark very hard rocks, or white chalky like rock which are rather soft and some reddish brown stones. Other description may be accepted as many varieties of rock occur in this country but a more informed answer could briefly distinguish three major groups of rocks such as*
 - (a) *Igneous rocks*
 - (b) *Metamorphic rocks*
 - (c) *Sedimentary rocks*
2. *No, there seems to be much variety in the types of rock found in the country whereby a general impression by some of you will be that in the western part of the country we have few visible hard rock. Mostly we find sands or limestone and clays and in the eastern part of the country we have hills here and there which consist of very hard igneous rock.*

3. *The distribution of rock is not uniform, and their properties are also not uniform. This tends to affect their individual strengths, whereby some are very hard and resistant, whilst some are soft and yielding. On closer examination many of the Sedimentary rocks are folded and the Igneous rocks (Basement rocks) contain many fractures or faults.*

It is true, therefore, that rocks are different and so miners must always ensure they are well equipped and well prepared when they want to exploit a mineral discovery.

After studying the geology of the area, miners would then do a further detailed study of the rock types. Let us discuss that in detail.

1.2 Rock types and minerals, and geological occurrence

Look at the following chart carefully and notice that for some of the minerals mentioned below, the rocks are either of sedimentary origin and are faulted and folded or they may be of igneous origin and are faulted.

Table 1: Minerals and their geological occurrence

Mineral	Geological Occurrence
Petroleum and Natural Gas	<p>Found in Sedimentary rocks.</p> <p>Formed from remains of many insects and small creatures that lived in shallow lagoons millions of years ago.</p> <p>The sediments must have been gradually covered and converted into oil and natural gas.</p> <p>Oil will normally be found between two layers of</p>

	impervious rock.
Coal	<p>Found in Sedimentary rock .</p> <p>Formed from decayed vegetation matter in swampy areas, which was later covered by Sediments and transformed in, coal a million years ago.</p> <p>Occurs as folded seams of up to 8m thick.</p>
Copper/Nickel	<p>Found in folded marine sedimentary rocks which have been changed by great heat and pressure.</p> <p>The ores lie in the depression of the fold.</p>
Iron Ore	<p>Found in Basement rock of igneous origin and in sedimentary rock.</p> <p>Occurs in folded and faulted rock.</p>

Depending on the type of rock and the state of the rock it may require special consideration as to how to mine the ore since some areas of the world are subject to tectonic activity such as earthquakes. Therefore if the rocks are fractured, unsuitable or weak there is a risk of killing people (miners) when the earth collapses and even losing equipment, as happened in the Witwatersrand area of South Africa.

Sometimes the conditions are favourable or people find a way around them and start mining in many instances e.g. Witwatersrand Gold mines in S/A and Copper/Nickel in Botswana.

Example

Study Fig 7 below and look at the geological section shown. It may be difficult or easy to mine the geological sections.

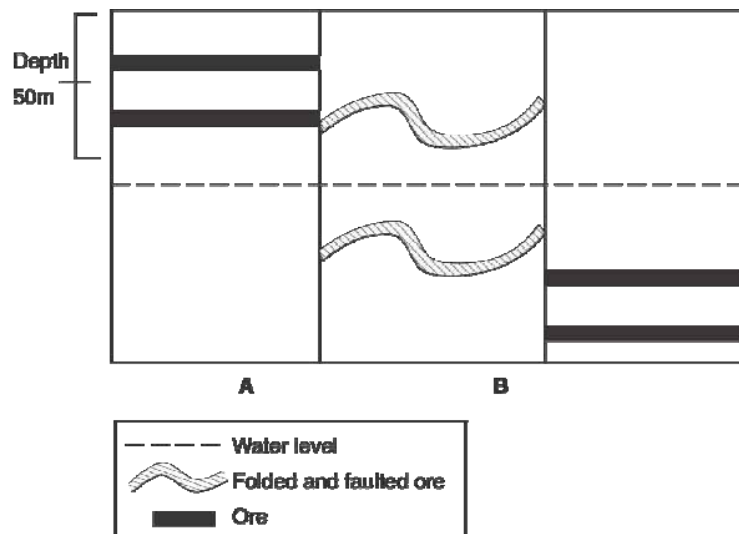


Figure 7: Geological section

You will realise that:

Section A: would be easiest to mine because the ore is close to the surface and above the water line. It is not faulted or folded. It occurs at about 50m or close to the surface, so open cast mining can be used.

Section B: might be difficult since it is folded and faulted and one section of the ore appears below the waterline. Since it is faulted/folded this may cause rock fall.

Section C: both sections of the ore appear below the waterlines. It will need pumping out the water and provision of ventilation which may be costly.

This shows that the geology of the area can determine whether it should be mined or not but that is just one consideration from several. Let us look at another consideration.

1.3 The depth of the mineral

In Botswana many of the minerals are found very close to the surface. This is very fortunate because mining companies do not have to spend a lot of money digging deep tunnels, putting in machinery and a lot of safety devices as they dig up the

minerals.

In Botswana minerals were not discovered earlier by the colonial prospectors and mining explorers. After independence, continued exploration unearthed diamonds deposits in the Foley Siding vicinity. These deposits were later found to originate in Orapa. Other discoveries followed at Letlhakane and Jwaneng. Copper was discovered in Phikwe and also in Selibe and the joint exploitation of these deposits resulted in the opening of the Selibe/Phikwe mine. Another major discovery was for Coal in the Serowe-Palapye subdistrict around Morupule and Mmamabula extending southwards towards Artesia. Fortunately most minerals mined in the country are located near to the surface.

Because these discovered minerals were near to the surface, they were not difficult to extract and were soon mined. The same can not be said for countries such as South Africa, Zambia and Lesotho where ores extend to great depths underground. In many instances the method adopted has been shaft mining. In South Africa some mines are over 2 kilometres deep. E.g. the Western Deep Level mines in the Witwatersrand area.

In a mine, especially the shaft mine, we have vertical shaft or tunnel dug into the surface and very deep down. When the miners get to the ore body they dig horizontal tunnels from the main shaft. The tunnels may occur at different levels along the main shaft and they are usually called stations. The first tunnel from the top of the shaft may be called Station 1. The stations will increase numerically as you go down the shaft. Inside the mine we have different personnel. There are people who drill for holes and use explosives to blow apart the ore body so that it can be removed easily. There are also those who operate the underground machinery such as the conveyor belts and haulage trucks and trains. Others manage the workers. These make the operation cost very high. You may find the set-up described above if you visit Selibi-Phikwe mine.

Except for the Selibe/Phikwe operations all our present mines are open cast. Open cast mining is done when minerals appear close to the surface at a depth not exceeding 50m. When minerals appear below this level shaft mining is employed.

As the depth of a mine increases it can sometimes cause the mine to be closed due to the following reasons:

- Excessive heat that requires big fans or air-conditioning

systems to pump in cold air deep down the mines and this is expensive.

- Unstable rocks which need shoring up with metals and wood or the waste from the mine. As you go deeper this becomes more difficult since underground pressures increases. This might encourage the collapse of underground tunnels, killing people and destroying expensive equipment.
- Water seepage in jointed rock. The water seeps underground and forms deep stagnant stinking pools which endanger the lives of miners and heavy pumps must be installed to pump out the water. This is an expensive undertaking.
- Weight and extraction time: as the mine gets deeper the cost of extracting the mineral ore also increases since bigger, heavy, winding, and conveyor equipment is necessary.

Looking at the above factors, you will find that sometimes a profitable mine will stop producing or may fail to start functioning if the mineral ores are too deep.

1.4 Quantity and quality of the ore

You have probably heard that Botswana Diamonds are expensive. Such a statement could be an indication that Botswana's diamonds are of high quality. It has also been suggested that Debeers cannot finish up the Botswana Diamonds even if they dig them up very quickly in large amounts. This statement will obviously relate to the larger quantity of Diamond reserves found in Botswana.

If you remember in Topic 1, we said these might last for the next 35 years, whereas the Selibe-Phikwe Copper/Nickel deposits may be depleted in less than 10 years from now. So due to the fact that our mines produce a lot of Gemstone diamonds which are used to make expensive jewellery, we can assume that the quality of the diamonds was an important factor in deciding to extract them since they fetch a lot of money when they are sold.

The other consideration may have been how long the diamonds would last. In our case these diamonds may last for many years to come. This would then make it less costly to set up the

mining infrastructure since over the years of mining such costs would be effectively recovered with a profit.

The same can not be said of other mineral deposits found in Botswana, such as the Gold deposits in Francistown, Ngami and Ghanzi districts. The reasons are that the deposits are small and the minerals are found deep underground. The other problem mostly experienced by the Selibe-Phikwe mine is the quality of the product that has less than 2% of the mineral content. What this means is that a lot of work is done to produce a lot of waste and very little mineral recovery at great expense. It is for this reason and, probably the great depth at which the mineral appears in Selibi-Phikwe mine that we expect the mine to close down soon.

The quality and quantity of the mineral ore is critical. It can even determine the future of a mining town. To help you figure out the importance of the quantity and quantity of the mineral ore, do the following activity.



Activity 2

1. For how many years are Botswana's Diamonds expected to last?

2. How soon can the Selibi-Phikwe mine be expected to close?

3. Give **two** reasons that may lead to the closure of the Selibi-Phikwe mine.

4. Why are the gold deposits in Ngami and Ghanzi not being exploited fully?

5. Name the type of Diamonds mined in Botswana.

Feedback

I hope you managed to answer the questions correctly. Check your answers against mine below.

1. 35 years
2. 10 years
3. (a) due to their small concentrations.
(b) poor quality of the ore.
(c) the depth at which the ores occur.

[Any two reasons from these accepted]

4. (a) Due to the fact that they are deep underground.
(b) They appear in small concentrations (quantity).
(c) They are of poor quality.

[Any one reason from these is acceptable]

5. Gemstone diamonds.

1.5 Markets

Markets, like other factors mentioned before are very important. You see that without a consumer for our product they would be useless to us. This is quite important link since the worth of a product is determined by its demand. So market and market forces can sustain the value of a commodity or cripple it forever. It is important therefore, that we must decide whether there is an outlet for our products and how profitable they are before we rush to spend much money extracting them.

In Botswana the greatest bulk of our marketable commodities are minerals especially diamonds. Marketing of diamonds is done by a centralised organisation managed by Debeers called the Central Selling Organisation (CSO). The CSO has controlling interests in many countries of the world and has helped in regulating the sale and price of diamonds on the world market for many countries.

Without such organised structures for marketing our diamonds, we would probably accumulate them and still find it very difficult to sell them for a profit. A country that we may like to give as an example of the changes that occur when minerals lose value is Zambia. It once had a thriving and vibrant mineral based economy during the years 1920 to 1980s. Unfortunately now, their mineral is no longer in high demand and the economy has deteriorated over the years. The same could happen to Botswana in future if we do not diversify our economy in the next few years.

The activity below will help you to reflect on the importance of markets in the mining industry.



Activity 3

1. Name a place where goods are sold.

2. What is the importance of markets to a country?

3. Which organisation sells our diamonds?

4. Mention one country that once depended heavily on a mineral commodity that has since

lost its market value.

Feedback

1. *Market (marketer).*
2. *Act as an outlet for goods, they help sustain the value of goods and they can also reduce the value of goods.*
3. *Central Selling Organisation (CSO).*
4. *Zambia.*

I hope this activity was easy to do and has helped you visualise the importance of markets in mining. Now let us continue with our discussion of factors influencing mining.

After reading all that we have discussed so far, what do you think is the role of government in mining of minerals? Try to imagine how Botswana could be like if government did not have a role to play the mining industry. With your answer and thought in mind, let us discuss how government policy affects mineral extraction.

1.6 Government policy

In Botswana you do not just start extracting minerals or looking for them. You must follow certain organised structures. These would force the miner or explorer to seek out a concession from the government. Once they have a concession they are then awarded a lease that allows them to start working on the designated concession area.

When mineral discoveries are made, the company enters into agreements with government. This is because in Botswana, as we said in Topic 1, nobody owns land; they only hold it on behalf of government. People have surface rights only whilst below the ground all land belongs to government. It is therefore important that when a mine starts to operate the displaced people who had surface rights on the mine area should benefit from their loss. And so some money called royalties can be paid to these people as compensation to their district administration department, particularly the Land Board. Depending on the value of the mineral and or its strategic

importance to the economy of a country, including the perceived cost that it would bring to the political stability of the country, a discovery may be mined or left as it is. The following factors are most critical in deciding whether or not to mine a newly discovered ore deposit. These are:

- (a) The quality and quantity of the ore.
- (b) The geological structures of the rock.
- (c) The market for the mineral and whether there are too many market fluctuations, if markets are available.

Then the miners will have to acquire capital or money to pay machinery and other things needed to start the mine operation. This can be very costly and a hasty decision is not advised to start mining. With available money, the next step would be to acquire labour, power, water, and provide the necessary transport and communications plus service infrastructure. Full-scale mining may then start in earnest.

That brings us to the end of the second topic of this unit. Let us recap what we have learnt.

2.0 Summary

In this topic you have learnt about the importance of studying geology or structure of rocks in which minerals are found before starting to mine mineral ore. This is to avoid weak rock structures that may collapse because of heavy faulting and folding occurring in them. You have also learnt that the depth at which a mineral occurs will ultimately determine the method that may be used to extract it. For deep ores, shaft mining is used and for shallow ores open pit mining is used. You have learnt that the quality and quantity of mineral can affect the decision to mine it, or not. When they are both good, it may eventually be mined. The other thing was that the availability of markets would also prompt people to extract their minerals but when markets are not good or available they may not mine them. Other factors that must be considered before mining are the following:

- availability of labour to work at the mine
- power to operate mine equipment
- transport and communication networks to move the

minerals from the mine to the markets

- water to cool the machinery
- money to buy machinery, pay for labour services and many more.

We have come to the end of Topic 2. You can now work on Exercise 2 under the assignment section. Remember to mark your work using the answers at the end of the unit. Also revise any sections of the topic that you did not do well on.

So far, we have introduced you to mining and have discussed in general terms factors to consider before a mine is set up. Now, we are going to look at specific cases of mining. In Topic 3, we will use a case study of a mining in Botswana while Topic 4 will take us to a neighbouring country (Zambia).

Topic 3: Diamond and Copper-Nickel Mining in Botswana

Introduction

In this topic an outline of what goes on in mining operations such as the one in Orapa where diamonds are extracted from the ground will be presented. You will be introduced to the various stages of the operation from clearing the area, setting up infrastructure, digging, recovery, and processing of the mineral. The uses of the mineral and its importance to the economy will also be discussed. Note that Orapa mine is used here but any diamond mining process in Botswana would follow the same processes and procedures.

Lastly, the impact of mining on the environment will be discussed using Selibi-Phikwe copper-nickel mine as a case study.

Topic Objectives

After the completion of this topic, you should be able to:

- describe how mining and recovery of diamonds is done
- describe how the ore is processed to get the diamonds
- state the uses of the mineral (diamonds)
- state the importance of diamonds to the economy of Botswana
- evaluate the impact of mining on the environment - a Case Study of Copper-nickel in Selebi Phikwe.

Topic Contents List

- 1.0 Mining for diamonds in Orapa**
- 2.0 Preparation of the mining area**
- 3.0 The impact of copper-nickel mining on the environment in Selebi-Phikwe (A Case Study)**
 - 3.1 Negative Impact
 - 3.2 Positive Impact
- 4.0 Summary**

1.0 Mining for Diamonds in Orapa

Mining of the diamonds started in 1971 at a remote area in the Central District called Orapa. Before this period in time, as already mentioned in Topic 2, Botswana was not thought to have any useful mineral heritage. This was a result of the fact that no useful mineral deposits had been discovered before 1967.

It would be important to note that other than Orapa we have other diamond mines in Botswana; these are the Letlhakane mines that started operation in 1975, the Jwaneng mine that was discovered in 1975 and started its operations in 1982.

Mining is an expensive undertaking as has already been outlined in Topic 2. You need to conduct exhaustive researches to determine whether you can actually risk starting operations on a newly discovered ore deposit.

The mining company currently working in Orapa and mentioned in our previous topics is Debswana or Debeers Botswana Mining Company. It originates from South Africa and was founded in the late 1880's when the Diamond and Gold rush were taking place in South Africa. This company has since expanded its workings to cover many countries of the world.

The total amount of money spent in setting up the three mines mentioned above amounted to about 367 million Pula, where by 55 million was used for Orapa, 29 million for Letlhakane and 283 million for Jwaneng. And so money is a serious issue when we talk about setting up mine infrastructure.

Debeers Botswana is a joint venture between Debeers Consolidated and the Government of Botswana, with each partner getting half of the profit made after selling the diamonds.

The following activity will help you reflect on what we have just discussed.



Activity 1

1. In which year were Diamonds discovered in Orapa, and when did the mine begin operation?

2. How much money was spent to develop the existing Diamond mines of Botswana?

3. Which company is engaged in the mining of diamonds in Botswana?

4. How are the profits made shared by this company and the government?

Now check how well you performed in the activity from the feedback given below.

Feedback

1. *Discovered in 1967 and began operation in 1971.*
2. *365 million pula (365 000 000).*
3. *Debswana.*
4. *On a 50/50 basis.*

I hope you got the answers right as they are in the section we just discussed. If not go back and read the section.

Remember the last section gave a broader picture about diamond mining in Botswana. Now, let us discuss what obtains in Orapa mine in detail.

(a) The Mine: An historical background

In 1961 a diamond pipe was discovered in Orapa and known as AK 1 after a long period of prospecting for diamonds from 1955 to 1965.

Before 1971 – Orapa was just like any remote rural area in Botswana. There were no roads connecting it to Francistown or Serowe. Most of the development infrastructure was set –up as part of the mine in 1971. The Orapa diamond pipe is 110.6 to 117 hectares in surface area. This makes it one of the largest in the world. Orapa has a population of about 6000 people and is located about 200 km to the west of Francistown. The mine used to get much of its water from Mopipi pan, but due to the recurrent droughts in Botswana, the mine now gets most of its water from bore holes.

2.0 Preparation of the Mining Area

In the mine area huge tracts of vegetation are removed to make way for the mine surface infrastructure. Then a lot of soil or overburden is removed to get to the mineral ore. Once the ore is exposed the rock is broken up by a combination of methods such as drilling and blasting using explosive devices.

(a) Geological occurrence

The Diamonds are found in a type of rock called Kimberlite. Kimberlite (rock) is a name derived from the Diamond bearing rocks of the Kimberly mine in South Africa. It is a soft bluish green igneous type of rock. It is important to note that not all Kimberlite pipes contain Diamond deposits. Those that do are called Diamondiferous Kimberlite ores and those that do not are called non- Diamondiferous Kimberlite,

(b) Mining method

At Orapa, mining is currently done using the open-pit or open cast method. This is because in Botswana our ore body is very close to the surface. Open pit is a method of extracting mineral where you simply dig up a large hole on the ground. The hole will normally not go deeper than 50m. On the edges of the hole there are a series of step-like cutting that allows vehicles to go down and collect the ore from the bottom of the hole. The vehicles go round the hole following the terraces cut into the

side of the mine.

Fig 9 shows the open pit mine in Orapa. You must study this figure carefully. Can you see the terraces cut into the side of the mine?

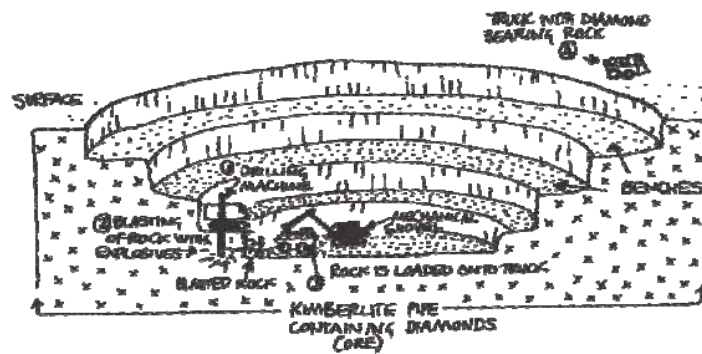


Figure 9: Orapa open pit mine

(e) Recovery stage of the mineral

Once blasting and primary crushing have broken down the mineral ore, it has to be recovered from the mine using gigantic mechanical shovels. These machines, which are composed of front-end loaders and caterpillar earthmovers or huge trucks plus a system of conveyor belts, then take the material to the surface. Once they get there, further processing is done to the ore to get the minerals from the ore.

In order to help you keep focused on your study, work on the following activity. It will assist you in checking whether you understand our discussions about Orapa mine.



Activity 2

1. Explain briefly the status of Orapa before Diamonds were discovered in that area.

2. When did development infrastructure such as roads, telecommunications and other services first appear in Orapa.

3. How large is the Kimberlite ore pipe found in Orapa.

4. In which directions is Orapa relative to Francistown.

5. Explain briefly what an EIA is.

6. Name the type of rock, which produces diamond-bearing ore.

7. State the method used to recover diamond at Orapa.

8. How deep do these mines usually go?

9. How is the ore taken to the surface?

Feedback

*The answers are clearly found in the previous section.
Check your answers against mine below.*

1. *Orapa was like any remote rural area in Botswana.*

There were no service infrastructure of any sort.

2. 1971
3. 110.6 to 117 Hactres.
4. West of Francistown
5. An EIA in a study undertaken to find out how harmful an Activity may end up being to the areas where it is to be set-up.
6. Kimberlite or Diamondiferous Kimberlite rocks.
7. Open pit /open cast or by drilling and blasting.
8. About 50m
9. By using front-end loaders, caterpillar earth moving equipment and conveyor belts.

Look at the diagram below (Fig 10). It shows the various stages involved in processing diamond ore.

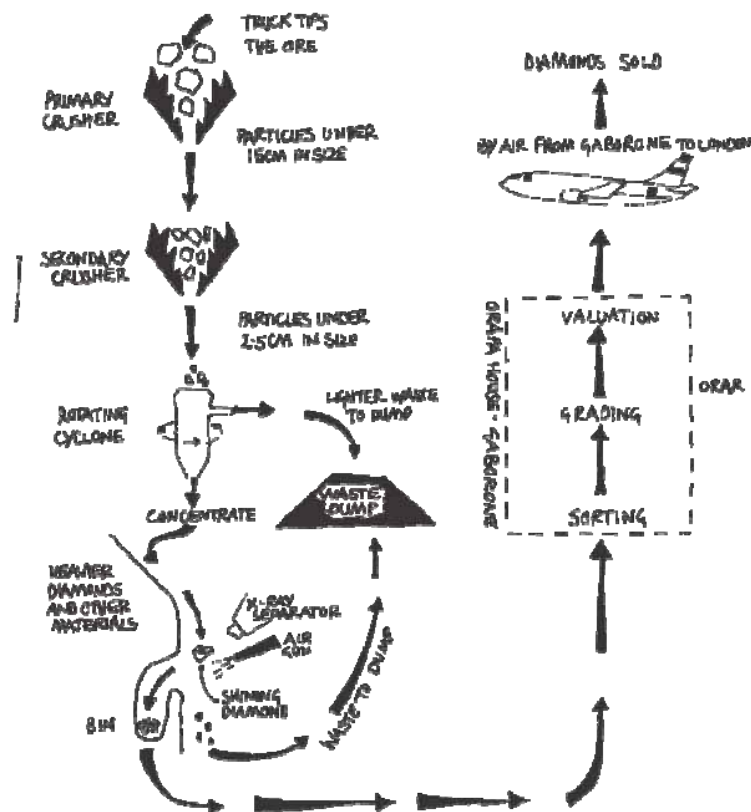


Figure 10: Processing of diamonds

Note that this diagram shows you a holistic picture of diamond processing. So far we have touched on blasting and primary crushing of the ore. We will continue with the other stages of the process. As we discuss each stage, keep referring to this figure.

(d) Crushing stage

The broken up rocks now called boulders and gravels have to be crushed further so they can be handled easily. **The first stage** is at the primary crusher that reduces the particles to about (150 mm) or 15 cm in size. They are then taken to the **next stage** where they are reground to produce pieces of about 2.5 cm (25mm) in size. Any other pieces of rock found to be more than 25mm is returned to the **secondary crusher** for further reduction.

(e) Concentration and separation stage

When all the ore is satisfactory at about 25mm size, it is placed into a concentration (sludge mixture) by adding a chemical called ferro-silicon and water. The sludge is then put in a **rotating drum called a cyclone**, the ferro silicon will stick to the diamonds. This tends to increase their weight causing them to sink down to the bottom of the cyclones where they can be recovered.

The remaining material that will be regarded as waste is taken to the waste dump. The recovered diamonds will be put to another processing stage where they are passed through an x-ray machine. When they pass through the x-ray, the stones that are diamonds produce a light that activates a system that causes the stones thus identified to be blown into a separate bin. Waste particles are carefully scrutinised by hand to search for any diamonds missed by the x-ray machine. This is the last stage in finding the diamonds called Hand Sorting. The recovered diamonds are then weighed and sent to Gaborone.

(f) Transportation of diamonds

The Diamonds are sent to Gaborone using special air transport.

This aeroplane does not carry passengers except those on mine employment and it travels under heavy security.

Once the Diamonds are delivered at the Botswana Diamond Valuing Company House in Gaborone they go through the following processes.

- **Sorting:** this time the sorting does not eliminate diamond from waste, since this has already been done, but separates the diamonds into two distinct groups. Namely the gemstone diamonds you have already read about and the industrial diamonds
- **Grading:** The diamonds will then undergo further sorting according to sizes, shapes, colour, and purity.
- **Valuation:** The diamonds are then weighed to establish their Carat value and are inspected by the Government chief evaluator before being passed on to the Central Selling Organisation for sale. The CSO then takes them to Zurich (Switzerland) where they are sold to dealers from different countries such as Belgium, United State, Israel, Holland and India.

Up to this point, we have discussed extraction of diamond ore and processing it to get diamonds. In the past, that would be the end of what happens to Botswana diamonds within Botswana. Nowadays, a lot more is done to add value to the diamonds as discussed in the next section.

(g) Local diamond companies (cutting and polishing gemstones)

So far very little value addition was made to our diamonds before they were sold to the CSO. It is only recently that two Companies one in Serowe called Teemane Manufacturing and one in Molepolole have undertaken the task. They **cut and polish** the Diamonds before they can be sold. Better still, yet another company called Diamond Trading Company Botswana is set up to actually oversee the cutting and polishing as well as trading of diamonds.

(h) Uses of diamonds

A mineral such as diamond, which has such a high economic value, can provide those who have it with valuable resources in the form of foreign exchange, and government revenue from exploration and mining leases. The money once acquired can

be channelled into many areas of economic development for the country that produces the diamonds.

We have already mentioned that there are two types of Diamonds that are found in the Letlhakane, Orapa and Jwaneng mines. These are:

- Gemstone Diamonds
- Industrial Diamonds.

The value or quality of diamonds is determined by several factors such as:

- (a) The weight or carat of the stone.
- (b) The colour.
- (c) Size
- (d) Purity (Flawlessness).

Those which have less impurities or flaws, are large in size, show more colour, normally get graded as high quality diamonds or gemstones and the other diamonds which are dull, have irregular shapes, and more impurities will be classified as industrial diamonds.

The essential difference between gemstone diamonds and industrial diamonds is found in what they end up being used for.

Gemstones since they are of higher quality and are more value than industrial diamonds are used in the manufacture of jewellery such in necklaces, tiaras, earrings and bracelets.

Industrial diamonds are of lesser quality and are less valuable than gem diamonds and are used to make cutting and grinding tools. The secret lies in the resilience of diamond. Diamond is the hardest material known.

(i) The importance of diamonds to the economy of Botswana

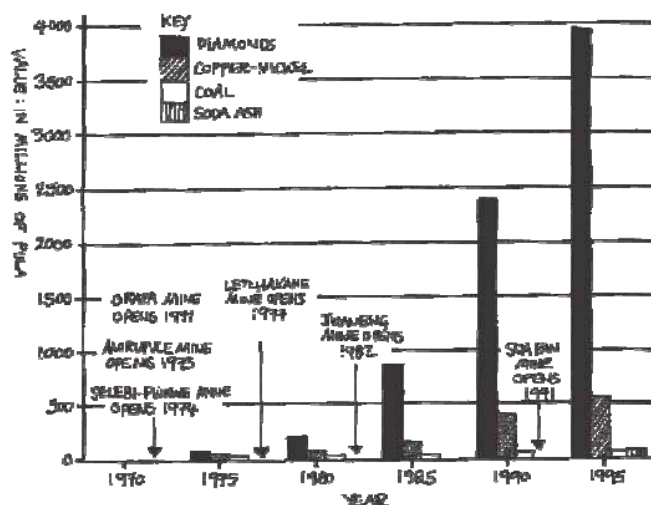
It was only after the discovery of the Orapa, Letlhakane and Jwaneng mines and their operation that Botswana started to be a country with an up-coming economic infrastructure.

Activities at the Botswana Diamond Valuing Company House (Orapa House) have helped to increase employment creation in Botswana. They have helped to develop skills and training in certain aspects of industry previously not well known in Botswana. They have led to an improvement in the social

standard of some Batswana who are employed by the companies and also they help to feed our markets with locally manufactured goods.

Look at Table 1 which shows us production figures for Orapa and other mines and the total estimated value of the diamonds.

Table 1: Production and Total estimated Value of Minerals Mined in Botswana (1970- 1995)



Do you realise that over the years our production of diamonds is steadily increasing? This is due to the fact that other than mining we have few economic activities that can generate a lot of money.

Mining and diamond mining accounts for 74% of the total export revenues, though it employs only about 3.5% of the workforce in Botswana. The largest user of the workforce is agriculture with roughly 75%. The total export revenue from this sector makes up a mere 4% or below of the total export revenue.

Mining provides the government with about 50% of its revenue, therefore much of the money we have that we use to develop infrastructure such as roads, schools, clinics and even other economic sectors such as Agriculture, comes from mining. Without minerals Botswana might probably still be in the same situation as in 1965 (before independence).

At that time Botswana only had 8 km of tarred road, now it has

over 2500 km of tarred road with almost all the main villages in the country connected. There was no electricity and good drinking water in many villages like we have today and the source where available was from diesel operated thermal power stations which were mainly put up to assist such critical service dispensing organisation as the Government Hospitals and Administration offices.

Now many settlements have electricity and piped water being reticulated to individual homes. And these and many other services such as telephone communications, Agricultural subsidies and many more are all recent developments because of our ever -increasing exploitation of our mineral potential.

Minerals have provided so much of infrastructural developments that we need to be alert to potential disaster. What do you think this could be? If you said over reliance on a single economic commodity then you were right. Over-reliance on a single economic commodity can be dangerous because when that commodity is finished then a country has nothing more to sustain the living conditions of its people. Problems such as poverty pressure on existing resources, lack of schools, shortage of medicine and medical facilities, over crowding and many others that are related to overpopulation soon occur.

Therefore we need to diversify our economy by promoting other sectors like manufacturing and processing industries, textiles, agriculture and human resources such as accountants, personnel managers, technicians and engineers, medical personnel and teachers. As a developing country we still lack many important skills and we depend a lot on other countries to resource us. I believe you have heard such terms as expatriate workers and contract workers, these are people hired to alleviate the problem of shortage of skilled labour in this country.

The government has embarked on an aggressive policy of addressing problems relating to shortage of many of the skills and professions mentioned above. To this end Government has had to increase even more the mining of diamonds. Orapa 2000 and its sister project in Jwaneng have been launched aimed at expanding or doubling the present extraction process for Diamonds in the country. In doing this, admittedly we are also quickening the potential expiry of these valuable resources that we depend so much on. And the question that should

concern you as a Motswana is what will happen when the Diamonds are exhausted, whilst we are still trying to develop many areas of our economy that are not yet fully developed. In the same vein I wish to show you how important it is to have a multi-sectoral economy which is complimentary, whereby one sector of the economy does not entirely rely on others but each sector can work independently towards the promotion of others.

We have had a lot to discuss about diamond mining so far. To help you recall our discussions, work on the following activity.

Activity 3

1. Looking at fig 10, how many stages of processing does the diamond ore pass through before it goes to the CSO.

2. Explain briefly why you think it is important to break up the ore to sizes of about 150 mm – 25mm.

3. Why is ferro-silicon added to the concentrate solution at recovery stage.

4. What does the CSO do?

5. Name any **two** countries that end up as the major consumers of our diamonds.

6. Name **two** types of diamonds mentioned in this topic.

7. Which of the **two** types you have mentioned in

question 6 is more valuable?

8. Give reasons for your answer in question 7.

Feed back

You would easily obtain answers from our previous discussions. Check your answers against mine below.

1. *10 stages*
2. *To bring the rocks to a size, which is easily manageable, so that diamond can be extracted easily.*
3. *So that it sticks to the Diamonds making it easy to separate them from other rocks which are not Diamonds.*
4. *It sells the Diamonds on behalf of producer countries such as Botswana.*
5. *United States of America, India, Belgium, Israel and Holland.*
6. (a) *Gemstone Diamonds*
(b) *Industrial Diamonds*
7. *Gemstone diamonds*
8. *Gemstones are of a higher quality and because of a higher demand on world market command a high-value.*

This topic is about mining in Botswana. The last section focused on diamond mining and it gave all the process involved in mining diamonds. It also gave the importance of minerals in the economy of Botswana particularly diamonds. Like we said earlier, mining like any other industry has its own impact on the environment. That is why there has to be an EIA prior to setting up of any mine.

Now we are going to discuss the impact of mining in the environment. For our discussion, we shall use the Selebi-Phikwe copper mine as a case study. Note that some of the impacts of the copper mine would apply to other mines.

3.0 The Impact of Copper-Nickel Mining on the Environment- Selebi-Phikwe (A Case Study)

Copper-Nickel is mined in Selebi-Phikwe and the method of mining is the shaft. In Selebi-Phikwe the landscape began to change as soon as prospecting for the minerals started.

Prospecting trenches were dug, footpaths and roads constructed and later trees were cut on a large scale to give way to the shaft mine and buildings as well as other mining structure.

We can describe the impact of mining in Selebi-Phikwe on the environment in the following manner.

(a) Negative impact and

(b) Positive impact.

Let us consider the negative impact first and then the positive impact.

3.1 Negative impact

The negative impact involves the following:

(a) The initial stages in the processing of copper-nickel have led to the dumping of granulated slag at the mining area thus creating mounds of waste and causing some form of pollution on the landscape.

(b) Open holes (shafts) have made the land surface irregular and have transformed the landscape of the area.

(c) In some areas there appear scars of bare earth without vegetation. The natural vegetation was initially cleared using large machinery such as front end loaders, and caterpillars to prepare the identified areas for the mining of copper-nickel and building for the mine workers.

(d) The vegetation around some of the areas has been affected by air pollution (sulphur dioxide) released from the mine chimney. The vegetation has therefore experienced poor growth. Sulphur dioxide from the mine mixes with water vapour in the atmosphere to form sulphur acid and so on a small scale acid rain is produced during the wet season and it damages plants.

- (e) Atmospheric pollution associated with sulphur dioxide released through a chimney stack causes respiratory and eye irritation among the people of Selebi-Phikwe. The Bamangwato Concession Ltd (BCL) has curbed the problem by spending over 10 million Pula on the construction of very tall chimney stack (153metres) to discharge the gas at a higher level.
- (f) Sometimes clothes on washing lines are speckled with soot expelled through the chimneys.

3.2 Positive impact

- (a) The mining of copper-nickel has led to the establishment and development of Selebi-Phikwe. Several buildings appear in the mine areas and in the residential areas.
- (b) The initial development of the mining site led to the development of the infrastructure such as net work of roads, and railways (to transport semi processed copper-nickel to overseas centres for final processing and also to the market). Other infrastructure includes power transmission lines and water storage towers. The railway was constructed initially to convey coal from Morupule to the mine as raw material for the then thermal power station.

That brings us to the end of Topic 3. But before we move to the exercise, what can we say you have learnt?

4.0 Summary

In this topic you have learnt that mining is a very expensive activity. Another thing you have learnt is that once the ore is recovered from the ground it goes through several stages of processing. Recovered Diamonds are separated into either Gemstone or Industrial diamonds before they are sold to the CSO. You have also learnt that over-reliance on one economic commodity can be dangerous since when that commodity is finished people will have nothing to depend on.

We also discussed the importance of the environmental impact assessment study since without it we can never know the potential hazards of mining to the area where it is being done, at the time of starting of operations and for the future. Finally we discussed the impact of mining on the environment and used the Selibe-Phikwe mine as a case study. We outlined both negative and positive impact of copper mining on the

environment.

Now that you finished reading through this topic you should be able to do Exercise 3 under the assignment section. Remember that even if you do not get all the answers right, there is a feedback provided at the end of the unit to help you. Do not look at the feedback until you have completed the exercise.

Topic 4: Copper Mining in Zambia

Introduction

The previous three topics have mainly focused on mining in Botswana. We will now use one example of mining in a different country. In this topic you will learn about the mining of copper in Zambia. You will be given a brief overview of the geological occurrence of copper. From there you will be taken step by step through the mining or extraction stage to the processing stage and finally the uses and importance of copper especially to Zambia.

Topic Objectives

After completing this topic you should be able to:

- state where copper mining is carried out in Zambia
- describe the extraction and processing stages of copper ore
- explain the various uses of copper and its importance to Zambia
- describe the effects of mining on the environment.

Topic Contents List

1.0 Copper mining in Zambia (The Zambia Copper-Belt)

1.1 Shaft mining method

1.2 The processing of copper

1.3 Uses of copper

1.4 The problems of a mineral-led economy

1.5 Importance of copper mining to Zambia

2.0 Effects of mining on the landscape

3.0 Summary

1.0 Copper Mining in Zambia (The Zambia Copper-Belt)

You may wish to know what type of mineral copper is. Copper is a reddish-brown metal. It is used widely in electrical appliances because it is a good conductor of heat. It is used to make telephone wires as well.

As a mineral ore, copper is found in folded sedimentary rocks. The amount of copper concentration in the rock ore differs from place to place. In the case of the Botswana copper (Selibe-Phikwe mine) the concentration is between 1 to 3% whilst in Zambia it is as high as between 3 to 5%.

In Zambia the copper lode is found on the border areas between Zambia and Democratic Republic of Congo (DRC). The Zambia copper deposits are found in a 50-km wide belt, which extends from the Ndola – Luanshya area north-westwards to Bancroft. These deposits continue into the DRC through Lubumbashi, Likasi and almost to Le marinel. As was observed in Topic 1, it is possible that the rock type that contains the Zambia copper may well extend into Botswana through the Ghanzi ridge. These rocks are believed to have been laid down up to 600 million years ago.

In the Katanga (Shaba Province) area of southern DRC due to the nearness of the copper ore to the surface, mining is by open cast method. This is similar to the method referred to in Topic 3 when we discussed Diamond mining in Orapa (Botswana). For most of Zambia though, the ore is mined using the shaft method since it appears deeper underground.

Like in many other countries of the world, foreign companies operate the Zambian mines. However, the Zambia government has a controlling share in the mine. A company known as the Zambia Consolidated Copper runs the mine as BCL does in Botswana.

The section above is loaded with information you need to remember. To help you recall what we have discussed, do the following activity.

Activity 1

1. Describe the appearance of copper.
-

2. Name some of the uses of copper.

3. State the methods used to mine copper in Zambia.

4. Where in Zambia is the copper ore found?

5. Which company administers copper mining in Zambia?

Feedback

Check your answers against mine below. If you missed any of the answers, go back and read Section 1.0 above.

1. *It can be described as a reddish brown metal.*
2. *Making electrical wires, paints, making electrical appliances.*
3. *Open cast and Shaft mining.*
4. *Between the border area of Zambia and the DRC. In Zambia it extends for a 50 km wide belt from Nodola-Luanshya area in the Northwest through to Lubumbashi.*
5. *The Zambia Consolidated Copper*

As has already been mentioned, copper can be used in many applications ways.

- (a) It is mainly used in electrical equipment since it is a very good conductor of electricity.
- (b) It is used in the manufacture of paints.
- (c) It is used for making chemicals such as sulphuric acid.

- (d) It is also used in making some currency and building materials i.e. (coins and pipes).
- (e) It can also be mixed with other metals to make other very resistant metals called alloys like bronze.
- (f) In some cases it is used in the military for the manufacture of copper-jacketed bullets.
- (g) It is used in telegraph/telephone wire connectors.

The largest of all of Zambia copper mines is called Mufulira. Other mining centres are found at Luanshya, Baluba, Bwana-Mkubwa, Ndola, Nkana, Kitwe, Chibuluma, Chimbisi, Chingola, Nchanga, Bancroft and Chililabombwe. Refer to Figure 5 included in Topic 1 of this unit.

It is important to note that Zambia like other countries has other trade commodities other than just minerals, especially copper. Some of her main export commodities include tobacco, maize, zinc and cobalt. In recent years with the slump in copper prices the Zambian economy has diversified into other sectors like the manufacturing and processing industry plus the service sector.

Section 1.0 above gave you an introduction to copper mining in Zambia. The following subsection is a discussion of everything that happens during the process of mining copper and even giving the uses of copper. We shall start our discussions with how copper is mined.

1.1 Shaft mining method

As opposed to the open cast mining method where the overburden is removed then drilling and blasting for the mineral starts, shaft mining requires more, as we indicated earlier in this unit. First you drill deep vertical tunnels into the ground until you reach the mineral ore deep underground. Assuming your mineral is not in a straight layer, but in a syncline or curved layer, you will also need to drill horizontal tunnels to get to the layer of ore.

Look at figure 12, showing a section through the earth's crust and how copper ore appears amongst other rocks plus a section through a shaft mine

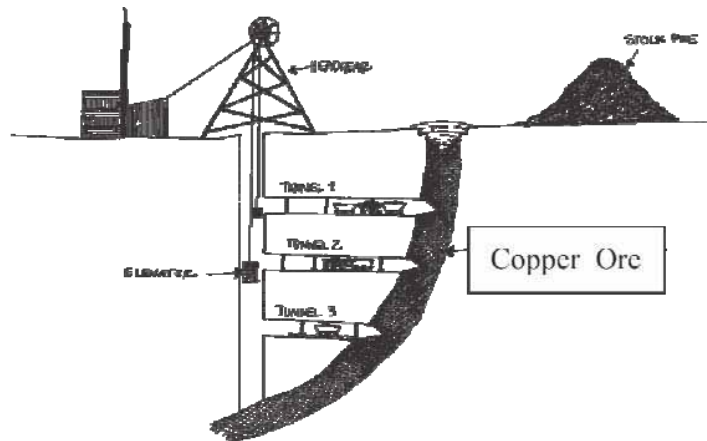


Figure 12: Geological occurrence of copper ore and the shaft mining

Shaft mining requires more capital or money to operate. There are the Derricks or Head Frame Gear to set-up. This contraption is used to haul both the ore and the workers. Due to the depth sometimes involved, such assistance as underground ventilation, pumping of water, strengthening the tunnel walls against underground stress, particularly in faulted areas of the mine, can be very demanding.

When mining is in progress, much of what goes on in extracting the copper ore involves drilling the rock and blasting it with explosives. The loosened ore is put into skips or small railway carriages or carried by conveyor belt to a transport centre where the ore is lifted out to the surface. To reduce its bulk the ore may undergo primary crushing underground

We have mentioned that open cast mining is different from shaft mining in some ways. Do the following activity to help you remember these differences clearly.



Activity 2

1. Explain briefly the difference between an open cast mine and a shaft mine.

2. Name **two** considerations that a shaft mine has to contend with which an open cast mine may not be bothered with very much.

Feedback

Well, I hope you have answers similar to the ones below. If not, it means you have not understood the difference between the two mining systems. Thus you should revise the relevant sections before you move on.

1. *In open cast you simply remove the overburden soil and drill then blast the ore. With shaft mining you do that and you may also be forced to drill deep holes/shafts into the ground.*
2. *This may also include expensive retrieval infrastructure to recover the ore, like putting up Derricks and underground railways.*

Once the copper has been mined, then the ore is processed. Let us see how.

1.2 The processing of copper

In Zambia copper smelting is done mostly using electricity. Electricity is particularly needed when you deal with smelting copper oxide as compared to copper sulphide. Zambia gets most of this electricity from the Kafue Kariba and Kafue Hydro electric water schemes. Some electricity comes from thermal power stations.

We will now outline what happens to the copper ore when it reaches the surface. It undergoes three main stages. These are the crushing stage, the concentration stage and then finally the smelting stage. You may look at the stages in Figure 13.

Figure 13 shows the processing stages in copper nickel mine in Botswana. The Stages are similar to those that the copper ore in Zambia has to go through before it reaches Stage 8 when it

goes for further refinery using electricity or electrolysis. The stages are explained below figure 3.

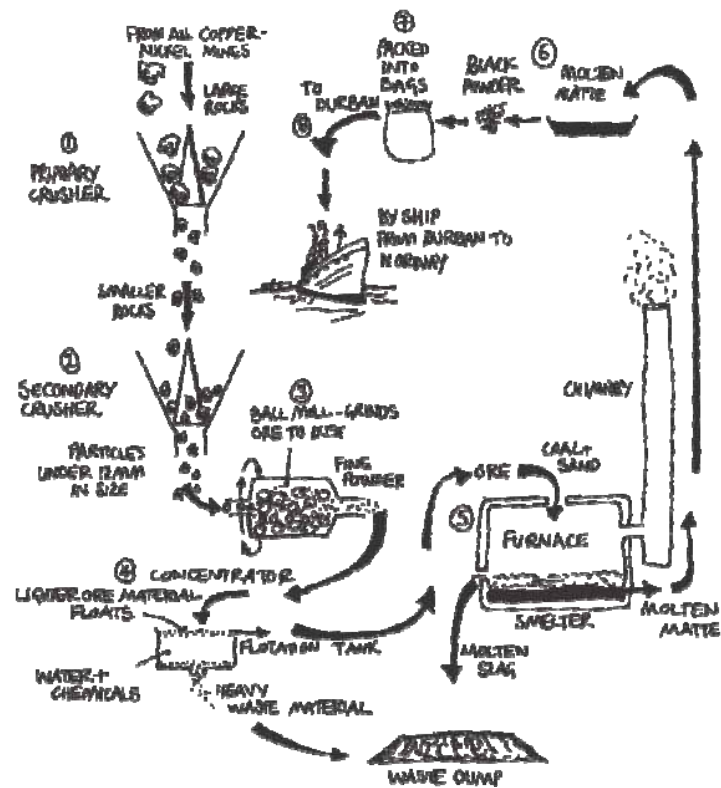


Figure 13: Processing of Copper-Nickel at Selibi-Phikwe

(a) Stage 1: Crushing and grinding

- The primary crusher crushes the ore into small pieces
- The secondary crusher crushes the ore into pieces of about 12mm in diameter
- The pieces are then put into a machine called the ball mill. In the machine there are rotating shafts that crush the ore into a fine powder.

From here the powder is taken to the next stage of processing.

(b) Stage 2: Concentration

The powder is mixed with water and chemicals namely, lime, potassium amy-1-xanthate and trio-ethoxy- butane in the concentration tank. This causes the lighter copper to float

whilst the other unwanted material called slag, sink to the bottom.

The copper concentrate is skimmed from the top of the tank and put out to dry in a kiln or furnace. The dry concentrate is then taken to the third stage, the smelting.

(c) Stage 3: Smelting

During smelting, the concentrate is first mixed with dry silica or sand, recirculated dust from the waste heat boiler and precipitators and pulverised coal. The purpose of recirculating dust is to remove any of the remaining mineral impurities it might still contain. All this mixture is then put into a blast furnace. A blast furnace is like a very large oven where rock ores are heated at extremes of temperature so that they melt to liquid rock.

During the smelting process impurities produced include slag which is taken to the waste dump. There are also gases produced of which the most notable is sulphur-dioxide. Sulphur dioxide can cause respiratory problems for people and even environmental damage if left uncontrolled over a long time.

Try to recall what you have learnt so far in this topic by doing the following activity.



Activity 3

1. Explain where in Zambia we find copper.

2. How is copper extracted? State briefly how the method of extraction is used.

3. In terms of depth when is the method you mentioned in question 2 above used for recovering mineral ores.

4. How many stages of processing does the ore go through once it reaches the surface?

5. Mention **two** things that come out of the smelter or blast furnace.

6. Name the impure copper that comes out of the blast furnace and the converter furnaces.

7. What can sulphur-dioxide do to people?

Feedback

1. *Between the Zambia and DRC border in the area extending from Ndola to Katanga called the copper-belt province.*
2. *Using shaft mining, the method of extraction operates by:*
 - *Drilling*
 - *Blasting*
 - *Use of conveyer belt*

- Tunnels

3. *When the ore is found deep underground or below 50m.*
4. *Three stages and it goes through the crushing stage, grinding stage, smelting stage.*
5. *Impure copper (matte/blister) slag or waste material.*
6. *Copper matte and blister copper.*
7. *It can cause them to suffer from respiratory and eye irritations.*

You may have found the activity a bit challenging as it requires you to reflect on the entire content you have studied so far in this topic. But if you understood as you read, then you should have given all the correct answers to the questions.

Now that you know how to mine and process copper, let us look at its uses.

1.3 Uses of copper

These are some of the common application to which copper can be used. Many of them are not completely new to you.

In a car, the wiring used in a car is made up of copper wire insulated with plastic; you will make the same discovery if you check the electrical wiring in your house. For some of you who have done chemical experiments in the laboratory, you probably came across a very corrosive acid called sulphuric acid. This is one of the by-products from copper extraction. You may also have seen many different varieties of paint products from white wash to oil paint and other specialised paints. These are very useful in protecting our homes and property from atmospheric corrosion. They also lend a bit of colour and sparkle to our surroundings. These paints are also made from by-products, which come from copper. In Botswana you have come across some coins – the 5 thebe coin in particular. It is made of copper.

Like in the case of Botswana, Zambia is a mineral-lead economy. And we have already mentioned some of the

problems facing such an economy. Now let us see what Zambia's problems could be.

1.4 The problems of a mineral-led economy

The importance of copper to the economy of Zambia cannot be underestimated, even now when Zambia is seeking all other ways to diversify its economy. Copper was for a long time the main export commodity and the largest foreign exchange earner for Zambia. This meant that the mainstay of the Zambia economy was centred on minerals.

This has up to now put Zambia into a lot of difficulties- the same thing could end up happening to Botswana in future. Once the value of a mineral is lost then very little foreign exchange can be gained from selling it and so the buying of foreign goods and other necessary commodities may become a problem for such a country, especially if the country still lacks self-sufficiency in such matters as food security; education, manufacturing and processing industries, engineering and medicines or other vital areas which serve to keep things working smoothly in a country.

Just to help you remember what you have studied since the last activity, do Activity 4 below.



Activity 4

1. Name at least **two** uses of copper not mentioned in Activity 1 of this topic.

2. Mention **one** importance of copper mining to Zambia.

3. What can happen if a country which depended on one commodity find itself unable to sell it for a profit any longer?

Feedback

Answers to this activity should be easily obtained from sections 1.3 and 1.4 above.

1. - Wiring in cars and houses.
 - Paint work.
 - Making metal alloys, i.e. bronze; making bullet casings.
2. *It is a foreign exchange earner.*
3. *It can not provide itself with enough food; enough manpower in many of services related industry. Problems of unemployment and poverty may occur.*

Let us continue by discussing the importance of copper mining in Zambia.

1.5 Importance of copper mining to Zambia

Just like in the case of Botswana, mining provides people of Zambia with a lot of things other than just as an export of commodities.

It provides employment opportunities to the citizens of the country. It reduces poverty and provides salaried wages through which people improve their standards of living. It provides money to develop other service infrastructure like village developments and even other industries i.e. agriculture and manufacturing. It provides raw materials to set up local industries that in turn produce goods for the local market. The industry can give the countries name recognition making it enviable to attract more foreign investors to the country helping to develop it further. Mining is therefore a very valuable industry to Zambia where other forms of national development are still at their infancy stages.

2.0 Effects of Mining on the Landscape

Mining has provided an easy ladder for many developing countries of Africa south of the Sahara to reach their more developed counterparts in the north a degree of development almost similar to (Europe/America). As already mentioned above it has brought many good things. But that is not all, for it has also brought some elements of harm to the environment, the most notable of which is pollution. This can be air pollution caused by dust, smoke and other atmosphere emissions. Some of these, like sulphur dioxide in copper mining have serious long-term impacts on the surroundings. It affects both people (causes bronchitis) and vegetation (kills the surrounding plants and makes the land bare of vegetation). Mining produces deep holes that leave the ground looking unsightly and huge dumps that also make it look untidy and barren. Some waste products could pollute ground water and sometimes rivers through heavy rains or flood. The removal of great tracts of vegetation might also be seen to encourage soil erosion.

In conclusion we find that mining is a capital-intensive industry and uses a lot of machines unlike agriculture, so much that a complete dependence on it may still create problems of unemployment. It is also an industry that is based on non-renewable resources. When they are depleted before alternative sources of making ends meet have been realised, it can lead countries into trouble, as is the case for Zambia and presumably for Botswana in the near future.

Although we have discussed these issues under copper mining in Zambia, note that they apply to almost all mining situations like you saw in the case of Selibe-Phikwe mine in Botswana.

This actually brings us to the end of Topic 4. Read the summary below before you do Exercise 4.

3.0 Summary

In this topic you have learnt about the different methods of extracting copper. You have also learnt how copper is processed. From processing you learnt about some of the uses of copper and of its importance to the country that produces it.

Mention has been made of the positive and negative effects of mining to conclude the topic. You have also learnt that the processing of copper in Botswana and Zambia is similar.

Now that you are through with this last topic, do Exercise 4 to check your understanding.

Unit summary

In this unit, we focused on mining. The first topic introduced you to mining and gave you all the necessary steps one has to follow in order to obtain a mining licence. It also detailed out what miners do in order to satisfy themselves that a prospective mine is actually turned into a mine. Topic 2 then focussed on diamond mining in Orapa while Topic 3 gave environmental impacts of mining using Selibe-Phikwe copper mine as a case study. We then concluded the unit by taking another mining activity but this time using a case study of mining in Zambia. Overall, we discussed that mining is critical to the lives of people where it is done. But we also discussed the dangers of a mineral-lead economy as well as the positive and negative impact of mining on the environment.

That brings us to the end of Unit 14. Once you have finished Exercise 4 and you are sure you understand all the topics in this unit, you can proceed and work on the unit assessment. Remember to submit this assessment for marking.

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Assignment

Assignment

Self-assessment Exercise 1

1. The following is a list of names, some of which are minerals.

Copper/Nickel, Gold, Coal, Rubber, Soil Peat, Charcoal, Petroleum, Natural gas minerals, Wood and Rocks.

Using the information above, fill in the spaces provided with the correct answers for the named category of minerals. [6 marks]

(a) **Liquid/Gas**

(b) **Metals**

(c) **Non-metals** _____

2. Name any **two** companies that carry out explorations and extraction of mineral resources in Botswana. [2 marks]

(a)

(b)

3. Study map (fig. 4) showing 3 broad geological groups in Botswana and answer the following below: **True or False** (circle the correct answer). [3 marks]

(a) Mineral discovery is an unplanned activity where people find mineral deposits because they got lucky.

True or False

(b) Any body who is a citizen or non-citizen can mine mineral where they live in Botswana.

True or False

(c) A lease is an agreement signed between an individual/company and Government asking to do exploration and mining in a country.

True or False

4. Look at the map (Fig 4) page 14 again and use it to answer questions 4 (a), (b) and (c).

(a) The map shows 3 broad distributions of rock types (found in Botswana). Name them.

[3 marks]

(i) _____

(ii) _____

(iii) _____

(b) In which area of the country do we have the greatest mineral concentration discovery so far?

[1 mark]

(c) Which rock type covers most of the country's surface?

[1 mark]

5. Name **two** examples of rock which are called basement rock and sedimentary rock.

[4 marks]

(a) Basement rock: _____

(b) Sedimentary rock: _____

6. List any **five** different minerals found in Botswana.

[5 marks]

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Total [25 marks]

Self-assessment Exercise 2

1. Explain briefly why it may be improper to quickly erect mining infrastructure on a newly discovered ore site.

[4 marks]

2. What factors would you consider before mining a newly discovered ore site?

[10 marks]

3. Study the figure 8 which shows a geological section of a rock in which certain mineral has been discovered. There are four sites A,B,C and D and an open pit mine has been proposed to be dug on one of them.

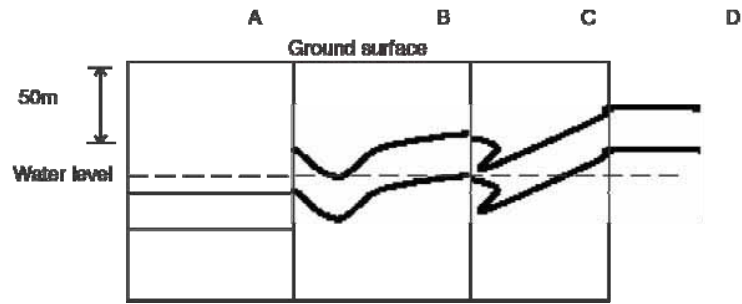


Figure 8: Geological section

(a) State which of the sites you would use for the new shaft and describe the advantages of the site.

[3 marks]

(b) State giving a different reason in each case why you rejected the other three sites.

[3 marks]

4. Some mining areas in South Africa and Botswana may be declining because either the mineral deposits are too deep or they are being exhausted.

(a) State why mining at great depth is difficult, dangerous and expensive.

[4 marks]

(b) Why do you think it is important that we have a centralised market for our diamonds.

[1 mark]

Total [25 marks]

Self-assessment Exercise 3

1. Name any one of three places where diamond mining is done in Botswana?

[1 mark]

2. When did the first important discovery of Diamonds take place?

[1 mark]

3. Name a place in Botswana where the first diamond mine started operation and also state the year of operation.

[2 marks]

4. Explain briefly the work involved in getting at the rocks containing a mineral ore.

[3 marks]

5. State **step by step** the processes undertaken once the ore reaches the surface until the Diamonds are sent to the CSO.

[4 marks]

6. Name **two** types of diamonds mined in Orapa. [2 marks]

7. What are the high quality diamonds used to manufacture? [1 mark]

8. In terms of employment mining caters for a small amount of the total employment figures in the country but it produces a lot of the overall export revenue. How much does it produce? [1 mark]

9. State **four** of the possible problems that may befall a country that has an overreliance on one economic commodity such as mining. [4 marks]

10. Name one country that has experienced the negative results of over-reliance on minerals in the SADC region. [1 mark]

Total [20 marks]

Self-assessment Exercise 4

1. Name a country in Southern Africa that was once very famous for the production of copper? [1 mark]

2. Mention any **two** countries which share borders with that country. [2 marks]

3. Which one of these countries shares the copper deposits with the country mentioned in your answer for 1 above.

[1 mark]

4. Give a brief name for the overall copper field extending from Zambia to DRC.

[1 mark]

5. How many types of copper ores may we find in Zambia/DRC? Name them.

[2 marks]

6. Which company controls and administers the mining of copper in Zambia.

[1 mark]

7. Mention the stages of processing copper.

[4 marks]

8. Where does Zambia get most of its electricity to refine the copper?

[2 marks]

9. Explain what is meant by over-reliance on one commodity.

[2 marks]

10. Describe what can happen when a country which depended on one commodity suddenly finds itself unable to market it.

[3 marks]

11. Mention some of the negative and positive effects of mining on the area where it is practised.

[5 marks]

Total [25 marks]

3. (a) Site D
- it is closer to the surface open cast can be used.
 - It is above the water table no need to pump water.
 - Seams are straight not faulted or folded.
- (b) C - was faulted, and part below the water level.
- mineral at great depth.
- B - was folded, with part of mineral underwater.
- Need to pump water
- mineral at great depth.
- A - mineral at great depth.
- mineral below water level. Need to pump water.
4. (a) The rocks become unsuitable due to high internal pressure they collapse and kill people.
- Problems of water logging in the mine that require pumping, which is expensive.
- Problems of explosive and poisonous gases at depths which require good ventilation systems.
- Problems of moving a lot of weight from great depths which require strong winches that are expensive.
- (b) Prevents unnecessary price fluctuations by independent market forces.
- Prevents smuggling and value price reduction due to sale of inferior products which are not regulated.

Exercise 3

1. Orapa or Letlhakane and Jwaneng.
2. 1967
3. Orapa, 1971
4. (a) Removal of surface over burden (soil) and vegetation.
- (b) Drilling of the rocks.
- (c) Blasting of the rocks.
- (d) Conveyor belts or shafts.
5. (a) Crushing.

- (b) Concentration.
 - (c) Ray sorting.
 - (d) Hand sorting.
 - (e) Grading and valuation.
6. Gemstone and industrial diamonds.
 7. Jewellery such as necklaces, watches, and rings.
 8. 74%
 9.
 - (a) Mineral may get finished (exhausted).
 - (b) Markets may get saturated.
 - (c) Unemployment.
 - (d) Economic recession.
 - (e) Poverty and fall in standard of living.
 - (f) Shortage of schools.
 - (g) Shortage of medical facilities such as hospitals and clinics.
 - (h) Over crowding.
 10. Zambia

Exercise 4

1. Zambia
2. Zaire, Zimbabwe, Angola, Tanzania, Uganda, Mozambique, Botswana, Malawi and Namibia.
3. Zaire
4. The Copper-Belt
5. 2 types
 - (i) Copper oxides
 - (ii) Copper sulphides
6. Zambia Consolidated Copper Mines
7.
 - (i) Crushing
 - (ii) Concentration
 - (iii) Smelting
8.
 - (i) Kafue
 - (ii) Kariba
9. Depending on a single commodity to provide most of what people need both for export and import of goods.

10. (i) It will lose its foreign exchange earning capability.
(ii) It will find itself with unemployment problems.
(iii) It will not be able to support most of its other economic activities.

11. **Negative**
- (i) Pollution
 - (a) Smoke
 - (b) Noise
 - (c) Water
 - (d) Land
 - (ii) Dump hills which look barren.
 - (iii) Excavation pits which are dirty/smelly.
 - (iv) Soil erosion through extensive removal of vegetation cover.

Positive

- (i) Foreign exchange earner.
- (ii) Development of infrastructure.
- (iii) Promotion of other industries.
- (iv) Provision of employment.
- (v) Improved standards of living.
- (vi) Providing raw materials for local industry.

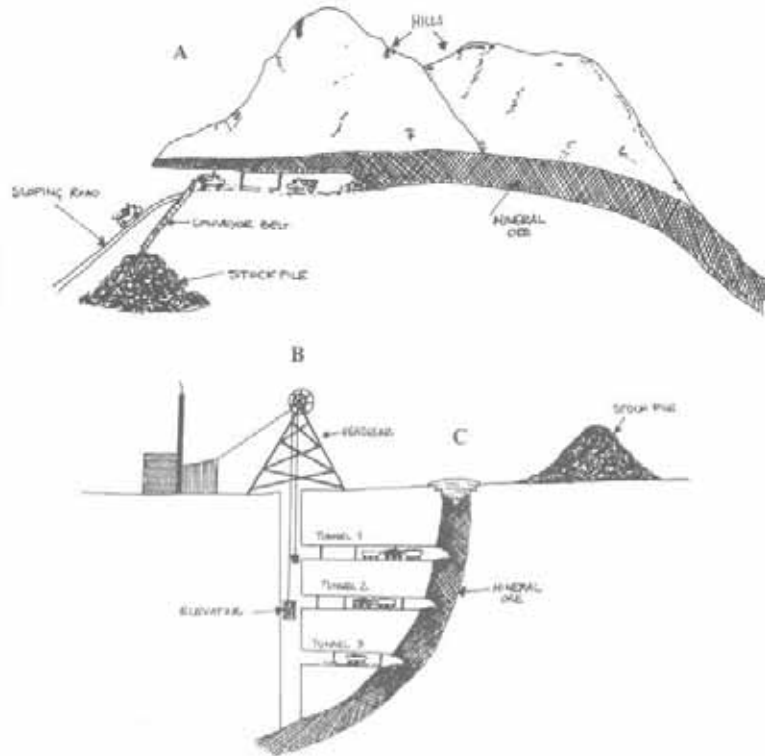


Assessment

Instructions to students

1. Answer all the questions.
2. Write all your answers in the spaces provided.
3. Marks for parts of the question are shown in brackets.
4. You may spend no more than 1 hour 30 minutes to do this assignment.

1. Study diagrams A, B, and C showing the geological occurrence of some minerals and the methods of mining them.



(a) Each diagram shows minerals occurring in different geological conditions. Write down A, B, and C as a list and for each diagram name the appropriate method of mining which would be used. [3 marks]

(b) Give one reason why the methods you have named would be used in each instance. [3 marks]

2. (a) A mineral ores is said to have a concentration of 6%. Explain what this means. [2 marks]

(b) Why would the first stages of processing for this ore be carried out close to the mine? [2 marks]

(c) State the factors you would consider before undertaking to mine a newly discovered ore deposit. [5 marks]

3. Choose either diamonds or copper and for the mineral you have chosen:

(a) Name one location in Africa South of the Sahara where it is mined in large quantities. [1 mark]

(b) Describe the geological conditions where it is found and the method used to mine it. [3 marks]

(c) State briefly the uses of the mineral. [2 marks]

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Unit 15

Population Studies and HIV and AIDS

Introduction

Welcome to Unit 15 of the Grade 12 Geography course. In this unit you will learn about population and related concepts like population census, population distribution, the factors underlying population distribution, population growth, population density, population explosion, population pressure and its effects on the resources. You will also learn to read, draw and interpret population information in the form of graphs known as population pyramids. You will study the Demographic Transition Model (the DTM), the model that suggests that all countries have their populations passing through four stages or phases. You will also look at population mobility, types of migration in which people are involved, and reasons for migration, as well as problems created by such movements. Finally, you will learn about the Botswana government's efforts to reduce rural-urban migration.

The study of population relates to all the different units that you have been studying in this course. For example, people choose to live in conducive environment with good weather and climatic conditions; productive land of economic value; and prospects of industrialization. Unit 12 talked about tourism and if we do not care for our environment, we will lose it. We know that the increase in population has led to occupation of land that was formerly preserved for wildlife. Population affects productive land especially in Botswana where some of the land that was used for agriculture has been turned into settlement areas. The world population has grown tremendously over the past two thousand years, placing a lot of pressure on resources.

Your study of this Unit will give you an idea of how many people there are in Botswana and in the world and how these are counted. You will identify differences among countries and reasons why certain countries have less or more people than others. This will enable you to appreciate and understand the impact of over-population in any given country.

The last two topics address HIV and AIDS and its impact on Botswana. Having learnt about factors influencing population distribution and growth and also settlements in Botswana, you should also understand how people are affected by the pandemic and account for the distribution of HIV/AIDS in Botswana.

These topics, thus, tie with all the others you have studied so far. They relate to the social aspects of life and how people handle their life especially their health. We know that in Botswana, HIV and AIDS is more prevalent in settlements with more people such as Gaborone, Francistown, Selibe-Phikwe and those gateways to other countries such as the Chobe region. Several people come in and out of Botswana through Kasane and many develop relationships with Batswana sharing and spreading the HIV/AIDS virus.

It is essential that people who live in areas that are vulnerable to the virus must be more careful about their associations with foreigners, reduce multiple partners and use condoms when indulging in sexual relationships.

To get information on HIV and AIDS, you are advised to visit a clinic or hospital or attend any

health public addresses. You are likely to see very informative charts and read them carefully as they will broaden your understanding of HIV and AIDS. You can also get a lot of information through pamphlets on HIV and AIDS. Check in the newspapers, they may also have some information related to HIV and AIDS. You may want to refer to them as you go through the topics.

Unit 15 has 9 topics and these are as follows:

Topic 1: Definitions of population concepts and factors influencing population

This topic provides an understanding of what population concepts mean. You will learn about the factors influencing population distribution, view maps of the world population distribution and identify population distribution in Botswana.

Topic 2: World population growth and its consequences.

Here you will continue to learn in more detail about the factors influencing population growth and establish the different growth rates of several countries, including Botswana. You will learn about the results of increase or decrease in population growth.

Topic 3: Rapid population growth versus resources.

The third topic deals with the way people in the world utilize the resources available to them. It distinguishes renewable and non-renewable resources. Issues of globalization, which developed through industrialization, are detailed to help you understand the consequences of modernization.

Topic 4: Reading and interpreting population information

This requires knowledge and interpretation of data especially the ability to translate and synthesize statistics, read population pyramids and provide analysis of data and produce reports.

Topic 5: The Demographic Transition Model.

A description of the Demographic Transition Model is provided to enable you understand how population of countries differ due to changes in death or birth rates. It enables geographers to make projections about the type of population a country will have at a certain period.

Topic 6: Population movements.

You know how Botswana men and women have over the years been migrating to some neighbouring countries in search of jobs. This topic is essential because it provides an overview of what happens when people migrate to both the country and their families.

Topic 7: The impact of migration on rural and urban areas in Botswana.

Most of the people migrating to either cities or other countries come from rural areas. This has an impact on the productivity level of these places. This topic discusses the efforts the government is making to reduce rural urban migration.

Topic 8: The transmission and control of HIV and AIDS

This describes what HIV and AIDS stand for and how it is transmitted. It further describes the myths that people still have about the HIV and AIDS scourge. The topic further discusses efforts made to control the spread of HIV and AIDS.

Topic 9: The impact of HIV and AIDS in Botswana

It has been noted that HIV and AIDS has had huge social and economic impact on Botswana. The Botswana government has spent a lot of money in educating us on preventing the spread of this virus.

You should study the topics in this order since each topic leads to the understanding of the next one.

Upon completion of this unit you will be able to:



Outcomes

- *define* the following concepts: population (de facto and de jure), population pressure, optimum population, population explosion, population density, population distribution, fertility rate, mortality rate, over-population, under-population and population growth.
- *account* for the world's population distribution patterns. (with the aid of a map)
- *discuss* factors influencing population growth.
- *describe* the growth of the world's population and its consequences.
- *evaluate* the impact of rapid population growth on the available resources.
- *interpret* population pyramids of developing countries and those of a developed country.
- *describe* and explain the different stages of the Demographic Transition Model.
- *explain* any country's position in the Demographic Transition Model - case study: Botswana.
- *account* for the population density and distribution with the aid of a map, case study: Botswana or Namibia.
- *project* future population growth trends of any developing country in Africa- case study: Botswana.
- *define* migration.
- *differentiate* between types of migration, for example: local, regional and international, internal and external, temporary and permanent.
- *critically* assess population movements and evaluate their impact on available resources.
- *evaluate* the impact of migration on both rural and urban areas.
- *evaluate* Government's effort to curb rural-urban migration.
- *define* HIV/AIDS.
- *interpret* HIV/AIDS statistics of any developing country and account for its distribution.
- *assess* the demographic and socio-economic impact of HIV/AIDS in any developing country
- *discuss* efforts being taken to address the HIV/AIDS problems in any developing country - case study: Botswana or Swaziland.

Time

As mentioned in the previous topics, each topic in this unit should take you about 2 hours to complete. Note that the self-assessment exercise time is inclusive of the 2 hours. You may take slightly more time or less time than estimated, it depends on how fast you can learn. The number of topics in this unit may also affect the time you need to finish it. Do not just rush to finish a timed topic. Make sure you understand what you are learning. On completion of all the topic self-assessment exercise, you may proceed to the unit assessment found at the end of the unit. You are advised to spend at least one hour in the tutor-marked assessment.

Teaching and Learning Approach

The studying of population has been made easier by making the material very interactive and using a wide variety of activities. The language we have used throughout the unit is engaging and also encourages reflection of your own experiences.

In most cases you may find yourself alone to work on your materials. This does not mean you cannot be creative and /or apply the knowledge you possess as an individual or have learnt from others. The study materials provide you with the opportunity to think through problem-based learning or collaborative projects that are given as exercises within the text. In some instances there maybe 2 or more of you. Learn to work together and share ideas since this could be more beneficial for each of you, bringing in their knowledge and experiences to enrich your learning.

Learning on your own or with peers and asking for help during tutorials that you hold with your tutors will help you increase retention of both knowledge and skills. Visit the library where available. If you are in a rural area that has no public library but has a school that has one, kindly request the school management to allow you to use the library. They may allow you to use their computers and if they have internet connection you would be able to carry out a lot of research.

You must read in advance before you meet your tutors in order to ask questions about anything you find difficult to conceptualize. It is important that you open up and ask your tutors to help you. I hope you are not afraid to talk to your tutors. Most of the time if you depend entirely on the teacher this inhibits your creativity and innovation. Use all the opportunity you have to discuss your concerns with your tutors.

In places where there is non-formal education, other long distance learning institutions, visit the offices and ask for help when necessary. These institutions have documents, newspapers and other types of materials you can use to answer questions.

Assessment

As you work through the unit, you will come across some activities in each topic. These activities are based on the

information relevant to different sections of the topic and form part of your learning. They are meant to help you interact with your study material, reinforce what you have learnt and also to reflect and apply your experiences. It is therefore very important for you to do all these activities. You are advised to attempt the activity before looking at the feedback given immediately below the activity. If you do not do well in the activities do not be discouraged, as you may review the section related to the activity and later carry on with the topic with more concentration. You are advised to review the sections you did not do well before continuing with the topic.

On completion of each topic, you are advised to go to the assignment section found at the end of the unit. You will find a self-assessment exercise for each topic. Do the exercise for the topic you have completed. This will help cement your learning or understanding of the whole topic. Feedback for all the self-assessment exercises is provided at the end of the assignment. If you score lower marks you must not be discouraged. Learn from the mistakes and try again by going over the topic and the exercise.

The assignment self-assessment exercises are followed by a tutor-marked assessment. This should be done after you have satisfactorily completed and marked the assignment. Submit or post your assessment, to be marked by your tutor. You are advised to take note of and act on your tutor's comments. You may ask your tutor for more information or look at other resources to correct your work. If you are satisfied with the feedback received from the tutor, then go on to the next unit.

Demography



Terminology

Arid	A region with very little or no rainfall.
Chlorofluorocarbons	chemicals released by cooling systems like refrigerators air conditioners, and they are capable of destroying the ozone layer.
Conservation:	preserving of or preventing from waste, damage and loss
Data	describes numerical or collected information
Decline	a drop or a fall in quality or quantity.
Demography	the study of population such as birth and death rates, population growths and other changes
Demographic structure	the proportion of men and women, old and young in a population

Demographic transition	the main changes in population patterns that take place over a period of time in a country
Dependants	people who are aged 1-15 and those aged 65 and above relying for support from people with paid employment.
Developed country	are countries with small commercial sectors and large industrial and service sectors. In such countries most people live in towns and cities and average incomes are high e.g. Britain. Sometimes such countries are referred to as rich countries or “ first world countries ” or “ industrialised countries. ”
Developing country	are countries with large agricultural sectors, low average incomes, and small but rising urban population. Often they are referred to as “ countries of the South ” because most of them are found in the south. Sometimes they are referred to as “ less developed countries ” or “ third world countries ”.
Economically active population	People who are able to work and earn a living
Emancipation of women	setting women free from social restrictions
Emigrate	leave one’s country or place of settlement in order to settle in another.
Emigrant	a person who leaves his/her own country/place to settle in another.
Greenhouse effect/Global warming	the warming effect that occurs when greenhouse gases like carbon dioxide and methane accumulate in the atmosphere. Layers of these accumulated gases trap heat from the sun and prevent it from escaping back to space. As a result the earth’s surface becomes abnormally hot.

Habitable land	suitable for human habitation (to live on).
Habitat	a place where an organism prefers to live. Habitats are either in water or on land.
Inhabitants	people occupying an area or a place permanently..
Intercontinental Movements	movements between continents for example movement from Botswana in Africa to the United Kingdom in Europe.
Immigrate	to come to a place/country of which one is not a native in order to settle there either permanently or temporarily.
Immigrant	a person who comes to a place/country of which he/she is not a native to settle there either permanently or temporarily.
Life expectancy	average number of years which a person can live.
Model	a simplified representation of a system designed to facilitate descriptions and predictions of patterns.
Natural resources	materials not made by people but existing naturally in a place.
Ozone layer	a thin layer of air in the upper atmosphere. It exists as 3 atoms of oxygen (O ₃) The ozone layer protects us from sun burn. If it is destroyed, we can get diseases like eye cataracts or skin cancer
Political persecution	harassment or oppression of individuals or groups of people by the government or other political groups on the basis of political differences.
Post-Reproductive group	people who can no longer bear children
Pre-reproductive age group	children under the age of 12 years.

Projection	an estimate for the future based on present facts and population data or figures.
Refugees	are people who have fled from their countries from some danger or problems especially political persecution.
Religious persecution	oppression or harassment of some religious groups by the government or other religions groups because of religious differences.
Sanitation	the system of removing sewage and rubbish/dirt from households and the surroundings. Keeping the surroundings clean and healthy.
Sparsely populated	occupied by very few people.
Species extinction	the disappearance of plants and animals from life because of being overused.
Sustainable use of resources	use of resources in such a way that adequate supply is maintained.
Tubal ligation	sterilization in a woman, by cutting and tying the reproductive tubes
Vasectomy	sterilisation in a man by cutting and tying the reproductive tubes.
Remittances	money or goods sent home by those working in distant areas.
Social amenities	oppression or harassment of some religious groups by the government or other religions groups because of religious differences.
Social strain	a situation where one is responsible for doing many things e.g. women in a single parent family.

Topic 1: Definitions of Population Concepts and Factors Influencing Population

Introduction

Welcome to the first topic of Unit 15, Population Studies which refers to the scientific study of human populations or learning about people. In this topic you will learn to define or to tell the meaning of concepts that are used quite often in this study. There are some concepts that you will have to use quite often while you learn about people, their distribution on the land surface as well as their numbers in relation to the resources available to them.

In some places there are many people while in others there are very few. In some areas there are so many people that there is no space for them all. In others there is plenty of space. How can you describe your own local area? Are there few or more people in your area and why? Think about these questions as you go through this unit.

You will also learn about the factors influencing the way people are spread over the land surface. There must be reasons for even and uneven distribution of people on the earth's surface. Some areas have favourable conditions while others do not. For example in Botswana most people live in the eastern part of the country with fewer people as you proceed towards the Kalahari Desert.

Topic Objectives

At the end of the topic you should be able to:

- define the different terms used in population studies such as population, population census, *de facto* and *de jure* population.
- use maps to identify the world's population distribution.
- discuss factors influencing population growth

1.0 Definition of Population Concepts

In the previous units we have mentioned the impact of population on some natural resources like water, vegetation, soil and energy resources. We are now going to find out meanings of concepts that we use in the study of population. You know we live in communities with other people and that makes the population of that particular area. The first concept we will learn about is population.

Population: This refers to the number of people living in an area. The area may be the whole world or part of it. The people living in Botswana, for example, make up the population of Botswana, just as much as people living in places like Mahalapye, Xanagas, Gaborone etc. make the populations of those areas, e.g. district, town or village.

It is important to know how people are spread around in their area. This is known as “**Population distribution**”. Look around your community and observe how your homesteads are structure and placed. Are they close together or separated? Population distribution refers to the spread of people over an area. An area may refer to the whole world, a continent, a country or part of it.

How many people are in an area is one way of understanding population distribution. For example, think of the number of people in your house as compared to the number of rooms the house has. Sometimes there might be few or more people in a house with few rooms. **Population**

density describes the number of people per unit area, usually per square kilometre, that is, the number of people in a given area. It can be calculated for any area or country for as long as you know the total area in kilometres and the total number of people living there.

The equation used to calculate population density is:

$$\text{Population density} = \frac{\text{Total number of people in the country}}{\text{Area of that country}}$$

Given that country X has an area of 583000sq kilometers and a population of 13 399 000, calculate its population density. Did you get 23 people per square kilometre? If yes that is correct.

If there are too many people in a small house it would be difficult to share facilities and some of them may fight over who uses the bathroom first in the morning to get ready for school. This places pressure on the facilities available because of the high number of people. Therefore, this is known as **population pressure**. Population pressure refers to when there are too many people in an area such that there is shortage of resources like land, water, and minerals. Services provided such as clinics, and schools also become inadequate.

Optimum population is the opposite of population pressure. When there are an adequate number of people in your house, you will be able to save money on electricity, water and food. This will enable your family to use the resources available properly. Optimum population refers to when the size in the population in an area or a country allows the sustainable utilisation of the natural resources available to improve the standards of living of all the people. Most of the developed countries have their populations at optimum level.

Imagine all of a sudden your relatives decide to come to your house in the village/town/city to share your resources. This would be like an explosion. There would not be enough resources to go around and you may become very unhappy. This happens to countries too and it is called **population explosion**. It is a rapid increase of population that makes available resources and services inadequate. Most of the developing countries experience population explosion.

Sometimes there may be too many people in an area. Remember when the Zimbabweans came over to Botswana in large numbers due to the political instability in their country our population increased and this put pressure on the government to provide health facilities and other resources. This caused **overpopulation**. **Overpopulation is** a situation when there are too many people in an area such that the available resources and services cannot support them or improve their standards of living. Some countries are overpopulated.

However, there are instances where you find very few people in an area that has adequate resources. When this is the situation, the place is said to be **under populated**. It is when the population is too small to use the resources fully. Refer to figure 1, which has examples of such countries. What would you do if your local area was under populated? You may recruit people from other communities to come live with you!

Figure 1: Population numbers and densities for three African countries in 1975

Country	Area (x000 km ²)	Estimated population x000	Densities
Uganda	236	11549	

Ghana	239	9866
Nigeria	924	62925

During the years when a lot of Batswana died due to HIV and AIDS, the population decreased because babies died at birth, mothers and father lost their lives and this affected the **population growth**. **Population growth** refers to the increase or decrease in the number of people living in an area. Populations in different countries grow at different rates. An increase of births over deaths will result in positive population growth. Births can increase over deaths due to cultural beliefs like polygamy, desire for male heirs and early marriage. In-migration can also contribute to a rapid population growth. When there are more deaths than births, there will be a negative population growth. You will learn more about population growth in the next topic.

Every 10 years the Botswana government counts the number of people in the country to enable it plan for their needs. The next counting of people will be in 2011. This is called the **Population census**. This is population enumeration or the counting of people in a country or an area in a specified period of time. In a population census, every person is counted. It is a very costly exercise but very important. It is so important that all countries of the world carry it out, though at different times. The enumerators (people hired to count others) write down details about each person. Have you asked yourself why it is important to be counted? Read on and find out what a census involves:

The census tries to:

- count all people in a country by age and sex
- find out the literacy rates in each age group
- find out the size, skills and distribution of the labour force
- give information on the number of people in schools
- find out if enough people are trained in the most required skills like in science and technology for the needs of the country
- give information on the housing situation, e.g. how many houses are available? Whether the houses are electrified or not? Are people using running water etc?
- get a complete and clear picture of all the people and where they live in the whole country.

When the enumerators have collected all this information, it is taken to the Central Statistics Office where it is entered into computers that tabulate it settlement by settlement. The information is then sent to various government sectors, non-governmental organisations, community based organisations and even individuals who may want to use the information for making decisions and planning ahead.

The information collected helps a government to know the needs of its population and to plan ahead to meet these needs. So a population census is important for a country's economic planning. At the end of the census for example the Botswana government will know how much money should be spent on education (in primary, secondary and tertiary), health, old age pension fund, etc in the next ten years. It also helps countries to set priorities in spending their finances.

One way of counting people is called the De facto population: *De facto* means "in fact," so *de facto* population describes the number of people who were in fact in the country at the time of the last national population census.

Some people are Batswana but live in other countries, work there or are studying. This is the **De jure population:** *De jure* means "in law," therefore *de jure* population describes the number of

people who were present plus those who were outside the country at the time of the national population census. That is, all the people belonging to a country by law.

You know how good fertile soil produces abundant food growth. This can be equated to the ability of people to have children. **Fertility rate** can be described as the birth rate or the rate at which people bear children.

As mentioned above, there were times when people in Botswana died in large numbers. This measured the **Mortality rate** which refers to death rate or the rate at which people die in a population. Mortality rate can help to show a country's economic situation and progress in health provision.

The following activity will help you reflect on what we have just discussed.



Reflection Activity 1

- 1 What do you think would happen if the population places pressure on the environment?
- 2 How would you describe the population of Botswana?
- 3 Write down at least other four countries (not listed in the table) which you think are experiencing population pressure.

Feedback

Your answers may have included any of the following responses:

1. *Population pressure leads to pressure on resources especially land.*
2. *Botswana has a small population with few resources such as food. Therefore a lot of people despite the small population still live in poverty.*
3. *India, Japan, Germany, Pakistan, Bangladesh, Portugal, Spain, Bulgaria Mauritius and any other country you are sure of.*

You have now learnt important concepts in population studies. This will help you to understand various aspects of population as we progress through this unit. In the next section, we will look at one of the major aspects of population studies, and that is, factors influencing population.

2.0 Factors Influencing Population Distribution

Look at figure 1 once more. Have you wondered why some parts of the world are densely populated while others have few inhabitants?

You might have wondered why your community chose to live where they are now. There are several reasons why people decide to settle in a particular area. Below are some of these reasons.

Where people choose to live is influenced by various factors which may be physical (e.g. relief, climate, fertile soils, pest and diseases), economic (e.g. mining, industrialisation and urbanisation). Political factors may also influence population distribution e.g. government policy to resettle people for the provision of services like schools, clinics water etc. Read on to understand how the various factors influence population distribution. First let's look at the physical factors.

2.1 Physical factors

In Units 1 and 8 you learnt that the physical factors are conditions imposed by the environment. Look around your local area and observe the physical appearance of it. You may find hills, plateaus or a river. These are referred to as the **Relief** of a place. The relief of a place has a great influence on the population distribution.

(a) Slopes

The slope of land has a great influence on population distribution. Steep Slopes cannot be cultivated and as a result they tend to be more sparsely populated than gentle cultivatable slopes.

(b) Climate

In units 3 and 4 you learnt about Botswana's climate. Sometimes there is no rainfall and we cannot plough. This is why most of the people live in the eastern part because of good rainfall. Areas of high rainfall tend to be more populated than arid areas. The arid parts of the world like large parts of the extensive Sahara desert, the Atacama; Namib, Kgalagadi, Arabian and Australian deserts are sparsely populated. The dry conditions are unfavourable for settlement, as people need water for themselves, for their animals and for the cultivation of crops. The soils are mainly sandy and infertile. Cold deserts too are sparsely populated. Imagine how it would be like to live in the Arctic Circle!! Would you survive living there after the Botswana climate? Few people are found in hot deserts and they are mainly confined to river valleys and oases.

(c) River valleys

People in the Chobe live around the river to catch fish and plough for their livelihood. River valleys, like the Nile Valley, are densely populated because rivers provide water for irrigation and lay down fertile alluvial soils during floods. Some rivers such as the Chobe and Zambezi are navigable (can be used for transport). Some have lots of fish. Have you noticed that most early settlements started on river banks or near rivers? Mmadinare, Mahalapye, Molapowabojang, Tonota, London, Paris, Lagos and Cairo are examples of such settlements.

(d) Fertile soils

You know that the eastern side of Botswana has good soils. That is why there are more people in this area. Areas of fertile soils tend to be more populated than those of infertile soils e.g. deserts or badly drained areas like swamps. The more fertile a soil is, the more food it is capable of producing hence the greater the number of people it can support. See the population distribution map of Botswana (Figure 2). Where do you think are the fertile soils? The map should provide you with an answer to this question.

Map 1.6 Distribution of the Population

Scale 1:2,000,000

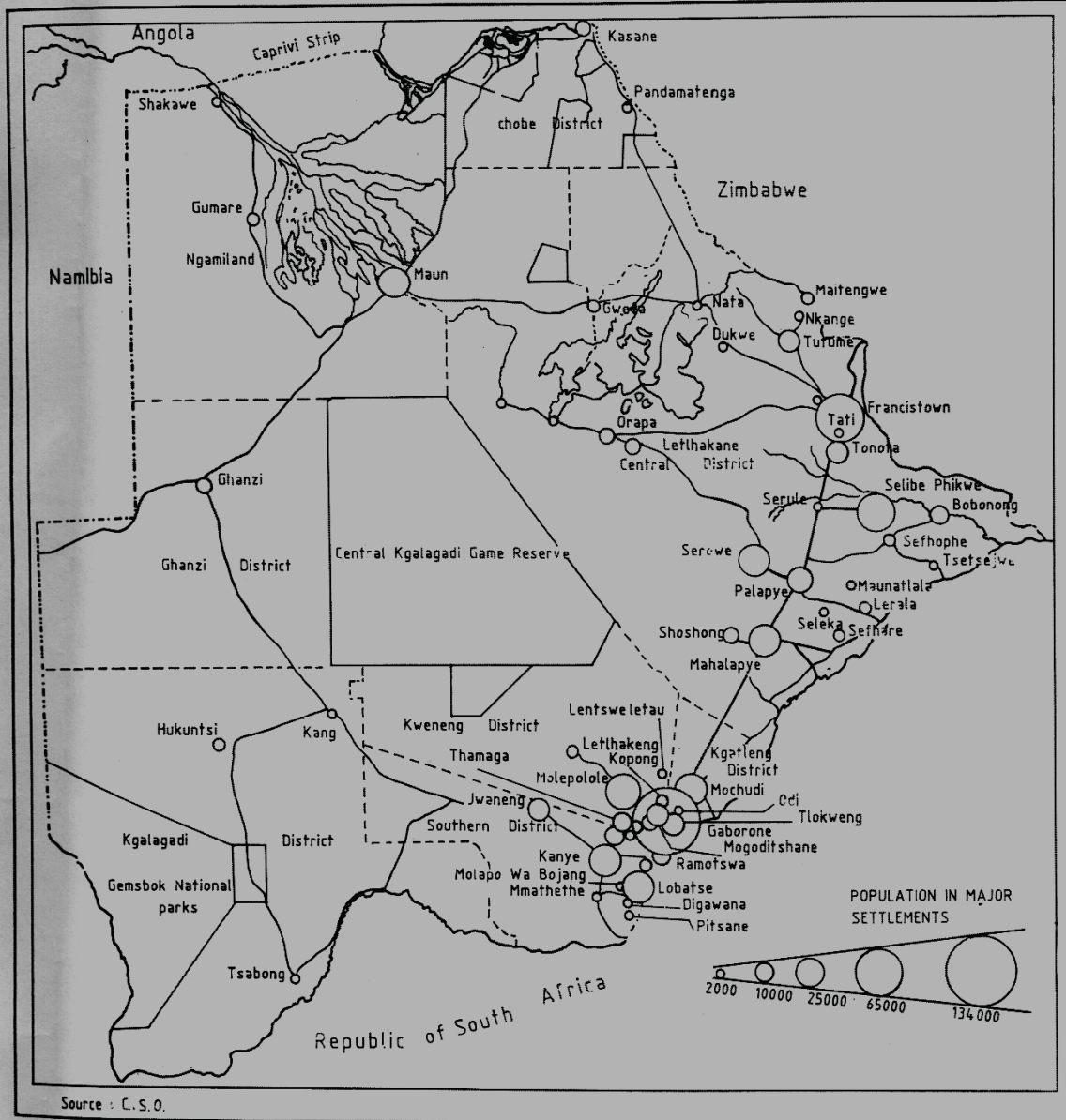


Fig 2: Botswana's Population Distribution

Source: Botswana National Development Plan 8, p 15

(e) Pests and diseases

People tend to occupy places that are free from pests and diseases. Swampy areas like the Okavango Delta do not attract many people because they provide breeding places for disease

causing insects like mosquitoes, tsetse flies and others. Which disease do mosquitoes cause? You are correct if you said malaria. Places infested with pests like mosquitoes are thinly populated.

By now you know the physical factors influencing population studies, let us now look at the human factors.

2.2 Human / Economic factors

(a) Mineral wealth

Do you know what the main source of income for us is? Minerals are a source of income for Botswana. The money received from mining has improved our lives one way or another. Areas of mining have attracted many people throughout the world, for example the mining towns of Orapa, Jwaneng and Selibe Phikwe. The high populations we find in these towns exist due to the economic activity of mining. The discovery and the mining of minerals lead to the creation of densely populated settlements.

(b) Industrialisation and urbanisation

Do you know anyone in your family or community who used to work in South Africa? Some of them worked in mines while others in industries. Industries are concentrated in towns and they attract large numbers of young people. Young people move to urban centres to look for jobs and education. This movement contributes to larger populations in urban areas than in rural ones.

(c) Government policy

Remember the issue of the Basarwa and Botswana government about making Basarwa settle in one place to enable the government to provide facilities for them. This matter is very controversial because some people feel the Basarwa must be left as they are hunters and gatherers while others think they should form communities and live in one place. Government policy (plan of action) may force a cluster of small settlements to join together to form a bigger one to make it economical to provide them with services. The Botswana government encourages this unifying of small villages.

The Ujamaa Policy in Tanzania is another example of government's encouragement to have people settling together in large numbers for the provision of services.

Consider your own country. Where are most of the people living? Find out why this is so! You will know the answer to this question after doing Activity 2.



Activity 2

Carefully study the map of the world population shown in figure 3 and the world climatic map in figure 4 and answer the questions that follow:

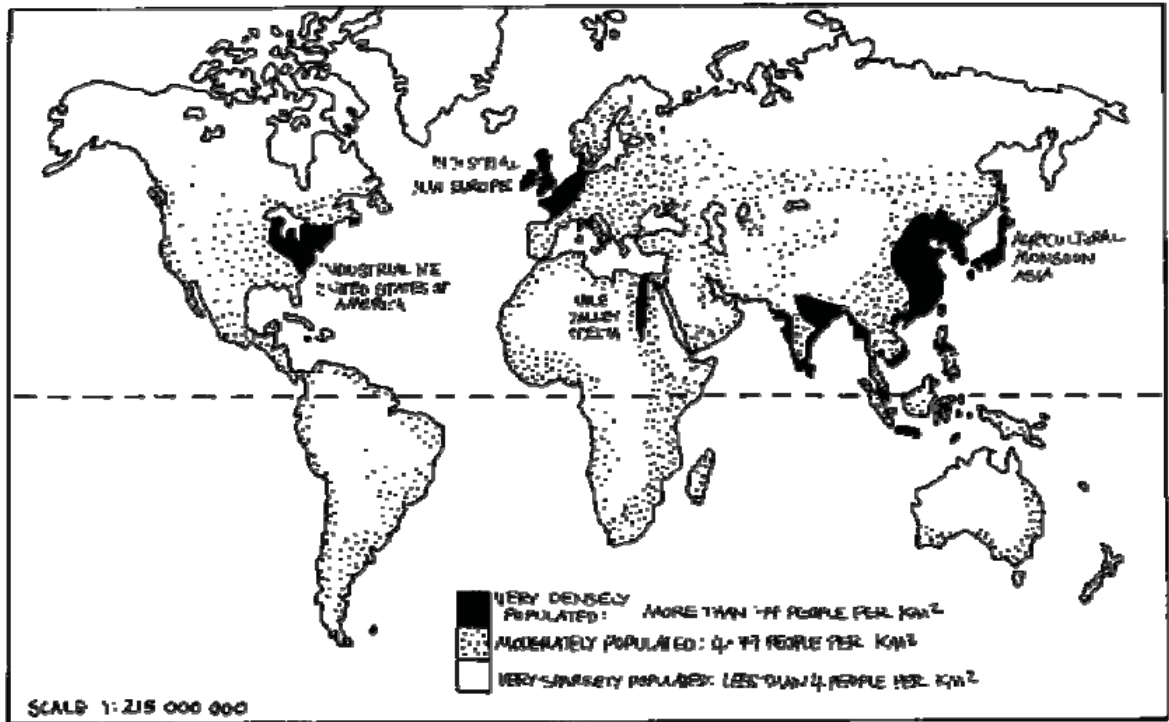


Fig 3: World map showing population distribution.

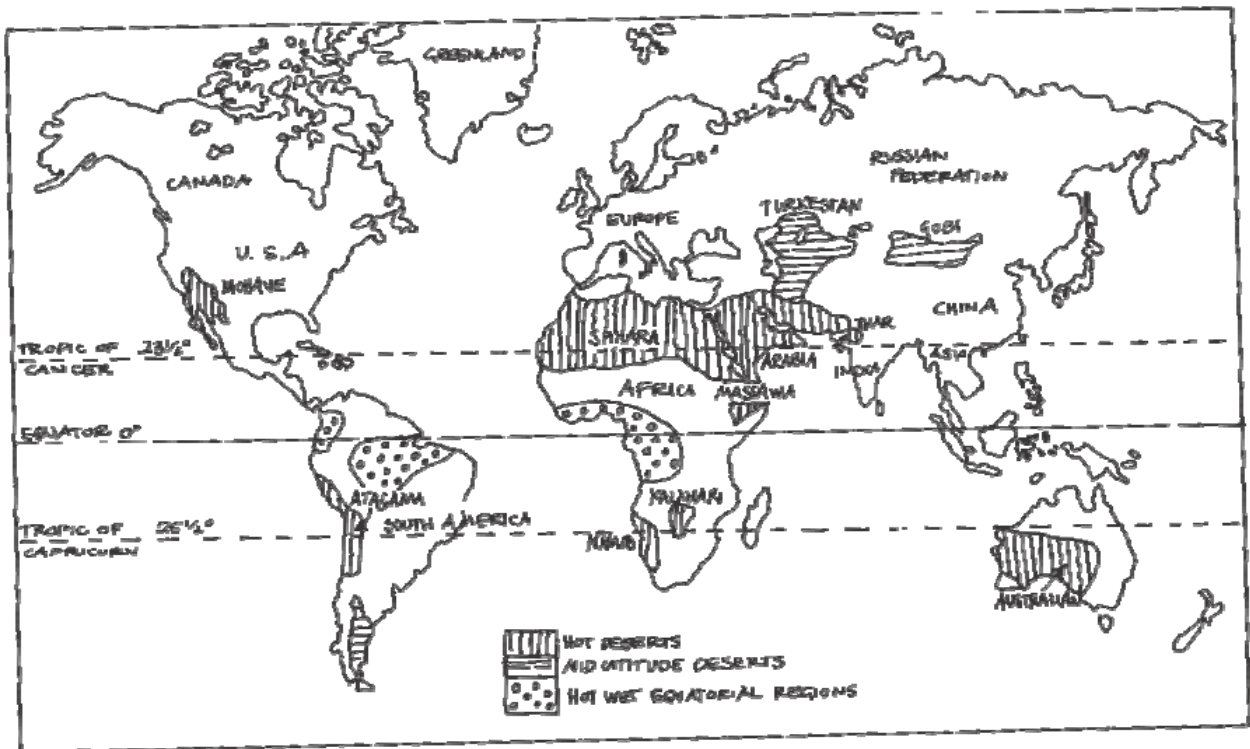


Fig 4: World map showing some climatic regions.

1. What do you notice about the way people are spread over the land surface? How would you relate world population distribution with the world climatic regions?
2. Why do you think people are distributed on the earth's surface as shown on figure 3?
3. Use figure 3 alongside figure 4 to answer the following questions.
 - a) Mention any four areas or countries with most people in the world.
 - b) Name any three areas or countries with fewest people in the world.
 - c) How would you describe the density of:
 - (i) areas with too many people?
 - (ii) Areas with very few people?

Feedback

For Question 1, if you have said people are unevenly spread with too many people in some areas, too few people in certain areas, some areas moderately populated while other are unoccupied; then you are correct. You can also see that places with harsh climates, that is too hot or too cold are sparsely or thinly populated while places with moderate climate are densely populated.

For Question 2 if you have said because of the influence of relief, climate, drainage and soils, mineral deposits, then your answers are correct.

For Question 3 the correct answers should be:

- a) River valleys like the Nile valley and countries like China, India

- b) *Mountainous areas, deserts areas, unfertile areas, extremely cold areas*
- c) *Description of population*
 - (i) *densely populated*
 - (ii) *sparsely populated.*

The map in figure 3 shows that world population is not evenly distributed. The map in figure 4 helps us to relate population distribution to climate. However population distribution is not only influenced by climate. There are other physical factors, which you have learnt about in Unit 1 that influence population distribution.

Attempt the following activity to apply population concepts to population distribution.



Activity 3

Refer to figure 3 again and the population related concepts to answer the following questions:

- (a) Why do you think that certain areas are likely to have a population explosion?
- (b) Name **four** countries that you think have their populations at optimum level?
- (c) Which **three** countries do you think are overpopulated?
- (d) Identify areas of the world you think are under populated.
- (e) Which countries do you think have high population growth rates?
- (f) Suggest reasons for your answer in (e)
- (g) List at least **four** countries that are likely to have high fertility and high mortality rates.

Feedback

The correct answers are as follows:

- (a) *Population migration, high birth rates and low death rates, increased food productivity and incomes, incentives to have children and cultures that encourage this*
- (b) *Developed countries/countries of the north/ rich countries like Denmark, USA, UK (Britain), Norway and Sweden.*
- (c) *Any three of the following: India, Bangladesh, Pakistan, Japan, China, Burma, Thailand, Java, Philippine Islands (countries in east, south and south east Asia), Britain, Germany, France, Belgium (Western and Central Europe).*
- (d) *Very cold areas e.g. the tundra, arid areas e.g. hot deserts, tropical rain forests and mountain areas.*
- (e) *Developing countries e.g. most of the African countries/ countries of the south/ less developed countries.*

- (f) *Most of the people are young or within the childbearing age, low acceptance of contraceptives, lack of sex education, children regarded as security, high birth rates and low death rates.*
- (g) *Sudan, Ethiopia, Sierra-Leone, Burundi, (Most of the African countries).*

From activity 3, you learnt how to apply concepts like overpopulation and under population. These are some of the key terms in the description of population distribution.

Did you get all the answers correct? If not, do corrections before you move on to the topic summary.



3.0 Summary

In this topic you have learnt the definitions of population-related concepts and to read population densities on a map. Population distribution is influenced by several factors, which may be physical/environmental, economic, social, and or political. Population densities vary from country to country. Population growth rates also differ from place to place depending on the factors influencing it. High population growth rates lead to population explosion, over-population, and population pressure and ultimately to shortage of resources and services provided. Low population growth rates lead to an improvement in the standard of living as population reaches optimum level. Too low population growth rates lead to underutilisation of resources.

Read through this topic once more. When you feel that you have understood the whole topic, answer the questions in the self-assessment exercise given at the end of the unit under the assignment section. Do not proceed to the next topic until you do this exercise. If on checking your answers with those provided you discover that you failed to get all the questions right, read over the relevant section of the topic again.

Once you have successfully completed the exercise, proceed to Topic 2.

Topic 2: World Population Growth and Its Consequences

Introduction

You have learnt to define population-related concepts in the previous topic. You also learnt about how various factors influence population distribution. In this topic you will learn about the factors influencing population growth rates and the consequences of rapid population growth.

Population growth rates have changed over time worldwide. Countries that have high living standards tend to control their population rates unlike the developing world. With less population growth rates these developed countries are able to cater for the needs of their people while developing countries depend on aids from rich countries. Botswana's population grows at around 3.5% per annum. If this continues into the future there will be too many people to care for with less funds and facilities. It is important to control birth rates to reduce pressure on resources such as land, food and shelter.

Topic Objectives

At the end of the topic you should be able to:

- discuss the factors influencing population growth
- describe the growth rates of population
- describe the consequences of population growth.

1.0 Factors Influencing the World Population Growth

Population growth describes a change where numbers of people are increasing or decreasing. Throughout the world the population is growing at an alarming rate. For instance in 1820 the world population was about 1,000 million and by 1930 it had doubled to 2,000 million. Now, the population had reached slightly over 7 billion in 2012. Different countries have different population growth rates. The highest growth rates are in the tropical world that is in developing countries. Have you wondered what the causes of such a rapid growth are?

Now carefully study figure 1 and try to understand the growth of population of the world and each continent from the 1950 to the year 2050. Do you think this trend will change sometime? To answer this question, study the graph in figure 1 below.

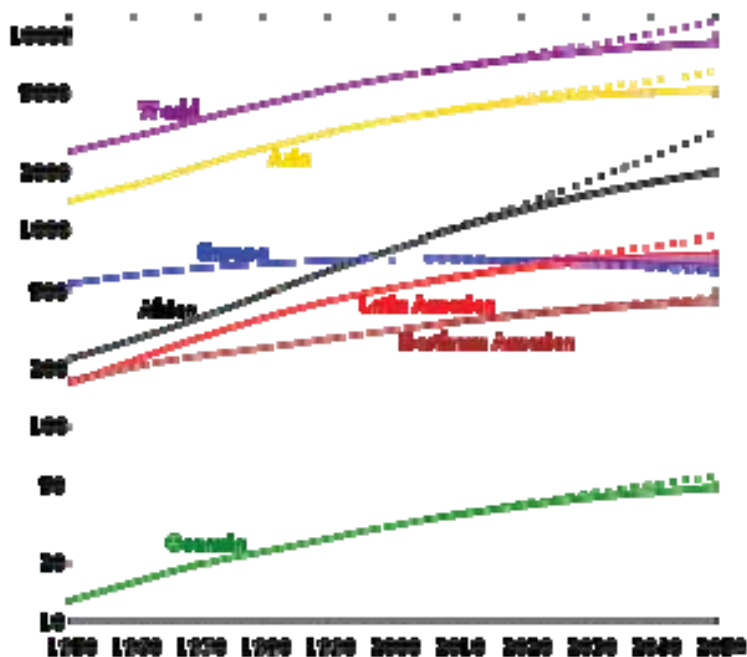


Fig 1: Population evolution in different continents. The vertical axis is millions of people. Retrieved from http://en.wikipedia.org/wiki/World_population on the 1st December 2010

According to the graph in figure 1, different regions have different rates of population growth. What is common about all regions is the upward trend of the graph indicating that the population will continually grow. What influences population growth?

Population growth is mainly influenced by factors that include:

- increasing birth rates
- decreasing death rates/declining mortality
- migration

Let us now look at factors influencing population growth rate in more detail.

1.1 Increasing Birth Rates and Decreasing Death Rates

When the number of births in a year is more than the number of deaths the population increases. When birth rates increase and death rates decrease in any place, population will increase rapidly. In the previous topic you learnt of basic meanings of birth rates and death rates, in this topic you are expected to understand exactly what birth and death rates mean. **Birth rate** means the number of live births per 1000 people in a given year.

Death rate describes the number of deaths per 1000 people in a given year.

The difference between the number of births and the number of deaths is called the **natural increase**. This can be calculated for any area or country for as long as you know the total births and deaths in a year for that area or country. The formula is as follows:

$$\text{Total births} - \text{total deaths} = \text{natural increase}$$

Suppose country X in 1966 had total births of 68 800 and total deaths of 14 200, what would be its population's natural increase? Did you say 54 400 people? Then your answer is correct.

Now give yourself more practice by doing activity 1.

The intention of the following exercise is to develop your skills in statistical analysis such as calculating by how much the population grows. Use the statistics provided to answer the questions in this section. If you find it difficult to do, keep practising over and over again.



Activity 1

Study Table 1 which shows the population of Jamaica between 1965 and 1968 and answer the questions that follow.

Table 1: The population of Jamaica in 1965 - 1968

Year	Total births	Total deaths	Natural increase
1965	69 800	14 300	
1966	71 400	14 300	
1967	67 400	13 300	
1968	65 400	14 600	

- Calculate the natural increase for each year and complete the table.
- What do you notice about total births and deaths in each year?
- In which year was birth rate highest?
- When was the largest natural increase?
- When was the smallest natural increase?
- Say in your own words what **natural increase** means.
- From the information shown on the table what would you say happens to the population of Jamaica every year?
- What do you understand by “developing countries”?
- Give **two** examples of developing countries.
- Why do you think population growth rates are high in the _____ developing countries?

Feedback

Your answers may have included any of the following responses:

(a)

Year	Total births	Total deaths	Natural increase
------	--------------	--------------	------------------

1965	69 800	14 300	55 500
1966	71 400	14 300	57 100
1967	67 400	13 300	54 100
1968	65 400	14 600	50 800

- (b) *Total births are more than total deaths in each year/ birth rates are higher than death rates in each year.*
Or
Total deaths are less than total births in each year/death rates are less than birth rates in each year.
- (c) *In 1966*
- (d) *In 1966*
- (e) *In 1968*
- (f) *The difference between total births and total deaths in a year especially where births are higher than deaths. Or, total number of births minus total number of deaths in a given population over a year.*
- (g) *It grows/ more people are born and stay alive.*
- (h) *Countries with large agricultural sector, low average income, and small but rising urban population are often referred to as less developed/third world countries.*
- (i) *All African countries, most Asian countries and Latin American countries.*
- (j) *Lack of education/early marriages, source of labour, religious/traditional beliefs, and security in old age, desire for male heirs.*

Note that this topic relates to the factors influencing the world population growth and increasing birth rates. You now know that population increase is when death rates decrease or declining mortality. You in turn know what and how to calculate the natural increase. This will help you understand factors contributing to high population growth rates. In the next section we will find out how migration is another factor influencing population growth.

1.2 Migration

Migration describes the movement of people from one place to another. It can contribute to population growth in a place or country if the number of immigrants is more than that of emigrants. **Immigrants** are people moving into an area or country, while emigrants are people moving out of an area or country. Look at table 2 showing the population growth in Botswana and then complete activity 2 to assess your understanding of the table and its implications for population growth.

Table 2: Population growth of Botswana's settlements 1991-2003 (x000).

Settlement /Year	1991	1997 estimate	2003 estimate
Gaborone	133.3	183.8	246.8
Francistown	65.2	88.3	116.6

Lobatse	26.0	29.9	34.5
Bobonong	7.7	8.5	9.4
Moshupa	11.4	13.1	15.0
Thamaga	13.0	15.0	17.3



Activity 2

Study table 2 above and answer the following questions.

- What can you say about the urban and the rural population growth rates shown in table 2?
 - Which city has the highest population growth? Give **one** main reason why this is so.
 - Identify a settlement that has the lowest population growth.
 - Briefly describe the population growth trend for any settlement shown in table.2.
 - Describe the growth of the population in Gaborone City?
- How is the birth rate like in your district?
 - Write down four factors that you think mainly influence the birth rates in your district.

Feedback

- Urban population growth rates are higher than the rural population growth rates/urban populations grow faster than the rural populations.*
 - Gaborone city in Botswana experiences the highest population growth rate. This is due to the migration of young people from the rural areas to the city.*
 - Most villages in Botswana especially those near or around cities, industrial and mining towns like Orapa, Selibe-Phikwe. Examples of such villages are Mmadinare, Bobonong, Mopipi, Tobane and Pilikwe. These villages experience the lowest population growth due to migration to cities and towns.*
 - The general trend is that the population continues to grow rapidly from year to year. By the year 2003 it was estimated that Gaborone will have the highest growth. All the settlements shown in figure 2 will experience population growth.*
 - It is the highest and rapidly growing.*
- (a) and (b) Your response will depend on what you observe in your district. You may find more information from your local library. Discuss it and compare your answer with the responses of your fellow learners. You may also contact your tutor to check if your response is correct.*

You have learnt three major factors influencing migration. In the following section we are going to look at other factors influencing population growth.

1.3 Other factors contributing to High Population Growth Rates

In this section we will learn about factors contributing to high population rates. It is important for you to realise that high population growth rates come about through the birth rates exceeding death rates or mortality rates. The birth rates may exceed death rates due to the following:

- **The demographic structure of the population** is the character of the age-sex composition of a population. Countries with a high proportion of young adults, such as Botswana, tend to have high birth rates, which lead to high population growth rates. This is characteristic of most of the developing countries. On the other hand countries or areas with a high proportion of the aged and small children will end up with low birth rates. This is typical of the developed countries.
- **Lack of education:** The more advanced the level of education reached the smaller will be the average size of families. People with no or little education tend to have large families. With education comes the knowledge and acceptance of birth control methods. Women tend to be empowered and can decide on the number of children to have together with their husbands. People opt for smaller families, as they desire material wealth.
- **Religious beliefs:** Some churches have for a long time encouraged large families to safeguard the continuance of their beliefs e.g. Muslim and Roman Catholic. These churches would oppose contraceptives and the result would be high birth rates.
- **Traditional beliefs/social customs:** High birth rates can also be encouraged by traditional beliefs or social customs such as polygamy, early marriage, desire for male heirs, regarding children as a source of labour and seeing many children as security and support in old age. In some societies men marry more than one wife and end up with many children. In others the traditional marriage age is about 16 years e.g. in India.

Throughout the world death rates are on the decline due to improvements in medical science, agriculture and living standards. Better medical services and supplies, lower death rates and prolong life today. Most of the diseases that used to claim human lives became curable. In the past, world population growth was very slow. Think of why it was so! What do you think? It was very slow because malnutrition and famine, epidemics of diseases such as cholera, tuberculosis, plague and influenza kept the death rates very high. Now think of the HIV/AIDS epidemic. You will see what the effects of this disease are in the Topic 9: **The impact of HIV/AIDS in Botswana.**

There is a connection between the rate of population growth and what happens when population increases or decreases rapidly. If people increase more than the available resources, problems arise. The following section is a description of what happens when population increases.

2.0 Consequences of Rapid Population Growth

Imagine what would happen if your family members have a lot of children. What would happen to the welfare of your family? Earlier in this topic you learnt that the population of the world is growing at an alarming rate. What do you think will happen if the world population continues to grow this fast?

Problems will surely arise, particularly in the developing countries where birth rates are highest. The world today has more than 6 billion (6,000,000,000) people including yourself. Is there enough room for everyone? Do you have enough water, air, food and land? Do the following activity to find out the kind of problems affecting the world as population continues to grow rapidly!



Activity 3

Read what each person in the diagram below is saying and then write down at least **five** consequences of a rapid population growth.



Feedback

Did you come up with any five of these answers! If you did that is very good! The following are some of the consequences of rapid population growth.

- *Poor standards of living*
- *Lack of food/hunger*
- *Shortage of educational facilities*
- *Shortage of health facilities/diseases*
- *High levels of unemployment*
- *Famine*

- *Pressure on the available resources like land and water/depletion of resources etc.*
- *Poverty*
- *Lack of clean water*
- *Lack of housing*

The list shown above shows that rapid population growth has a variety of consequences that can be very severe. You can now see that population growth does not only affect the environment but also the quality of human life. Note that consequences of population growth can also be positive. Large population growth can provide the large labour force required and can also stimulate economic growth. You will learn more about the listed consequences in Topics 3, 6 and 7 of this unit.

We have now come to the end of our topic discussion. Read the summary below to find the main points of our topic discussion.



3.0 Summary

In this topic you have learnt about the world population growth and several factors influencing the population growth rates in different parts of the world. You have discovered that different countries have different population growth rates. You can now define and calculate natural increase. You have learnt to read and interpret tabulated statistical information on population. You surely have learnt to identify problems resulting from rapid population growth or the consequences of rapid population growths.

Now, carefully read through this topic once more and then write the self-assessment exercise that follows. Do not proceed to the next topic before you do this exercise. Don't look at the answers unless you have completed the exercise and you are marking your work.

Now that you have heeded the above advice and have finished Topic 2, attempt the self-assessment exercise 2 given at the end of the unit under the assignment section. If you have failed to get all the questions right read over the relevant section(s) of the topic again.

Once you have completed the exercise and are happy with your progress, proceed to Topic 3.

Topic 3: Rapid Population Growth versus Resources

Introduction

In the previous topic you learnt about why population grows and the consequences of a rapid population growth. This topic is about how rapid population growth affects various natural resources. As the population grows, natural resources are used up. What are natural resources? You have already studied these natural resources in previous units: Units 5, 6, 7, 8 & 9. They are materials provided by nature like water, wind, land, soil, and air, veldt products, vegetation, animals, solar energy, rocks, and minerals that people use. They also include features that serve to attract tourists like the Okavango Delta, Makgadikgadi Salt Pans, waterfalls, coral reefs and sand beaches. Fossil fuels are also natural resources.

Natural resources fall into two categories, which are *renewable* and *non-renewable*. For example in Unit 9, you learnt about renewable and non-renewal energy resources. You will learn to differentiate between resources as we go along with the topic. What is likely to happen to them as population grows rapidly? Keep this question in mind and look for answers as you read through the topic.

Topic Objectives

At the end of the topic you should be able to:

- differentiate between renewable and non-renewable resources
- describe how a rapid population growth will affect the available natural resources.

1.0 Renewable and Non-renewable Resources

There are some of us who collect wood from the bush, others use gas or electricity to cook and all these are resources that we need. Tell me, what kind of fuel do you use at home? How would you identify it? Is it renewable or non-renewable? Throughout the world natural resources are used by human beings in one way or the other. You should know by now what natural resources are.

Minerals are mined, processed and exported to other countries. Trees are cut for various purposes, which include firewood, furniture making, timber, pulp and paper making. In the previous topic you learnt that the world population continues to grow at an alarming rate. It is indeed true that the world population continues to grow rapidly particularly in less developed countries. What do you think will happen to both renewable and non-renewable resources if the population growth trends do not change? This is another question that you should find answers for in this topic. For now let us differentiate between renewable and non-renewable resources.

Renewable resources are those materials provided by nature which renew themselves within short periods of time. Examples include crops, trees, wildlife, water, air, sunshine and land, which have the potential to be used on a sustainable basis without getting depleted.

Non-renewable resources are those materials provided by nature, which will not renew themselves in a reasonably short time and cannot be replenished once exhausted (finished). Examples include minerals such as diamonds, copper and fossil fuels like oil, coal and natural gas, landforms like waterfalls.

For you to check your understanding of what we have discussed so far, attempt activity 1.



Activity 1

Here is a list of some of the natural resources found in Botswana.

Palm trees (mokolwane), copper/nickel ore, reeds, soda ash, grass, coal, grapple plant (sengaparile), diamond.

1. (a) Draw a table to classify the resources mentioned above as renewable and non-renewable. Do not give examples already given.
- (b) In your own words define the terms or concepts: renewable and non-renewable resources.
- (c) Say what you think will happen to each of the resources in 1(a), if the population of Botswana continues to grow rapidly.

Feedback

1. (a)

<i>Renewable resources</i>	<i>Non-renewable Resources</i>
<i>Palm trees/Mokolwane</i>	<i>Copper/nickel ore</i>
<i>Reeds</i>	<i>Soda ash</i>
<i>Grass</i>	<i>coal</i>
<i>Grapple plant</i>	<i>diamond</i>

- (b) *Renewable resources are natural materials that can be replaced with time and can continue to be used in future.*
Non-renewable resources are natural materials that cannot be replaced within a short time; once they are finished nothing can be done to make them available again.
- (c) *They are likely to become depleted/get finished/become extinct/ reduced to very small amounts or quantities.*

You now know that when population grows it affects renewable and non-renewable resources. The non-renewable get finished while the renewable once are under pressure to satisfy the need of the people and never get a chance to renew properly. Our next section of this topic is about what happens to the resources when there is too much pressure from population growth.

2.0 Population Growth and Resources

Increasing population puts pressure on the resources and increases environmental stress. Remember how we defined **population pressure and overpopulation** in Topic 1. If population

increases too much, the available land and other natural resources may not be able to support it. Food supplies will be low and the population will starve particularly in developing countries where methods of food production and preservation are still poor. Educational, social services and employment opportunities are also pushed to the limits as population demands increase rapidly. It is important to realise that as population grows the resources do not, instead they become limited.

As population grows, over-exploitation of forests occurs and leads to deforestation. As deforestation takes place the effects are land degradation, soil erosion, increased flooding, destruction of habitats, plant and animal species extinction, species migration, trees species of medicinal value are lost. Trees also use up carbon dioxide so when they are cut there will be an accumulation of carbon dioxide in the atmosphere since there are no plants to use it. Consequently this accumulated carbon dioxide causes global warming because the layers of carbon dioxide prevent the heat of the sun to escape back into the atmosphere. The cutting of trees will also cause the reduction of forest and affect the livelihood of the groups of people like the Pygmies of the Congo Basin and the Red Indians of the Amazon Basin.

As industrialisation increases, particularly in developed countries to create jobs and produce goods for the growing population, large amounts of carbon dioxide are released from burning oil, gas, coal and from burning forest into the atmosphere, and then air pollution occurs. Non-renewable resources get used up quickly as industrialisation increases. Renewable resources like water, wood may become inadequate.

There may be acute shortages of most of the renewable resources.

Increase of carbon dioxide in the atmosphere could lead to global warming. Do you know what global warming is? Carefully study figure1 and try to understand these concepts.

Normally a balance exists where CO₂ from animals is equal to CO₂ taken up by plants. Also O₂ released by plants equals O₂ taken up by animals.

Blanket-effect of greenhouse gases (mainly CO₂, but also nitric oxide, methane and CFCs)

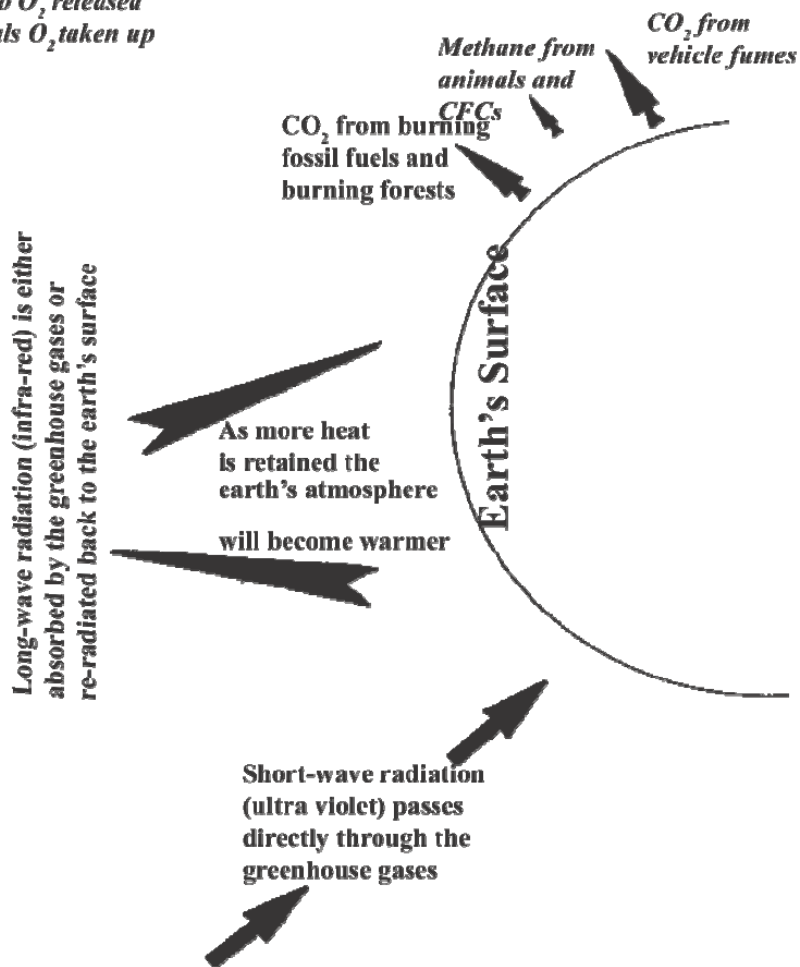


Fig 1 : Global warming

Source: Athlopheng, J. et al , (1998) : Environmental Issues in Botswana; page 142.

What do you do when there is garbage in your home? Do you just throw it anywhere? I do not think so because if you do you cause pollution. Many people own cars and many more want to buy cars. As a result, motor traffic worldwide is increasing twice as fast as human populations. You may wonder and ask “what is wrong with owning cars?” Cars produce exhaust fumes that pollute the air that we breathe. In the figure 1 you can see that fumes in the form of carbon dioxide coming from vehicles on the earth surface.

Chlorofluorocarbons (CFCs) from aerosols, food packaging, and refrigerators add problems to the atmosphere by causing the depletion of the **ozone** layer. The emission of gases into the atmosphere may lead to climatic change. Forests are cleared to increase farmland and this increases the amount of carbon dioxide released into the atmosphere. Large tracts of vegetation are cut to meet the demands of the growing population and this worsens the problem of deforestation.

As industrialisation increases more waste is produced and its disposal becomes a very serious problem. More chemical wastes are produced by industries and they pollute the environment. Water becomes contaminated and not safe to drink. Land also becomes contaminated and its reclamation may prove to be difficult and costly. Air pollution occurs and may lead to acid rain. See the effects of acid rain in figure 2.

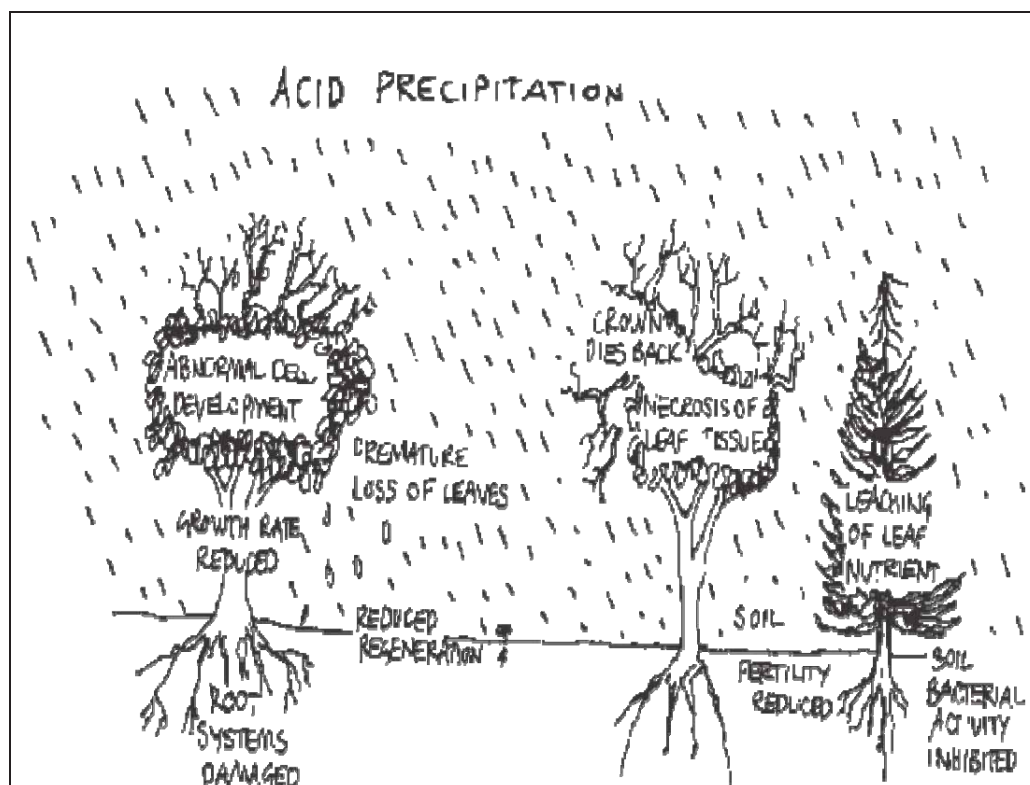


Fig. 3: The effects of acid rain

Adopted from: Nagle, G. and Spencer, K. (1997): Advanced Geography Revision Handbook, page 141.

The effects of acid rain as shown in the diagram are as follows:

- abnormal development of trees
- premature loss of tree leaves
- growth rate of trees reduced
- root systems damaged
- soil fertility reduced
- soil bacterial activity inhibited
- leaching of soil nutrients

You can now see that acid rain has adverse impact on the environment. It is formed when emissions of gases like sulphur dioxide and nitrogen oxide chemically reacts with water in the atmosphere.

Another problem, which may result from a rapid population increase, is desertification, the encroachment of desert-like conditions in a place. This problem results from poor use of land, like non-stop cultivation of worn out land, farming on steep slope, poor farming methods and poor water management. Pressures from human and animal populations aggravate land degradation. Human population cut trees for construction of settlements, for agricultural purposes and for commercial purposes and this may lead to the problems already listed in this topic. Carefully study figure 3 which depicts the factors leading to desertification and try to understand how desertification may occur in an area.

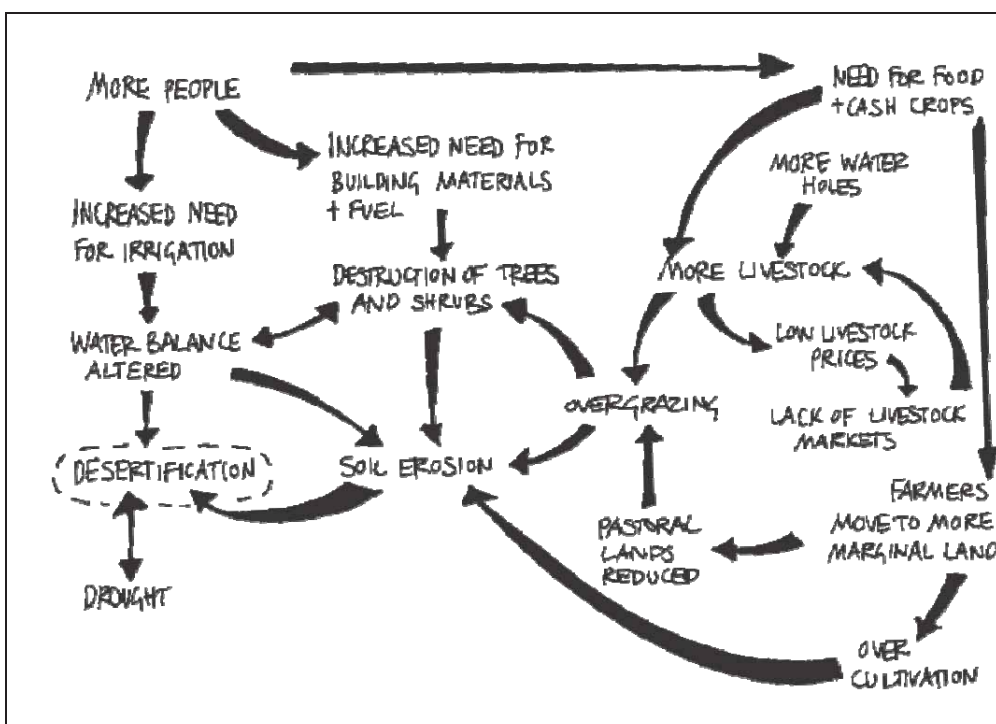


Fig 3: Factors leading to desertification

Adopted from: Nagle, G. and Spencer, K. (1997): Advanced Geography Revision Handbook, page 140

An increase in population means an increase in energy use and resource consumption. As energy use increases, coal, oil and natural gas are heavily used and the results are more carbon dioxide in the air and the depletion of those resources that are non-renewable.

In developing countries, to find food, fuel and shelter, communities are forced into bad practices such as cutting down forests, overusing and or misusing farmland, polluting and exhausting water supplies.

The next activity will help you identify problems affecting resources when there is too much pressure put on them. Do it with carefully so that you can retain this information that will assist you in caring for your own environment.



Activity 2

1.
 - (a) Make a list of resources that are affected by population growth.
 - (b) Briefly explain how each is affected by population growth.
 - (c) What do you understand by global warming?
 - (d) State at least **three** reasons why people cut trees.

2. Study the diagram below and answer the questions that follow:

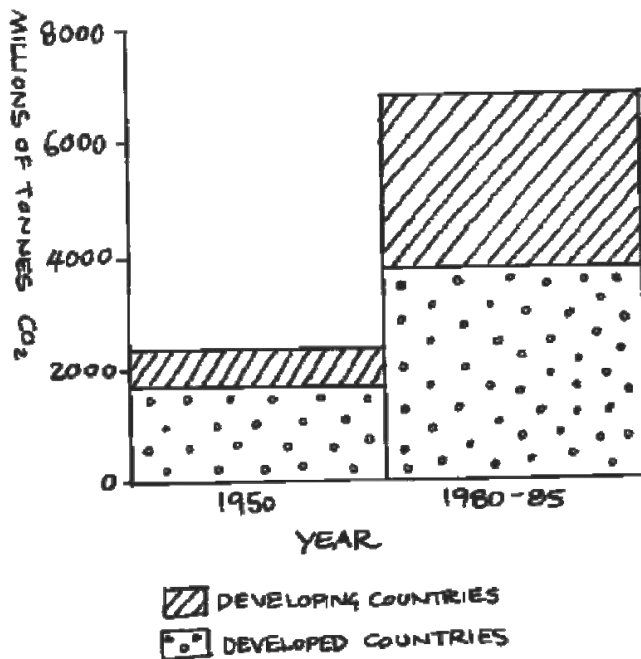


Figure 4: Carbon dioxide release in developed and developing countries

- (a) Which group or class of countries released more carbon dioxide in the atmosphere in 1950?
- (b) Propose a reason for your answer in 2 (a) above
- (c) Which group or class of countries released less carbon dioxide in 1950? Say why this may have been so.
- (d) Name resources that are affected by the carbon dioxide emissions
- (e) What happened to the carbon dioxide emissions from 1980 to 1985?
- (f) Propose a reason for the answer you have given.

Feedback

I hope you have done well. Check your answers against mine below.

1.
 - (a) Land, soil, water, air, vegetation, minerals and wildlife.
 - (b) Land: will not be enough for people's settlement, and this may lead to competition for land. Increase in population means increase in waste that need to be disposed. It also means an increase in pollution as more industries will be set up to meet the demands of the increasing population. In the process water, air, land and soil become contaminated. Minerals can no longer cater for all the people and finally get exhausted and result in loss of jobs. When a mine closes because a mineral is finished some people end up jobless. As humans increase, wild animals are pushed into marginal lands where they cannot survive. Some people depend directly on animals for food. Hence, they are likely to kill the animals faster than they reproduce.
 - (c) The rise in temperatures worldwide due to increases of carbon dioxide in the atmosphere.
 - (d) To construct buildings/shelter, to cultivate/produce crops, for fuel wood, for commercial purposes like rafters and poles for buildings, furniture and paper making etc.
2.
 - (a) Developed countries.
 - (b) Because they have more industries than the developing countries.
 - (c) Developing countries.
Their industries are less than in the developed countries and are small-scale industries.
 - (d) Air, water, land and vegetation.
 - (e) Increased drastically/greatly in both developing and developed countries.
 - (f) Population increased rapidly worldwide and industrialisation was increased to cater for the needs of the growing population.

The discussion above teaches us about the consequences of modernisation and industrialization that as people's lives improved resources are pressurised and destroyed. The following sub-topic deals with Botswana's natural resources that attract people to choose to live in certain areas, especially the eastern part. Carefully study this and appreciate the available resources in your area.

3.0 Botswana Population and Available Resources

You need to drink, eat and sleep in comfortable places. Imagine if you were made to sleep outside in the rain without shelter? It would be so unfortunate. However, in other countries there are people who live in the streets since they do not have a decent place to stay. This is not right though. The natural resources which Botswana depend on include water, wildlife veldt products (e.g. the grapple plant and wild fruits), soil, minerals, vegetation and people. People have both positive and negative impacts because they use resources from the environment. Vegetation grows slowly and is scarce in some places. The demand for fuel wood and grazing puts pressure on the vegetation.

The population of Botswana grows rapidly and exerts pressure on the land available as human activities increase and become more varied. Livestock numbers have also increased rapidly and they overgraze the land and make it easily degraded and prone to soil erosion. Water is very limited in Botswana except in the Chobe and Okavango areas. Already there is pressure on the limited water resources as population grows fast while rainfall is inadequate. The main mineral

deposits found in Botswana include diamonds, salt, copper/nickel, gold, coal and others. There is pressure on the land in the eastern side of the country where about 90% of the population lives.

In the eastern side soils are more fertile than over much of the country and this has contributed to the high population density found there. Pressure in the eastern part has led to people travelling long distances to collect firewood and an increase in the land use conflicts. Do you remember the recent land conflicts in Gaborone, Mogoditshane and Gabane? Such conflicts occur due to land shortage and lack of housing. Pressure is also exerted on the natural resources like veldt products (e.g. the grapple plant, Mophane worms) and others. Educational facilities, social services and employment opportunities are pushed to the limits as population continues to increase. Have you observed long queues at clinics and lack of admission of many students into senior secondary schools and tertiary institutions? What do you think causes these?

Do you understand why there is population pressure in the eastern part of Botswana? In Unit 4 on climate and unit 11 on agriculture you learnt that Botswana has large parts that are not habitable such as the arid and semi-arid areas of low unreliable rainfall in Kgalagadi. The very wet areas where disease causing insects can easily breed and multiply causes the **carrying capacity** of the land to be low as seen with the Okavango Delta area, for example. People are concentrated on the small habitable land found mainly along the eastern side. See the population distribution map in figure 3 in topic 1. Therefore resources available in the country need proper management in order to sustain everyone's life. You should now attempt activity 3 below, to check your understanding of what we have discussed thus far.



Activity 3

Carefully study photograph (figure 5) taken in an area in Botswana and then answer the questions that follow.



Fig.5: One way in which environment can be degraded.

Source: *commons.wikimedia.org/* Retrieved 4/2/12

- What major environmental problem do you think is shown in the photograph?
 - What other problem may occur as a result of what has taken place in the photograph?

- (c) Which **three** resources do you think are subjected to great population pressure on the photograph?
- (d) What do you think is likely to happen in the area shown if population continues to grow rapidly?
2. Explain why some countries like Botswana, with large areas of land, can still be described as having population pressure.
 3. Define the terms deforestation and desertification.

Feedback

I hope you have done this activity with ease because we have discussed a lot about resources so far, especially in Units 5, 6, 7, 8 and 9. Now check your answers against mine below.

1.
 - (a) Land degradation/overgrazing
 - (b) Soil erosion.
 - (c) Land, wildlife, vegetation, and soil.
 - (d) Desertification will occur.
2. *The available resources are not enough to sustain all the people's lives. The population has outgrown the resources available. Large areas of the country are not habitable therefore only a small part supports human settlements. Since people are concentrated on that small area, the population puts pressure on the land and other resources.*
3. *Deforestation: The cutting of forests without replacing them which leads to environmental problems like species destruction, habitat loss etc.*

Desertification: the occurrence or encroachment of desert-like conditions in an area due to mismanagement of the environment particularly vegetation.

You now understand why there is population pressure on the natural resources. This is mainly because the resources are very limited or not enough to sustain the life of Botswana. This brings us to the end of our topic discussions. Go through the topic summary to cement your learning of this topic



4.0 Summary

In this topic you have learnt about natural resources, what they are, how they are classified and how population growth affects them. You have also learnt about how population growth in Botswana affects some natural resources like land, soil and vegetation. Natural resources can be grouped as renewable and non-renewable. Rapid population growth puts pressure on the resources and as a result they either become inadequate, contaminated or get depleted. Air, land and water become polluted and reduced in quantities and quality.

Now that you have finished Topic 3, attempt the self-assessment exercise 3 given at the end of the unit under assignment section. If you fail to get all the questions correct read over the relevant sections of the topic again.

Once you have successfully completed the exercise, proceed to Topic 4.

Topic 4: Reading and Interpreting Population

Introduction

In this topic you will learn to read and interpret population graphs called *Population Pyramids*. Population pyramids are drawn after collecting information on the size and the characteristics of the country's population. They are constructed after a population census. Do you remember what a population census is from Topic 1? If you do not remember, quickly refer to the relevant section of Topic 1.

Population graphs are also known as age-sex graphs. They show population structures of countries in terms of age and sex and life expectancy of people. The population pyramids for developing countries look different from those of developed countries. You will understand and note the differences as you go on with the topic. At the end of the topic you should be able to compare the two pyramids without difficulties. The pyramids divide the population into 5-year age groups on the vertical scale and into males and females on the horizontal scale.

Topic Objectives

At the end of the topic you should be able to:

- interpret population pyramids of developing and developed countries
- compare the population pyramids for both developing and developed countries
- draw population pyramids from given statistical data.

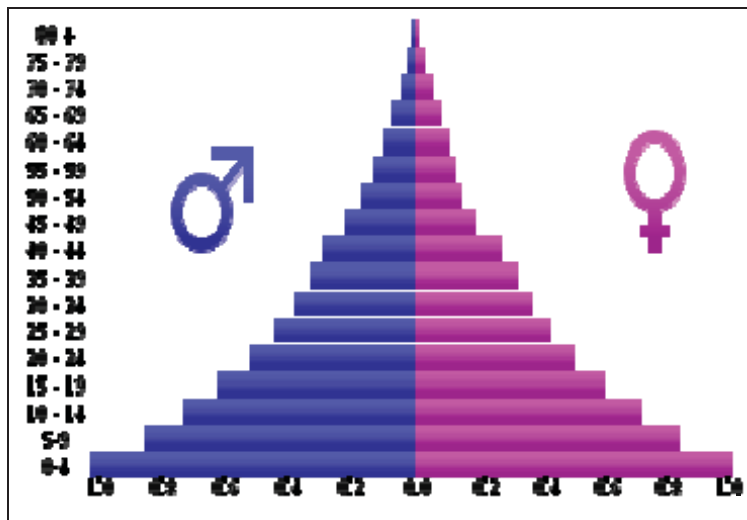
1.0 Population Pyramids

These are population graphs usually drawn to summarise population data collected during a population census. They show the proportions of people in various age and gender groups. It is very important for governments to know their people's ages and gender because these characteristics directly influence people's needs and what they do. The age and gender also influence how governments of various countries allocate their money to various services.

In the next sub-section, we will discuss the population pyramids of developing countries and thereafter those of developed countries.

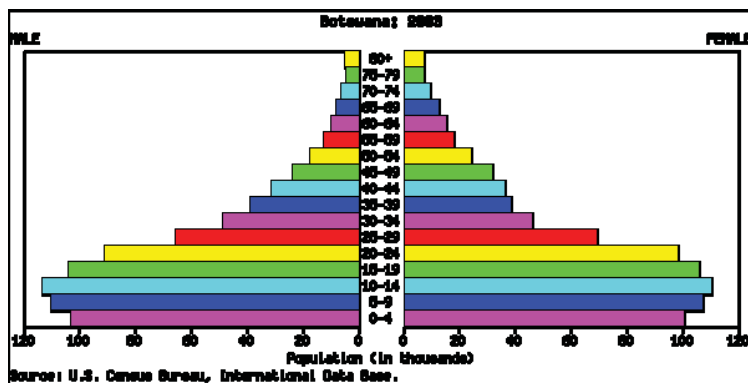
1.1 Population pyramids of developing countries

A: Angola pyramid



Source: http://en.wikipedia.org/wiki/File:Angola_population_pyramid_2005.svg Retrieved: 30/05/11

B: Botswana pyramid



Source: http://en.wikipedia.org/wiki/File:Botswana_population_pyramid_2005.png Retrieved: 30/05/11

Fig 1: Population pyramids of developing countries

Pyramids are made of bars drawn horizontally like two ordinary bar graphs turned on their sides and put together. Each bar stands for an age group. The youngest age group is at the bottom and the oldest is at the top. The lengths of bars show the number of males and females. The bars are of the same scale and equal thickness. The bars can be drawn using actual numbers of people or percentages. The bars representing males are always on the left and those representing females are on the right.

The population pyramids for developing countries have very broad bases formed by 0 to 14-year age sector. If you compare the two pyramids in figure 1 you will realise they are similar because they show population structures for developing countries. Most of the African countries are described as developing countries. However, you should be able to pick minor differences between the two. Compare the two pyramids and identify the minor differences shown. The two

pyramids have broad bases, which mean that developing countries have mostly young population. Can you see the broad bases? If the majority of the people are young it means that there are high birth rates. A population pyramid's broad base means a high birth rate.

Countries with population structures like in figure 1 are at a disadvantage because very large proportions of their budget have to provide for a large dependent population.

High birth rates means that more school places will be needed, so governments with such population structures have to set up more schools at all levels, that is, at primary, secondary and tertiary levels. They also have to aim to create a lot of employment opportunities for the rapidly growing population.

One other point that can be read off from the pyramids is that there are more females than males. This is quite common in most developing countries. However, there are instances where there are more males than females like in the population census of Ghana in 1960.

One way of checking on the structure of population is by finding out what the median age is. If it is low, say about 18 years then it means that the population is young and that it is growing rapidly. The median age is simply the age dividing the population of a country into two equal parts.

The pyramids are narrow towards the top showing that there are few old people. The narrow top indicates that the death rate is high and a low life expectancy of about 45-50 years. This is typical of population structures of developing countries. Population structure means the age-sex composition of people living in a country or an area. There are fewer people in the economically active group of 15 to 65 years. There are rapid falls upwards in each age group in both pyramids indicating high death rates. This is so because medical science is less advanced in developing countries. This explains why sometimes patients get referrals to hospitals that are outside developing countries like Botswana.

The economically active are the people who are able bodied and are working to provide for their families. This means that in developing countries there are many people dependant on relatively few workers. Children and young people still attending school and the aged above the age of 65 form the dependent group. This means that the **dependency ratio** is high. **Dependency ratio** is the number of non-working dependents in a population for every 100 workers. A high dependency ratio means the standard of living is low for the majority of the people.

This is how dependency ratio is calculated:

(Under age 16 and over age 65)

$$\text{Dependency ratio} = \frac{\text{number of dependents}}{\text{Number of workers}} \times 100$$

(16 to 65 inclusive)

See the example worked out below.

If country A has 35 700 000 as dependents under 16 years, 1 580 000 as dependants over 65 and the number of the economically active population as 45 600 000, the formula works as follows:

$$\text{Dependency ratio} = 35\,700\,000 + 1\,580\,000 = 37\,280\,000$$

$$\text{Total number of dependents} = 37\,280\,000$$

$$\text{Total number of workers} = 45\,600\,000$$

$$\frac{37\,280\,000}{45\,600\,000} \times 100$$

$$45\,600\,000 = 81.75\%$$

This means that for every 100 economically active people there are about 82 people to be supported.

Try the activity below to see if you understand what you learnt so far.



Activity 1

Study figure 2 showing the Botswana population pyramid for the 1991 census.

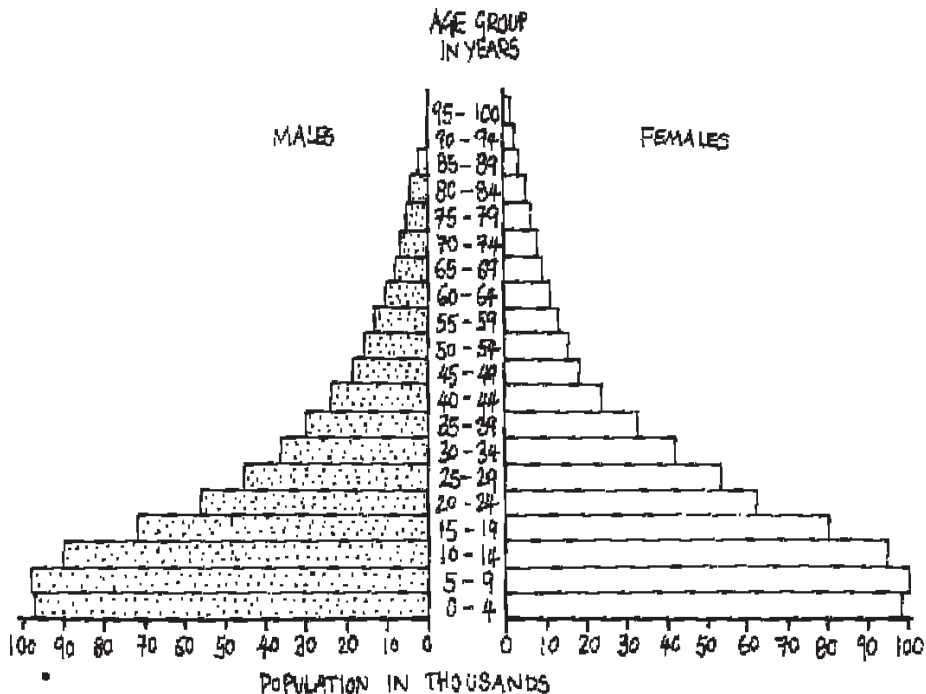


Fig 2: Botswana population pyramid, 1991.

1.
 - (a) Describe the shape of the pyramid and say what the shape indicates.
 - (b) What would you say about the sex ratio shown on the pyramid?
 - (b) How would you describe the dependency ratio as you read this pyramid?
 - (c) Given that country Y has 35 748 416 dependents and 36 470 580 economically active people, calculate the dependency ratio.
 - (d) Explain how you would interpret the answer you got in 1(c)

2. Use the population figures in Table 1 which are given in percentages to draw the population pyramid for country X.

Table 1: Population for country X in percentages

Age group	Male	Female
0-4	8.6	8.9
5-9	8.2	8.3
10-14	7.1	6.9
15-19	5.2	5.5
20-24	3.9	4.9
25-29	3.2	3.8
30-34	2.5	2.8
35-39	2.0	2.3
40-44	1.9	1.9
45-49	1.6	1.5
50-54	1.5	1.3
55-59	0.9	0.8
60-64	1.0	0.9
65-69	0.5	0.6
70-74	0.4	0.5
75+	0.6	0.7
Total	49.1	50.9

Feedback

Well I hope you have done well. Now check your answers against mine below.

1. (a) *The pyramid has a broad base indicating that the population consists of many young people/high birth rates. The pyramid has a narrow top clearly showing that there are few people reaching old age of 75+.*
- (b) *There are more females than males. Look at the top part of the pyramid for population over 95 years. You can see that it is almost nil for the male side.*
- (c) *The dependency ratio is high as indicated by the broad based population of people aged 0 to 14 and the narrow top showing people aged 67 and above (the retired).*

$$\frac{35\,748\,416 \text{ (dependants)} \times 100}{36\,470\,580 \text{ (economically active)}} = 98\%$$

For every 100 economically active people there are 98 people to be supported. This is a very high number to support.

2. *If you have plotted this correctly then the pyramid must have a broad base and a narrow top. Country X is a typical developing country.*

We have already discussed that a developing country pyramid is characterised by a broad base indicating a high population of the youth and a narrow top showing a small population of old people. The economically active population is very small compared to the dependent population.

In the next section you are going to learn about the pyramids of developing countries. It is very important to note the difference between the pyramids of developing countries and those of developed countries.

1.2 Pyramids for developed countries

Study the pyramids of the developed countries in figure 3.

Developed Country Japan

Developed Country Sweden

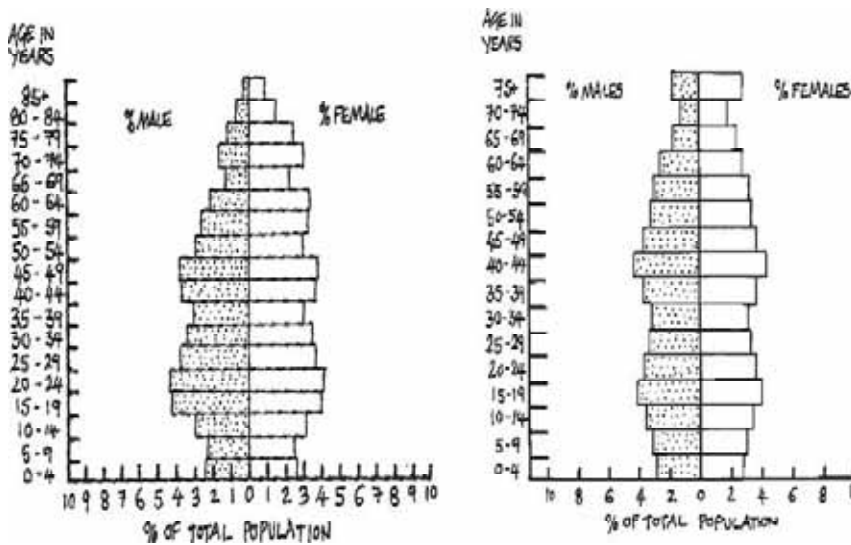


Fig.3: Population pyramids for developed countries

Look at the bases of the pyramids in figure 3. What have you noticed about them? Population pyramids for developed countries have narrow bases, an indication that the birth rates are falling or declining so there are few children. Usually, they have wide or broad tops indicating that there is a large number of old people, or there is an aging population in each country. The reason for this is that there are low death rates so people are able to reach the ages of 80 and 80+. Countries with such structures of population are described as having long life expectancies or life-spans. People are able to live longer because medical science has greatly advanced in these countries. A lot of diseases can be cured. The aging population means that the governments of developed countries have to spend more money in constructing more old age homes and have to cater more for old age pensions. They also have to spend more money on medical care for the aged.

Look at the pyramids in figure 3. What do you notice about them? What small differences can you pick between them? Sweden has a small proportion of its population in the pre-reproductive

age groups and a larger proportion in the post- reproductive groups. Therefore birth rates are low. There is a fall or decline in the total population.

The following activity is a reminder of what population pyramids are and how they operate. Complete this exercise to help you retain more information on population distribution and growth.



Activity 2

:

Study figure 3 showing pyramids for developed countries and answer the following questions.

- (a) Describe the shape of the pyramid shown in figure 3 and say what it means about the population structure shown.
- (b) What could be the reasons for the descriptions you made in (a)?
- (c) What can you say about the dependency ratio shown in this figure?
- (d) Given that country F has 42 000 800 economically active people and 20 100 000 dependants calculate the dependency ratio.
- (e) How would you interpret the answer in (d)?

Feedback

Your answers may have included any of the following responses

- (a) *You must have observed that both pyramids have a narrow bottom indicating a drop in numbers of children being born/ low birth rates/there are few people in the childbearing age. The top is wide/broad indicating that there are many older people surviving/ there are long lifespan/life expectancies.*
- (b) *Probably people plan their families and also use contraceptives. Long lifespan may be due to improvements in medical science/advancement in medical science making a wide range of diseases to be curable.*
- (c) *The dependency ratio is low. How do we know this? You can see that the population of the economically active population is relatively high to the dependency population.*
- (d) *This is calculated by dividing the number of economically active people by the dependent population. The answer you get is multiplied by 100. From this calculation you should get 47*
- (e) *For every 100 economically active people, that is, people that are working, there are 47 people to be supported.*

You can now read and interpret population graphs and statistics. You have noted the differences in the shapes of pyramids for developing and developed countries.

Read the summary below to cement your learning of the topic



2.0 Summary

In this topic you have learnt about population graphs called pyramids, how they are drawn and how they are interpreted. You have also learnt about the economic implications of population structures for both developing and developed countries. You have seen that population pyramids for developing countries almost look alike. You must have also noticed that those for developed countries also look the same. On the other hand you have seen that those population pyramids for developing countries are very different from those of developed countries.

You have come to the end of this topic. Go over the topic once more before you do the self-assessment exercise. Now that you have finished Topic 4, attempt the self-assessment exercise 4 given at the end of the unit under assignment section. If you fail to get all the questions right read over the relevant section of the topic again.

Once you have completed the exercise, proceed to Topic 5.

Topic 5: The Demographic Transition Model

Introduction

In the previous topic you learnt how to read and interpret types of graphs called Population Pyramids. You gained knowledge on how they are drawn and how they are interpreted. In this topic you will study another type of graph called *The Population Transition Model (PTM)*, a combined line graph. This type of graph has been derived from the study of birth and death rates for several industrialised countries in Western Europe and North America. The model was developed suggesting that all countries have their population passing through similar demographic transition stages or cycles.

You will also learn about the population of Botswana and be able to project the population's future trends. You should be able to place the population of Botswana in one of the stages of the Demographic Transition Model and even explain why you think it falls in that stage.

Topic Objectives

At the end of this topic you should be able to:

- describe the different stages of the Demographic Transition Model
- explain the different stages of the Demographic Transition Model
- explain Botswana's position in the Demographic Transition Model
- project future population growth of Botswana.

1.0 What is the Demographic Transition Model?

We are going to look at how a population changes over time. For example, think of the population changes that will take place in Botswana for hundreds of years! This is called the Demographic Transition Model, which is a population combined line graph that describes a sequence of changes over a period of time in the relationship between birth and death rates and overall population change. As indicated in the introduction, the model is based on observed population studies of some industrialised countries in Western Europe and North America. The model suggests that all countries pass through similar demographic transition stages (population cycles), or will do so some time in future. Most of the developed countries are in stage 4 while the majority of the developing countries are in stage 2. The model is used to show how the population growth of the country changes over time. It can also be used to compare rates of population growth between different countries at a given point in time. See figure 1, showing the Demographic Transition Model (DTM).

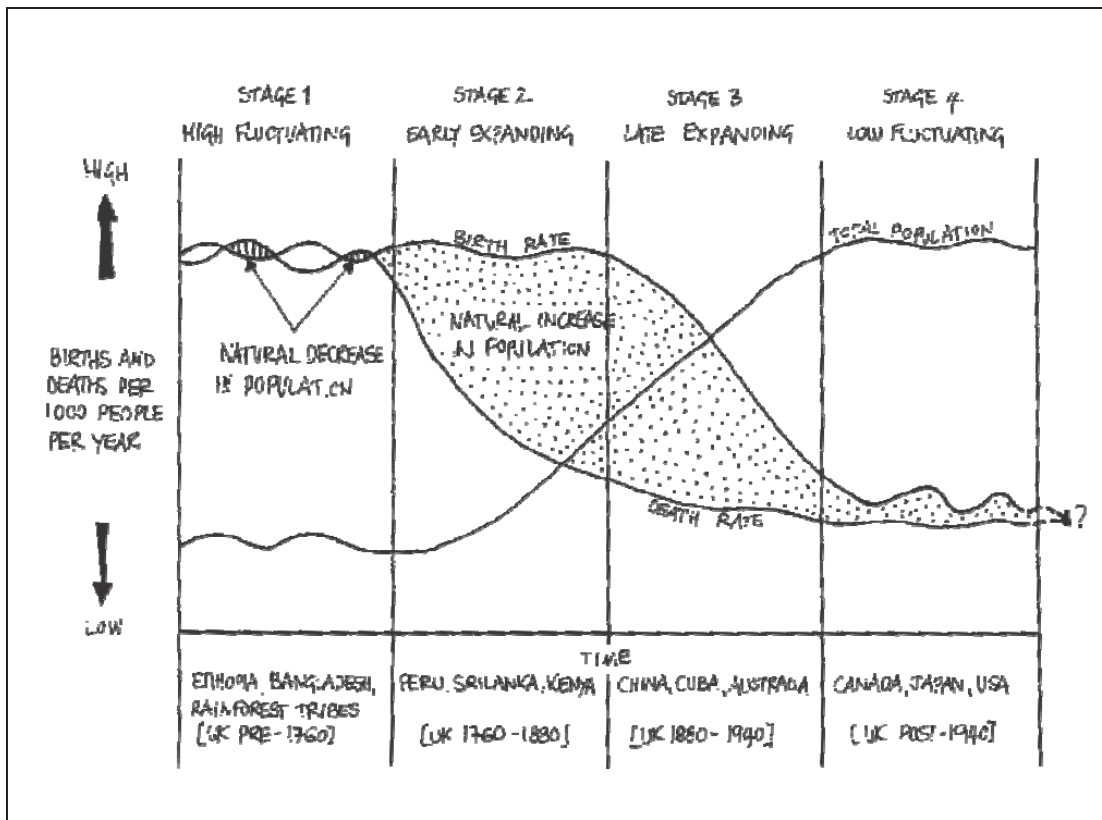


Fig. 1 The Demographic Transition Model

Adopted from http://en.wikipedia.org/wiki/Demographic_transition

The Demographic Transition Model (DTM) is used to predict how population for any country will change from time to time. It may be a difficult concept for you. What you need to do is study the stages closely and understand the description that goes with it. It takes a lot of practice to appreciate it. Now we are going to look at the stages of the DTM.

2.0 Describing the Different Stages of the Demographic Transition Model (DTM)

Studying the DTM in figure 1, can you see the different stages? How many stages are shown? Surely you can see four stages on the graph! Good! Now can you describe the trends of the birth and death rate graphs in each stage? Let us look at each stage at a time and describe it.

Stage 1: You can see that it is labelled, '*High fluctuating*' what do you think this means? To fluctuate means to rise and fall in short time periods. So it means that birth and death rates are high but are rising and falling all the time in this stage. Can you observe that when both birth and death rates are high and fluctuating there is a small population growth? There is a small natural increase in population at this stage, meaning that there is a slow population growth.

Stage 2: 'Early expanding' What do you understand by 'expanding' in this stage? To expand is to increase in size. What is increasing in size on the graph at this stage? Did you say population? If yes, that is a very good observation! In this stage birth rates remain high and slightly fluctuate, but death rates fall rapidly. You can see a steep fall in the death rate line graph at this stage. A rapid population growth begins in this stage. See the space between the two line graphs. It is showing rapid increase in population. Remember what you learnt in the previous topic? When the birth rates are higher than death rates, then population increases rapidly. There is a steep rise on the total population graph. It shows a fast population growth.

Stage 3: 'Late expanding' What are your observations here? Can you see any change in both the birth and the death rates? If you said that birth and death rates are declining or falling, then that is a very good response indeed! Now look at this stage again you will notice that birth rates are now falling rapidly and death rates continue to fall slightly resulting in a slow increase in population. In this stage, although birth rates fall rapidly, they are still higher than death rates. So the population continues to increase but slowly.

Stage 4: 'Low fluctuating' What are your observations here? How are the birth and death rates? What happens to the total population? Your observations should be that both birth and death rates remain low, fluctuating slightly with a steadily growing population. It is important to notice that the birth rates continue to be higher.

Activity 1 below will further assist your understanding of the Demographic Transition Model.



Activity 1

Study figure 1, again to answer the following questions.

1. (a) Where on the Demographic Transition Model would you place Botswana?
(b) Give reasons for your answer in 1. (a).
2. (a) Which country in Western Europe would you place in stage 4?
(b) Give reasons for your answer in 2. (a).

Feedback

I hope you got all the answers correct. Check your answers against mine below.

1. (a) *You must have placed Botswana at Stage 2*
(b) *Stage 2 indicates continued growth of birth rates and decreasing death rates. This is evident of Botswana as birth rates continue to remain high while death rates decline rapidly/ there is still a rapid growth of population(except of course death due to accidents and HIV/AIDS).*
2. (a) *In stage 4 you would place developed countries like UK or Britain/France/Portugal/Spain,*
(b) *You have observed that stage 4 has both birth and death rates remaining low and giving way to a steadily growing population. This is typical of developing countries.*

The sub-topic on the Demographic Transition Model we have just dealt with explains it to us in simple terms. Congratulations if you have made a good attempt. Now we are going to learn about the different stages involved.

3.0 Explaining the Different Stages of the Demographic Transition Model

You have studied the description of the different stages of the DTM. Now you have to learn about why it is as described in each of the stages of the model. Do you understand the difference between ‘describing and explaining information?’ When you describe you give an account of what you see (or how an object looks like) in words, but when you explain you justify by giving reasons why it is the way it is. Now let us look at the stages of the Demographic Transition Model.

Stage 1: The birth rates are high because this marks a period when:

- No birth control or family planning was used
- So many children would die in infancy and parents tended to produce more hoping that some will survive
- Many children were needed to work on the farms
- Many children were regarded as a sign of virility
- Some religious beliefs encouraged large families for the continuance of their beliefs e.g. (Roman Catholics, Muslims and Hindus).
- Death rates are high particularly among children due to:
 - Diseases (plague, cholera, marasmus, kwashiorkor and other hunger and malnutrition-related diseases)
 - Famine, uncertain food supplies and poor diet
 - Poor hygiene: no piped clean water and no proper sewage disposal
 - Undeveloped medical facilities with few doctors, few hospitals and clinics and also limited medication

Stage 2: The rapid fall in death rates results from:

Improved medical care: People are vaccinated against diseases, there are more hospitals, clinics and doctors. There are new scientific inventions and introduction of new medical drugs. There is improved sanitation and clean water supply.

Improvements have taken place in food production, more food is produced and it is of better quality

Improvements have occurred in transport, food, medicine, doctors and other essentials can easily reach the population

A lot of diseases are now curable so there is a decrease in child mortality.

Examples of countries still in this stage include Botswana, Egypt, Uganda and Brazil Because of all the above points, life expectancy increases.

Stage 3: The rapid fall of birth rates may be due to:

The introduction of family planning and birth control methods: Contraceptives, such as condoms, pills etc sterilisation e.g. vasectomy, abortion and government incentives e.g. the government taking responsibility to educate one child in the best schools for the complying families. Education reaches more people and they accept to plan their families and control births. Old traditions and beliefs become weak. Use of contraceptives becomes widely accepted.

A lower infant mortality rate leads to:

- less pressure on people to bear many children.
- Increased industrialisation and use of machines mean fewer labourers are needed.
- Increased desire for material possessions (cars, holidays, bigger houses and expensive lifestyles) and less for large families, as they are too demanding.
- Increased incentive to those who choose to have smaller families.
- Improved status of women (emancipation) which enables them to follow their own careers rather than being mainly child-bearers.

Have you observed any change in the status of women from the traditional lifestyles to the modern ones? Surely you should have? Examples of countries in this stage are Spain, Portugal, New Zealand and Canada. Population growth rate becomes rapid at first then slows down.

Stage 4: Birth and death rates slow down.

They remain low, but birth rate tends to fluctuate more than the death rate. This shows that further economic development takes place and people continue to plan their families and control births.

This shows that both birth and mortality levels are low and the rate of population growth is small. Population is stable or grows very slowly. This indicates economic wealth and high standards of living. Germany is an example of a country in this stage.

You should now attempt activity 2 below so that you can learn more about the Demographic Transition Model. You are asked to identify stages of certain countries and explain why you think they are at that stage. This will help you apply the concept than just knowing about it.



Activity 2

Use the Demographic Transition Model figure 1 on page 54 to answer the following questions:

1.
 - (a) Would you describe Britain as a developing or a developed country?
 - (b) Give reason for your answer in 1(a).
 - (c) Explain why Britain had a high birth rate between 1700 and 1760.
 - (d) Why did Britain have a rapidly declining death rate between 1760 and 1880?
 - (e) In activity 1 you clearly indicated that Botswana is in Stage 2. Why did you say so?

- (f) Explain why birth rates continues to be high despite the introduction of family planning and birth control methods.
- (g) What birth control measures would you suggest to governments of developing countries like Botswana?

Feedback

Check your answers against mine below.

1. (a) *Britain is a developed country. Remember that in the previous topic we gave Britain as an example of a developed country.*
- (b) *Britain is rich and highly industrialised/has long gone past stage 1, 2, and 3.*
- (c) *During that period Britain was in stage 1 with no family planning and birth control methods. Children were required to provide labour. Some religious beliefs encouraged large families.*
- (d) *There was improvement in medical care: people were vaccinated against diseases, hospitals increased specialist doctors in various ailments were available, new scientific inventions were made e.g. X- rays, more drugs produced. This made a lot of diseases that were bothering people to be curable. Sanitation improved as well as the supply of clean water. Diets improved and food was available in large quantities.*
- (e) *You must have observed that Botswana is still in stage 2. This is evident from its population structure and the fact that the country is not highly industrialised.*
- (f) *Botswana continues to experience high birth rate because of low acceptance of the use of contraceptives, lack of education/lack of knowledge on how contraceptives are used. Peer pressure, poverty and desire for material things.*
- (g) *Birth control measures that could be used includes*
- *Have clear population policies in place, e.g. 'two-child' policy i.e. every woman to have a maximum of 2 children.*
 - *Public education on how to use contraceptives; peer discussion group/ engage the youth in some community action groups geared towards contributing to the betterment of their lives e.g fund-raising for a community project, poverty alleviation by the government. Women should be more empowered/improve the status of women to give them greater control over their sexual and reproductive lives. Churches should encourage the youth to abstain from sex until they marry. Young married couples should be encouraged to use contraceptives.*
 - *Postpone the marriage age too. Non-governmental organisations particularly those aiming to protect the rights of the children (Childline, BOFWA) and those meant to counsel and guide children should be supported by the government to educate the youth on population and family life education.*

The descriptions of the different stages of the Demographic Transition Model are based on the birth rates, death rates, mortality rates and why they happen, including their consequences. It assists you to remember some of the factors you dealt with under the topic on factors influencing population growth. So you do not only learn about the stages but are reminded of your previous topic. This is a good thing because you will not easily forget these details.

We are in the next section going to focus our attention on the situation in Botswana.

4.0 Population Trends and Future Projections for Botswana

Data on the number of people, like in any other country are crucial for economic planning, especially because many population characteristics are changing at a fast rate. A national census is taken every ten years. The previous population censuses was in 1991, 2001 and 2011.

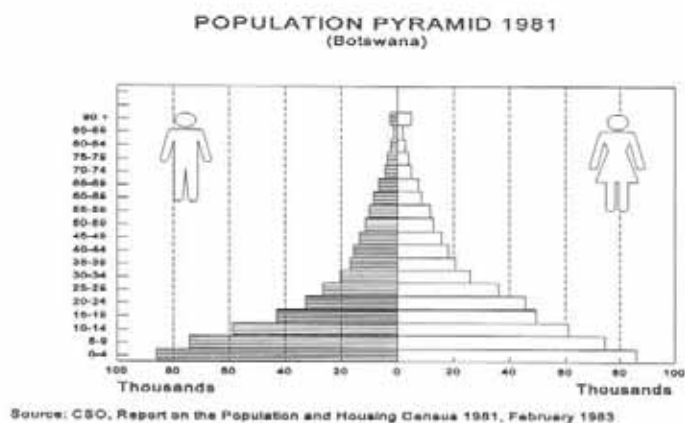
The main features of the Botswana population are that:

- it is small in relation to the size of the country. However, it is important to think of the population in terms of habitable land
- it is growing rapidly as a result of high fertility and declining mortality rates
- there is consequently a high proportion of children and young people
- infant mortality is declining and life expectancy is increasing.

Study the population Pyramids for 1981 and 1991 shown in figure 2.

1981 Pyramid

Figure 1.3 Population Pyramids, 1981 and 1991



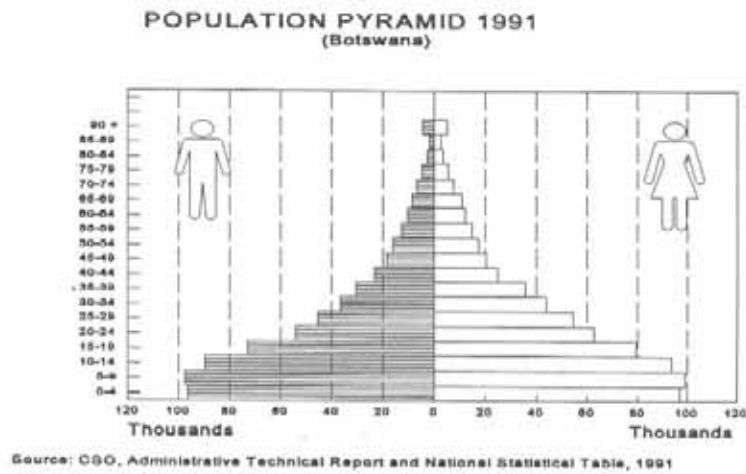


Fig.2: Population Pyramids for 1981 and 1991

Source: Botswana National Development Plan 8, page 16

What do you think the pyramid based on the 2011 census will look like? Do you anticipate any changes in the shape of the pyramid? If so, why? If you answered yes, you are right in thinking like that because of the HIV/AIDS pandemic and road accidents, which mainly claim the lives of the youth and the economically active population groups. Let us wait and see what the changes will be, once the census results are published.

If the population continues to grow at an annual rate of 3.5%, then the trend is that the population will continue to increase.

This activity is more statistical. You have already done one that requires you to do some calculations. You will find it easier to do these as you keep practising.



Activity 3

Carefully study figure 2 above and write down at least **four** differences between the 1981 and the 1991 population pyramids

Feedback

From the graph I hope you have noted the following differences;

- *1981 there were fewer people than in 1991 as shown by a broader base for 1991 pyramid*
- *there were more people in the reproductive age than in the 1981 pyramid*
- *More females than males in the 1991 pyramid than in the 1981 pyramid*
- *More males in the 1991 pyramid than in the 1981 pyramid*
- *A lower life expectancy in 1981 than in 1991.*

If you have not done well, go through this activity again.

It's now time to go on to the topic summary to recap what you have learnt.



5.0 Summary

This topic was about how to read and interpret a combined line graph called the Demographic Transition Model. From what you have learned, you will be able to describe and explain the four demographic stages, and to place different countries including Botswana on the appropriate stages. A description and explanation of the Population Transition Model has been provided. You must know that this model is 'Eurocentric' meaning that it is 'centred in Europe' and that it is an assumption that all countries would at one time pass through the 4 stages. However, it seems very unlikely for some less developed countries to become industrialised and reach stage 4.

You have also learnt about the characteristics of Botswana population and its future trends in the face of the HIV/AIDS scourge, which claims the lives of the majority of the youth. The recent population census took place in 2001, and we are expecting the results from the 2011 census soon. We are yet to see how the population structure will be affected.

I suggest you read through this topic carefully once more before doing the self-assessment exercise. Now that you have finished Topic 5, attempt the self-assessment exercise 5 given at the end of the unit under assignment section. Thereafter, compare your answers with those I suggested at the end of the unit. If you fail to get all the questions right read over the relevant section of the topic again.

Once you have completed the exercise, proceed to Topic 6.

Topic 6: Population Movements

Introduction

In this topic you will learn to define migration and to differentiate between different types of migration. Migration refers to the movements of people from one place to another. Remember in the last topic you learnt about people and how they increase and decrease in the world. People move from place to place for various reasons. Have you ever moved from one place to another? If yes, what are some of the reasons why you had to move?

Throughout the world people mainly move between two places that is from rural to urban centres. Do you know what urban and rural areas are? If you don't, check the meanings of *urban* and *rural* in your English Language dictionary. The movement of people from one place to another has a serious impact on the available resources. Do you remember learning about the impact of people on resource in Unit 5 on water resources, Unit 6 on wildlife resources, Unit 7 on forests and veldt resources, Unit 8 on rangelands resources and Unit 9 on energy resources? You surely should remember these units, because in each of those units we discussed and assessed the impact of people on available resources. In this topic we will go further to assess population movements and evaluate their impacts on the available resources.

Topic Objectives

At the end of this topic you should be able to:

- define migration
- differentiate between types of migration, for example: local, regional international, internal and external, temporary and permanent
- critically assess population movements and evaluate their impact on available resources.

1.0 Migration

Some of us always move from the village to the lands for farming and spend a few months looking after crops. When crops are ripe, we harvest and go back to the village. This is a form of migration. Describe your movement between places such a lands, cattle post, village, town, cities and reflect on this as you read through this topic.

Migration can be defined as the movement of people from one place to another, which includes either a permanent or temporary change of home. It also involves seasonal and daily movements. It includes movements between countries, continents and within a country or a continent. As you have seen in Topic 3, migration affects the distribution of people over a given area as well as the total population of an area. Let us begin by discussing the types of migration.

2.0 Types of Migration

There are several types of migrations depending on where people move to and from. Thus you have internal, external, international, temporary, seasonal and permanent migration. We are going to learn what is involved in each type.

2.1 Internal migration

This refers to population movement within a country, say for example, within the borders of Botswana. People who have moved from their original residences in some settlements to other settlements are described as internal migrants. The movement can be described as being local to Botswana. It can also be used to describe the movement of people within a specific continent say Africa. If people move within African countries the migration may be described as being internal with respect to the African continent. The movement can also be described as being local to the African continent. Internal migration may either be temporary or permanent. Examples of permanent internal migration include rural-urban migration, region to region migration, rural-rural, urban - rural and urban-urban. Internal migration involves mainly movement from rural to urban areas. This is the most important form of migration affecting the world nowadays. Examples of temporary migration include seasonal movements like from villages to lands or cattle posts during rainy seasons, weekly/monthly or periodic and daily movements. For example, from farming areas to towns to sell the farm produce.

You probably have moved from your original settlement to the present one. Find out from one of your elders where you originate. Again find out why your people had to move from their original home to the present. If your people have never moved from their original homes do they intend to move to some place? Find out why they would like to move. People have several reasons why they move within their own countries or locally. Internal or local migration includes:

- Rural-urban migration in which large numbers of people leave rural areas to seek jobs in urban areas.
- Regional migration in which people leave certain regions and move to other regions for a higher amount of rainfall and better soils.
- Seasonal movements like where Batswana move in one season to the lands to grow crops and back to the villages after harvest.
- Daily movements which includes rural to rural daily movements from homesteads to fields or grazing areas and urban to urban commuting to work places.
- Urban to rural e.g. people in towns retiring from work, going back to their original villages.

You now know a lot about internal movements or migration. This is because you are somehow part of this type of migration. Note that not all movements take place internally, sometimes people move outside their boundaries or borders. Let us now look at international migration.

2.2 International migration

This describes the movement of people between countries which involves greater distances than is the case with internal migration. In this movement people leave their home country for a foreign one to face a completely different physical and social environment. Just like with internal migration, it can be either permanent or temporary. It includes:

- Movement of people from one region to another which may be within a continent; for example some Batswana, some Zambians and some Zimbabweans migrate to South African Witwatersrand for work. It may also be between continents, like people from developed go to developing countries and vice versa for various reasons.
- Movement of people from a developing country to a developed one is also known as intercontinental migration. For example, the movement of Botswana students to USA, UK and Australia.

- Seasonal movement of some people from a developed country to a developing one for a pleasant climate or just for pleasure (tourism purposes).

Figure 1 below compare internal and international migration and is a useful summary of our discussion above.

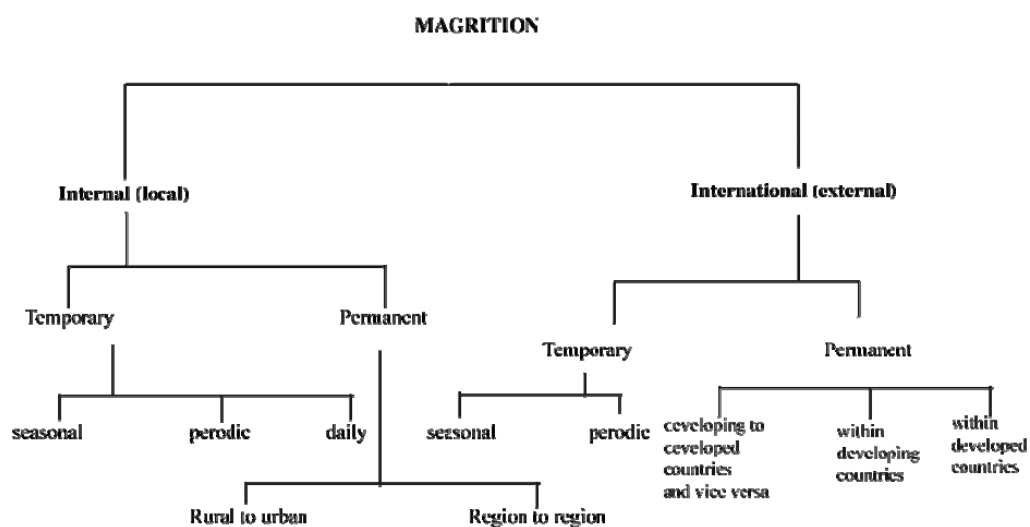


Fig 1: Comparison of internal and international migration

It is important to know that some movements made by people are **compulsory** or forced and others are **voluntary**. Find out from your English dictionary what compulsory means. What about the word 'voluntary', do you know what it means? If you don't, find out the meaning from your dictionary, too. Compulsory movements come about as a result of being unhappy due to violence or ill-treatment in an area. They result from warfare, civil strife and persecution. These conditions cause people to migrate as refugees. Do you know what refugees are? If you don't refer to your dictionary! Many of the compulsory or forced migrations that have taken place have either resulted from religious, political or economic reasons. An example of forced movement is that of slave trade (removal of the black Africans from Africa to work in the plantations of the recipient countries) began by the Portuguese in the fifteenth century and later by the Spanish, Dutch, French and British. Forced migration can also occur as a result of natural disasters like frequent floods, volcanic eruptions and famine.

Voluntary movements are by human choice. People make decisions to move for various reasons, which may be physical, economic, political or social.

Concerning physical reasons people may want to move from a dry area to a wet one or from an extremely cold area to a warm one. Economical reasons: people may move from areas where there is scarcity of jobs to where there are more jobs. Political reasons: people may decide to leave politically unstable areas to the politically stable ones.

It is important to understand what migration is, why and how it occurs. The activity here will challenge your understanding of the movement of people from place to place.



Activity 1

1. Define the term 'migration'
2. What is the difference between compulsory and voluntary movements?
3. Classify these movements under 'compulsory' and 'voluntary migration': forced labour or slavery, high salaries, British doctors to the USA, resettlement by government, retirement to a warmer climate, movement for social amenities and services, lack of food and famine as in Ethiopia.

Compulsory Migration	Voluntary Migration

4. (a) Pick from Fig.1 above at least **three** types of common voluntary movements you have recently made or have seen others make.
 (b) Say why you or they had to move.
5. Which of the movements shown in figure 1 is the most popular in the world?
6. Where and when do most people mainly engage in frequent daily movement?
7. Give examples of internal seasonal movements in Botswana

Feedback

I hope you got all the answers correct. Check your answers against mine below.

1. *The movement of people from their homes to somewhere else for different reasons, which may include work, education, to more pleasant areas and tourism.*
2. *Compulsory movements are forced whereas voluntary movements are by human choice.*

Compulsory Migration

Voluntary Migration

-Forced labour or slaves

-High salaries: British doctors to the USA.

-Lack of food and famine as in Ethiopia

-Retirement to a warmer climate

-Resettlement by government

-Movement for social amenities and services

4. (a) *You may have picked seasonal, daily, rural-urban, region-region movements.*
 (b) *You may have moved for farming purposes/ work, business, education, touring or any social activity like wedding or funeral.*
5. *Rural – urban which may either be international or internal is the most popular movement.*

6. *In urban areas when people have to go (commute) to work on a daily basis.*
7. *Tourist movements, movement during the rainy season to the lands to cultivate the land and movement back to the villages after harvesting.*

You can now give a description of the types of migration. Next, we are going to look at the reasons why people tend to move from place to place. You have moved from time to time due to different reasons. Now find out more about people's movement.

3.0 Reasons Why People Move

People move from their original places for many different reasons. People may leave their original residences in some settlements due to '**push factors**' that encourage emigration (movement out of the original residence or settlement). These are factors that make life difficult or unpleasant in an area and make one to leave for a better place. Examples of push factors include physical, economic, social and political conditions.

- **Physical conditions.** Harsh environmental conditions e.g. deserts; difficult relief and poor soils can make it difficult for people to earn a living. Some natural hazards can also compel people to migrate for example volcanic eruptions, earthquakes, floods, drought and famine. People will migrate to where there are '**pull factors**' that is to where the climate is pleasant, the relief is gentle, soils are fertile, areas are free from natural hazards.
- **Economic factors.** Lack of jobs/unemployment, low wages, poverty, starvation and poor or low standards of living and poor sanitation are push factors that make people move to where there are more jobs, higher wages, better or higher standards of living. Employment is normally available in mining areas e.g. the Witwatersrand in South Africa, the Copper belt in Zambia and in towns e.g. Orapa/Jwaneng in Botswana. Rich mineral deposits attract high population. Most young people migrate today mainly due to economic reasons and their movements are voluntary.
- **Social factors.** Family size may prompt some people to move to where there is enough room and freedom. Some members of large families may move to a settlement where they can own their own houses. Lack of recreational facilities and other social activities in an area can be a push factor, as people will migrate to where the facilities and activities are available. Pollution of any form can be a push factor as people can choose to leave in the countryside where there is a peaceful environment.
- **Political disturbance** e.g. political and religious persecution in a country can encourage emigration. People move to live in politically stable countries as refugees. Resettlement by government also can cause migration.

Note that the examples of these factors can be classified as push or pull factors. Push factors are those factors which force people out and pull factors are those factors that attract people into a place. On the basis of this understanding try activity 2



Activity 2

1. Carefully read the following factors and classify them as 'pull or push factors'. Write the answer in a table.
 - Lack of employment opportunities.
 - Racism and oppression.
 - Better entertainment facilities.
 - Drought
 - Lack of educational facilities.
 - Better medical facilities
 - Boredom
 - Better markets
 - High crime rate
 - Poor housing standard
 - Pleasant climate
 - War
 - Poor roads
 - Better career prospects
 - Peace

Push Factors	Pull Factors

2. Study Table 1 and answer the questions that follow:

Table 1: 1990 to 1991 migration status in Botswana

Migrant Category	Number	Percentage
Urban to Urban	37,994	34.4
Urban to Rural	23,061	20.9
Rural to Urban	28,151	25.5
Rural to Rural	21,175	19.2

- (a) Give at least **two** reasons why people would move between the places shown on the table.
- (b) Identify a migrant category that has the largest number of migrants? Why do you think this is so?
- (c) Which category of migrants has the smallest number of migrants? Give a reason for your answer.
- (d) In the space below construct a pie chart (graph) to represent the data in Table 1. Use your knowledge gained from unit 10 on various methods of data presentation.

Feedback

I hope you got all the answers correct. Check your answers against mine below.

Push factors

Lack of employment opportunities
Racism and oppression
Drought
Lack of educational facilities
Boredom
High crime rates
Poor housing standard
War
Poor roads

Pull factors

Better entertainment facilities
Better medical facilities
Better markets
Better career prospects
Pleasant climate
Peace

2. (a) *Urban to Urban: business, transfers, searches for employment, work and marriage.*

Urban to Rural: transfers, business, marriage, livestock farming, desire to be with relatives.

Rural to Urban: unemployment in the rural areas/employment in urban areas, lack of entertainment in rural/ better recreational facilities in urban areas, lack of medical facilities in the rural/better medical facilities in the urban; poor educational facilities in rural areas/better educational facilities in the urban etc.

Rural to Rural: transfers, marriage, agriculture, business, search for employment.

- (b) *Urban to Urban migrant category. Reason: there is a very serious problem of unemployment so there are many people who move from urban to urban searching for employment in addition to those who move for other reasons.*
- (c) *The Rural to Rural migrant category rural areas do not have many pull factors. Mainly people move from villages to the lands during rainy seasons.*
- (d) *Your pie chart should look like the one below with the proportions indicated in degrees.*

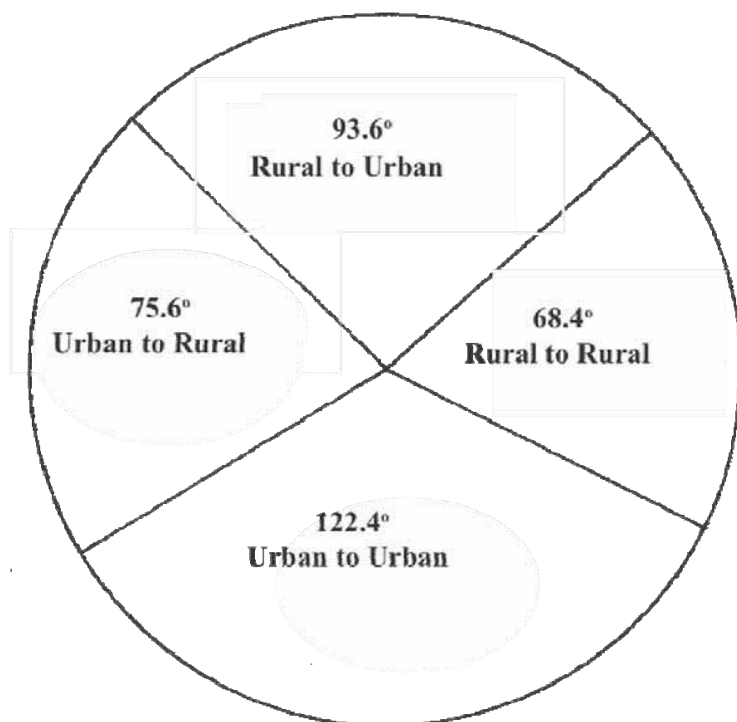


Fig. 2: 1990-1991 Migrant categories in Botswana.

We have just completed discussing the reasons why people migrate. Some of these reasons include looking for good climatic, soils, water or seeking protection. This will help you understand further why Batswana chose to live in the eastern part of the country rather than the other parts of the country. Now we are going to review what happens to resources as people move around.

4.0 Population Movements and Their Impact on Available Resources

In Topic 3, we have looked at the impact of rapid population growth on available resources. In this section our focus is going to be on the impact of migration on available resources. Migration is likely to have some effects on the distribution of population, composition and growth. Do you remember what population distribution is from topic 1? You should remember! Otherwise go back and revise that section. Throughout the world particularly in the developing countries, people are moving in large numbers to the urban areas. This great movement is partly accounted for by rural ‘push’ and partly by urban ‘pull’ factors. Cities and towns have more people than the rural areas. This leads to unequal distribution of the resources available. More resources will be spent in the towns and cities than in the rural areas, trying to provide social amenities and services for the ever-growing population. When natural resources like minerals are sold to other countries, a high percentage of the money from their sales will be used in the urban centres as they have more people than their rural counterparts. The towns and cities experience overpopulation. The

resources and the technology locally available become inadequate to maintain the residents' standards of living. This explains why in urban areas there are always some people who suffer due to low incomes, poverty and poor living conditions. Land also, as a resource becomes inadequate in urban areas. The rural areas on the other hand, become under-populated and tend to have inadequate social amenities and services.

This continues to encourage people to emigrate. The productive human resource moves from the rural areas as able-bodied people leave for urban centres. Crop land as a resource becomes underutilised as only the aged remain behind to till the soil ending up with meagre (low) returns

Do the activity below to further improve your statistical analysis skills.



Activity 3

1. With reference to one urban centre in Botswana show how migration is affecting the resources available.
2. Carefully study Table 2 and answer the questions that follow.

Table 2 : Population of towns/cities in Botswana.

Town/cities	1964	1971	1981	1991
Gaborone	3 900	17 700	59 700	133 500
Francistown	9 500	18 600	31 100	65 200
Lobatse	7 600	11 900	19 000	26 100
Selebi-Pikwe	-	4 900	29 500	39 800
Orapa	-	1 200	5 200	8 900
Jwaneng	-	-	5 600	11 200
Sowa Town	-	-	-	2 200

- (a) What observations have you made from the table which indicate that many people are moving into the urban centres?
- (b) Which city had the highest population increase in 1991 and why?

Feedback

I hope your answers are similar to the ones I have given below.

1. *With reference to Gaborone or Francistown or Selebi Phikwe or Lobatse you may face the following problems:*

High levels of unemployment / lack of jobs

Shortage of land

Shortage of water

Shortage of housing

Low wages

Low living standards

Poverty

Poor living conditions/squatting

Inadequacy of social amenities

2. (a) *The table shows an increase of urban population from past population censuses. There is a yearly increase of people moving into towns.*
- (b) *Gaborone, the capital city of Botswana has the largest population. This is because most government offices and industries are based in the city.*

You now understand the impact of migration on resources. In most cases these are similar to what we discussed under the impact of population growth on natural resources. Let's now move on to sum up what we have covered in this topic.



5.0 Summary

You have learnt to define migration as the movement of people from place to place due to a variety of reasons ranging from physical, social, economic to political.

You have studied several things about migration like to differentiate between different types of migration, for example, local migration, which may be (national) within Botswana or international within a continent. Regional migration may also be local, that is, between regions within a country and between regions in a continent. These types of migration are internal. You have learnt that international migration is external migration or movement of people between nations or across international boundaries. Two types of migration have been described as temporary and permanent migration. Permanent migration involves a permanent change of residence and temporary migration does not. There has also been mention of forced/compulsory and voluntary movements.

You have also learnt to assess population movements and to evaluate their impact on available resources.

Now that you have finished Topic 6, attempt the self-assessment exercise 6 given at the end of the unit under assignment section. If you fail to get all the questions right read over the relevant section of the topic again.

Once you have successfully completed the exercise, proceed to Topic 7.

Topic 7: The Impact of Migration on Rural and Urban Areas

Introduction

As you have learnt in the previous topic, people do not remain in one place, they move from one place to another for various reasons. As people move, their movements have impact on both the rural (source areas) and the urban (the receiving areas). In this topic you are going to learn about the impacts or consequences of migration.

You are also going to learn about the Botswana government's efforts to reduce rural- urban migration.

Topic objectives

At the end of this lesson you should be able to:

- evaluate the impact of migration on both rural and urban areas of Botswana
- evaluate Botswana government's efforts to curb rural urban migration.

1.0 The Impact of Migration on Rural Areas

Rural areas are villages, lands and cattle posts. Young people are moving in large numbers to towns and cities for the reasons already mentioned in the previous topic. Most migrants are people aged between 15 and 45 years. As they move in great numbers to urban areas, depopulation of the rural areas occurs leading to the decline in agricultural production, as there will be scarcity of farm labour. This also holds back the economic development of the rural areas, as the majority of those leaving for urban areas are skilled young people. The rural areas become areas of net emigration.

Reduced population growth often results in reduced birth rates as the reproductive age groups emigrate. This also leads to less development in the rural areas as the government caters more for high population areas. More males than females migrate to South Africa to work on the farms, mines and other industries and this creates sex-ratio imbalances.

This can damage family life. For example, if one partner is away for many months the marriage may break up. Most Batswana have long started to migrate to the mineral rich area of the Witwatersrand in South Africa. Their emigration in large numbers reduced when more mining towns sprung up in Botswana. The type of labour they provide in South Africa is termed **migrant labour**.

As more males than females emigrate, more females remain in the rural areas. The remaining females look after their homes and children. They cultivate the fields, too. This leads to a great social strain and lower farm yields. The living standards in the rural are often low. How many of your family members have migrated to urban areas? What were their reasons for emigrating? What about yourself? Have you also emigrated? If so, what are your reasons? By answering these questions, you will be able to understand whether and how your family has been affected by migration.

On a positive note, migration benefit families of the migrants as they are able to send part of their wages home to their families. Remittances give rural families some income. Migrants also acquire new skills and bring back home new ideas, which will help their rural communities. Table 1 shows the numbers of Batswana who migrated to work in the South African mines since 1910.

Table.1: Numbers of Batswana who migrated to work in the South African mines since 1910.

Year	No. of migrants
1910	2 000
1935	10 000
1960	16 000
1976	40 000
1981	18 000
1991	16 000
1995	13 000

Source: May, D. (1989): A Geography of Botswana, Page 193.

You are required to know that some Batswana migrated to South Africa for jobs. You will also need to think of the problems caused by migration among other things.



Activity 1

Carefully study Table1 and use it to answer the following questions.

- Which sex do you think are the people who migrated in large numbers to South Africa?
- As the sex you named in (a) migrated what **two** problems were likely to be experienced in their homes as a result of their absence?
- To which mineral rich area in South Africa did most Batswana migrate? Name at least **three** major towns found in this area.
- How is the labour they provided described?
- What happened to the number of migrants from 1910 to 1976? Suggest a possible reason for this.
- What happened to the number of migrants after 1976? What does this suggest?
- Apart from migration to South Africa name **four** places in Botswana to which most young people migrate to.

Feedback

Your answers may have included any of the following responses:

- Young Batswana males/men.*
- Social strain, low agricultural productivity, lower living standards*
- Witwatersrand. Towns: Johannesburg, Rustenburg, Krugersdorp, Klerksdorp, Roodepoort, Vereeniging, Witbank.*

- (d) *Migrant labour.*
- (e) *Increased tremendously, there were very few urban areas in Botswana there were very few jobs in Botswana.*
- (f) *A drastic/great decline or fall in the number of migrants occurred. This suggests that there were more jobs in Botswana as more urban centres had developed/sprung up so people were searching for jobs within Botswana.*
- (g) *Lobatse, Gaborone, Francistown, Orapa, Selebi-Phikwe, Jwaneng, Sua town.*

We have looked at the impact of migration on rural areas. When people move to towns or cities and leave the rural areas, there is no one to continue with the food production leading to poverty. You are now going to learn about what happens to urban areas when a lot of people move into them.

2.0 The Impact of Migration on Urban Areas

Urban areas are recipient or receiving areas, that is, they receive emigrants from the rural areas. These are mainly towns and cities as you already know. As more people migrate into these areas, these areas expand very rapidly. Employment opportunities in the large urban centres of Botswana have been a major factor in attracting migrants. The great influx of people into these areas is mainly due to ‘pull factors’ in the urban centres. Do you remember what pull factors are from Topic 6? They are factors that encourage people to move to cities and towns. Some of the pull factors in towns are better housing, better job prospects, better health and educational services. Add more pull factors from the books you have read.

As urban areas grow rapidly, problems set in. Examples include shortage of open space for the development of parks and gardens, lack of accommodation. Lack of accommodation often leads to the development of slums or squatter settlements on the fringes of towns and cities. High population growth rates occur, traffic congestion, noise, air and land pollution, overcrowding, shortage of health and educational services, shortage of water, unemployment also occur. These may encourage social ills such as increase in crime and prostitution and unbalanced development between the urban centres and the rural areas. Because of population that are ever on the increase, urban centres tend to develop faster than the rural areas. This is because government and private sector investments shifts and focuses to urban centres, where consumers of services are concentrated.

This activity will improve your statistical analytical skills once more.



Activity 2

Carefully study Table 2, which shows the growth of population in urban settlements, and then answer the questions that follow.

Table 2: Growth of population in urban settlements

Years 1971 1981 1991 Estimated 1997 Estimated 2003

Gaborone	17 700	59 700	133 500	183 800	246 800
Francistown	18 600	31 100	65 200	88 300	116 600
Lobatse	11 900	19 000	26 000	29 900	34 500
Selebi-Pikwe	4 900	29 500	39 800	45 600	52 700
Orapa	1 200	5 200	8 800	10 300	11 700
Jwaneng	-	5 600	11 200	14 900	19 400

Source NDP8; page13

1. (a) What do you notice about the population growth of the urban areas shown on the table? What do you think is the main cause of this?
- (b) Which urban centre had most people in 1971?
- (c) Name a city that experienced a very rapid increase in population after 1971. What do you think were the reasons for that?
- (d) What was the percentage population increase for Francistown between 1971 and 1981?
- (e) Which town has the least population increase? Why do you think this is so?
- (f) If the trend of population growth continues like this, what **five** major problems are likely to continue to occur in the major urban areas of Botswana?
- (g) What do you think the government should do to change the population trend shown in table 2?

Feedback

I hope you managed to answer the questions correctly. Now check your answers against mine below.

- (a) *It increases fast each census and may continue increasing in future. The main cause is rural-urban migration.*
- (b) *Francistown*
- (c) *Gaborone, because it is the capital city and has more varied industries and many government offices where people hope to find jobs.*
- (d) $31\ 100 - 18\ 600 = 12\ 500$
 $12\ 500 / 18\ 600 = 0.67$
 $0.67 \times 100 = 67\%$
- (e) *Orapa, because it is a closed town unlike the others which are open towns, it also has fewer industries.*
- (f) *High levels of unemployment, overcrowding, inadequate social amenities/pressure on resources, increased pollution, traffic congestion, shortage of land, development of slums, social ills like crime, lack of accommodation.*
- (g) *Encourage the rural dwellers to set up some businesses or industries to reduce rural unemployment rates. Make loans available to finance community based industries. Make agriculture a more attractive economic activity and equip farmers with skills. Distribute investments to include rural areas.*

We have noted that the consequences of migration to urban areas bring up the problems that affect the resources in towns/cities. We have learnt that when there are too many people in an area several problems such as development of squatters, increase in crime, poverty and many others arise. We are now going to discuss what the government's attempts are to improve the lives of the people in rural area to keep people there instead of moving to towns and cities.

3.0 Botswana Government's Efforts to Curb Rural-Urban Migration

To curb rural-urban migration, the government is trying to improve or upgrade the rural areas. Improvements have been made for example many rural roads are tarred and in some areas road tarring by the government still continue. Roads make rural areas more accessible and attractive to investors.

Health facilities are provided to the majority of the rural population for example 85% of the rural population lives within a 15km radius of a health facility. Again many rural areas have access to clean water. More schools have been built particularly Primary Schools and Junior Community Secondary Schools to cater for the rural population. The government also assists the rural people to improve their housing by borrowing money from banks to build modern houses. There is also rural electrification in which electricity is connected to the rural homes. All the people who can afford to connect electricity can do so.

Through some financial programmes the government tries to alleviate poverty or to reduce it in the rural areas. These programmes include the phased out Financial Assistance Policy FAP, Small Medium and Micro Enterprises (SMME) now replaced by Citizen Entrepreneurial Development Agency (CEDA). If you have forgotten what these programmes are, review the information about these programmes in Unit 11, Topic 6. These are programmes meant to assist Batswana to start their own businesses. Prior to offering financial assistance, the government trains people in the required skills and capacity to engage in business ventures. The Botswana government develops training programmes to ensure that Batswana are aware of these programmes and can take advantage of them. If people start businesses using these financial assistance programmes, it will create employment for other people. The government also tries to improve people's lives through increased salaries.

The government intends to develop the rural areas until they are modernised into urban areas. Due to the frequent occurrence of drought, which drastically affects arable agriculture, the government has introduced a project called Labour Based Relief Programme (LBRP). This project has provided much needed infrastructure in the rural areas, and income for roughly 35 000 beneficiaries annually. Some of the rural people have now abandoned agriculture and have become too dependent on the programme. The government is aware of this and will modify the programme such that the people can see the need to grow crops during the times of good rains. Diversification into horticultural production, meant to create employment and income generating opportunities for the rural population, is also encouraged.

The activity below is to help you remember the issues you have studied in this section of the topic.



Activity 3

1. Make a short list of government efforts to curb rural-urban migration.
2. What is the main function of CEDA?

3. How have some people in your area benefitted from some of the financial assistance programmes?

Feedback

Your answers may have included any of the following responses:

1. *Tarred rural roads, provision of health facilities, supply of clean water, construction of junior secondary schools, more primary schools, bank loans to improve houses, rural electrification, government financial assistance programmes, training people to equip them with the necessary skills prior to acquiring loans to start businesses, employment creation, increased incomes, introduction of Labour Based Relief Programme in times of drought, encouraging horticultural projects as a way of diversifying the economy.*
2. *To encourage and help Batswana to set up their own businesses by offering loans. To get Batswana to generate their own incomes and create employment for other people.*
3. *Have established small businesses like phone shops, poultry farms, goat rearing, pig farming, dairy projects, sewing businesses etc.*



4.0 Summary

You have now come to the end of the topic and you have learnt about the impact of migration on both the rural and the urban areas. People emigrate from the rural areas and immigrate into towns and cities of Botswana. This pattern of movement is not unique to Botswana. Throughout the world, people move from rural areas mainly due to social and economic factors. You have seen that migration creates problems in both areas of origin and destination and that the problems have to be solved by the government. In addition, you have learnt about what the government does to try and curb or control rural-urban migration. You have realised that the government makes some efforts to make rural areas more habitable and attractive to the majority of the people.

Now that you have finished Topic 7, attempt the self-assessment exercise 7 given at the end of the unit under assignment section. If, on checking your answers with those provided, you realise that you have failed to get all the questions right, read over the relevant section of the topic again.

Once you have completed the exercise, proceed to Topic 8.

Topic 8: The transmission and Control of HIV/AIDS

Introduction

As mentioned in the unit introduction, HIV and AIDS have a huge impact on population, particularly its size, structure and the well-being of all people. In Topics 1 to 7 you learnt different aspects of population and in this topic we are going to see how HIV and AIDS impact on various aspects of population. You have learnt that Botswana's population was expected to grow and double by the year 2016. This expected trend may not continue for long because of the impact of HIV and AIDS. The HIV and AIDS pandemic affects all people regardless of sex, age or social status.

In this topic, you will also learn about HIV and AIDS, how it is passed on from one infected person to the other and how individuals can avoid contracting the HIV, which leads to AIDS. Do you think the behaviour of Botswana is changing to reduce or increase the spread of HIV and AIDS? This topic will help you to address this question and many more that you might be having regarding the epidemic.

Topic objectives

On completion of this topic you should be able to:

- explain HIV and AIDS
- discuss how HIV and AIDS is transmitted
- describe the symptoms of HIV/AIDS
- discuss how individuals can avoid HIV infection
- discuss interventions for curbing the epidemic.

1.0 What is HIV and AIDS?

Let us begin by understanding what HIV and AIDS means. This must not be too difficult for you because we have been given so much information about it through media by our health ministry.

Do you know the meaning of HIV? HIV stands for Human Immunodeficiency Virus. HIV is a virus that attacks the immune system cells in a body and causes AIDS.

AIDS stands for Acquired Immunodeficiency Syndrome or Acquired Immune Deficiency Syndrome.

Acquire means to get or catch something.

Immune deficiency means inability of the body system to fight diseases.

Syndrome is a group of health problems that make up a disease. It is a state whereby the weakened body is open to attack by many diseases.

Did you know that HIV is not the exactly the same as having AIDS? First let us note that the immune system is actually the body's defence against diseases. HIV is a virus that attacks this immune system, in particular the white blood cells. These white blood cells are also known by different names such as the CD4 cells or T- cells. When HIV attacks these cells, they multiply and produce many more HIV viruses. Can you imagine what happens when more HIV viruses

increase? You are right if you said there is more loss of CD4 cells hence weakening the immune system. With a weakened body immune system, diseases can easily attack and kill. There is no cure for the HIV, but drugs available can only delay the development of HIV infection to full AIDS.

You must have heard a lot about HIV/AIDS. Activity 1 requires you to draw on this knowledge and answer the question asked.



Activity 1

You may have heard about people who are either HIV positive or negative. What distinguishes these people?

Feedback

HIV positive and negative people can only be distinguished through a blood test. People with no HIV virus are said to be HIV negative and people with HIV virus are said to be positive.

Do you think all people in your community know their HIV status? The answer is NO. Most people do not know their HIV status.

Now that you understand a lot about HIV let us now move on to AIDS. You already know that it is caused by HIV infection. AIDS can be diagnosed once the when the number of immune system cells known as CD4 cells in the blood of a positive person drops below a certain level. One of the AIDS defining conditions is a CD4 cell count of 200 and below. A normal CD4 cell count is considered to be between 600 and 1500. You may ask yourself where a person who is HIV positive and has not yet developed AIDS falls. You are correct if you said a CD4 count that lies between 200 and 600.

Now that you can tell the difference between HIV and AIDS let us move on to look at how HIV spread.

2.0 How is HIV Spread?

HIV is found in body fluids such as blood, semen (sperm) in men and in vaginal secretions in women. There are 3 main ways of transmitting HIV.

- through sexual intercourse
- through infected blood
- from mother to child

We are concerned more about how HIV and AIDS is transmitted. The description of how this happen will help you re-examine your behaviour in trying to avoid getting the virus.

2.1 Transmission through sexual intercourse

Most people get HIV by having unprotected sex with someone who is already infected with HIV. If you are planning to engage or already are, in any sexual relationship, remember to use protection during intercourse. HIV is passed from one person to another through semen or vaginal

fluids exchanged during unprotected sex. HIV enters a person's blood stream through the vagina or penis. It can also enter through the anus of either partner during anal intercourse.

Wounds or cuts in any of these areas make it even easier for HIV to enter the body. HIV transmission can happen from man to woman or woman to man or woman to woman or from man to man. HIV also enters a person's blood through deep kissing or oral sex if either person has cuts in the mouth to exchange infected blood and saliva.

The risk of infection is greater if either of the partners has other sexually transmitted diseases. Sexually transmitted diseases are those diseases, which are transmitted through sexual intercourse. Can you name some of the commonly known sexually transmitted diseases? Some of them are gonorrhoea, syphilis or herpes. These Sexually Transmitted Diseases causes wounds, cuts or open sores on or near the genitals. This makes it easier for HIV to enter the body through these wounds. Besides HIV and AIDS, most Sexually Transmitted Diseases can be cured. It is important to have them treated immediately or as soon as the diseases have been identified to reduce the chances of facilitating the transmission of HIV.

2.2 Transmission through infected blood

Sometimes when you are sick you may need blood transfusion. If you happen to receive contaminated blood it may contain the HIV and AIDS. You may get HIV from this transfusion. However, doctors try hard not to use infected blood. If infected blood gets into a person's bloodstream, then that person may become infected with HIV. This type of infection may be through blood transfusion. A blood transfusion takes place when blood is put into someone's body by medical officer because that person has lost a lot of blood. This happens for example after a serious injury in an accident. If the blood received is infected, then the person receiving it may be infected by HIV.

Infected blood may also enter the blood stream through using **non sterilised needles and injections** that have been used by infected person. This method of transmission is common among drug users who share needles when injecting themselves with drugs. At the clinic you must ensure that the fresh needle is used every time you are given an injection. Razor blades and scissors used for haircut and other sharp instruments can also pass on HIV if they are used non-sterilised from an infected person. Whenever you go for a haircut make sure that the instruments used have been sterilised. Direct contact of infected blood with an open wound will result in a person contracting HIV, if they do not take precautions.

2.3 Transmission from mother to child

Another way in which HIV is transmitted is from mother to child. Infected pregnant women can also pass the virus to their unborn babies (foetus). In such a case, the baby becomes infected while it is still in the mother's womb, because the mother and the baby share the same blood. The baby can also be infected during the process of birth. Breast-feeding can also transmit HIV from mother to the child. It is important to understand that as soon as somebody contracts the virus, that person can pass the virus to other uninfected people.

Now that you have learnt about how HIV and AIDS is transmitted among people, we now need to know what some people believe about the virus.

2.4 Myth about the transmission of HIV

Some of the beliefs are a concern because they may make people avoid taking precautions or free medication provided by the government.

We believe in many different things about how HIV and AIDS began or is transmitted to an

extent that some of us may not even visit the doctor when they are ill. Visit the doctor when you do not feel well. There are many untrue stories told about the transmission of HIV.

Try Activity 2 to learn more about untrue stories related to HIV and AIDS.



Activity 2

1. Write two examples of untrue stories or myths that are or were common in your local area about the transmission of HIV and AIDS.
2. What is the impact of these stories on HIV and AIDS infected people?

Feedback

I hope your answers are similar to mine below. You may also have different but correct answers based on your knowledge and experience.

Some people relate the spread or transmission of HIV to witchcraft. There are also untrue stories about the transmission of HIV relating to touching or sharing things. You may have said some men believe that sleeping with young children/virgins removes the virus from their system; some people believe that HIV and AIDS is a curse or punishment from God; some people believe that sharing items with an infected person can infect them; some believe traditional doctors can cure HIV and AIDS. These are not exhaustive. You can probably think of other myths you know.

It is important to know that a person cannot infect someone or get infected by sharing food with someone who is infected. It is safe to touch, hug or shake hands with a person infected with HIV/AIDS without getting infected with the virus. HIV/AIDS cannot be contracted by sharing such things as combs, towels or clothing with infected persons. It is also safe to share the same toilets without contracting the HIV/AIDS. It has been proven that the HIV virus cannot live in mosquitoes and as a result, they cannot transmit it to human beings. Thus insects such as mosquitoes and bed bugs do not transmit HIV/AIDS. The contacts shown in figure1 cannot transmit the HIV/AIDS.

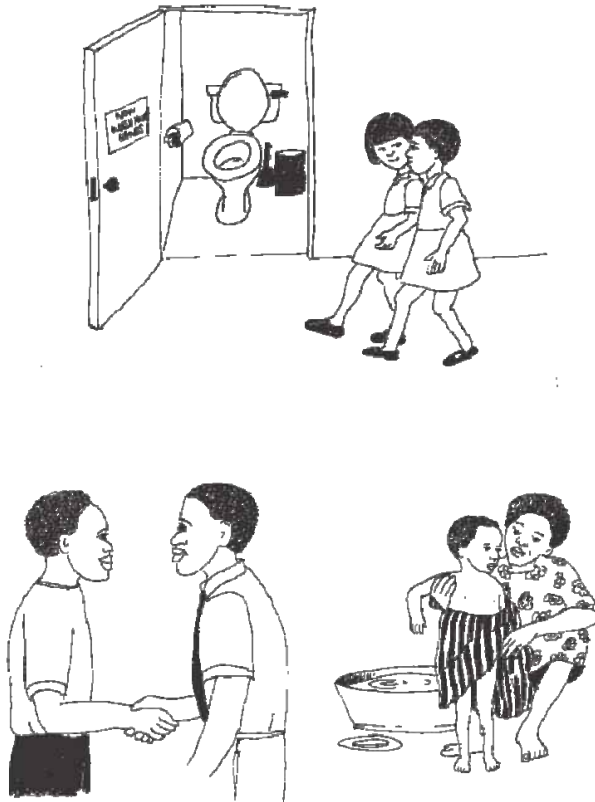


Fig 1: Examples of contacts which cannot transmit HIV/AIDS

*As mentioned earlier, myths about HIV and AIDS are of great concern because people are afraid to come out and take the necessary precautions. People are afraid of being **stigmatised**. **Stigma** refers to a disgrace or reproach that is attached to someone. Some people are discriminated because they are regarded as a disgrace from being HIV positive. World-wide, stigma is one of the main barriers to administering HIV prevention and care.*

You have learnt ways in which people contract HIV and how it is not transmitted. In the next section we are going to discuss the signs that HIV or AIDS people have. It is not easy to know because some people do not show anything. They look healthy to us because they might be on drugs or are taking good care of themselves, eating well and exercising and being positive.

2.5 HIV/AIDS symptoms

Can you tell by the physical appearance that someone is HIV positive? Not always. An HIV infected person may feel or look healthy but is capable of passing the virus to others. As mentioned earlier in this topic, HIV weakens the body's immune system and this might eventually lead to AIDS if the necessary precautions are not heeded. A person has AIDS only when the immune system can no longer protect the body from other diseases. It may take 2 to 10 years for a person to start showing AIDS symptoms. It is for this reason that people can carry the virus and still appear and feel healthy. When the body has lost its defence system, other diseases such as Tuberculosis and Pneumonia which the body would be capable of dealing with under

normal conditions, get the opportunity to infect the body. This results in HIV developing into AIDS. Opportunistic diseases like Tuberculosis, Pneumonia, Malaria, which infect the weakened body are called AIDS related diseases. Figure 2 shows some of the HIV and AIDS symptoms.

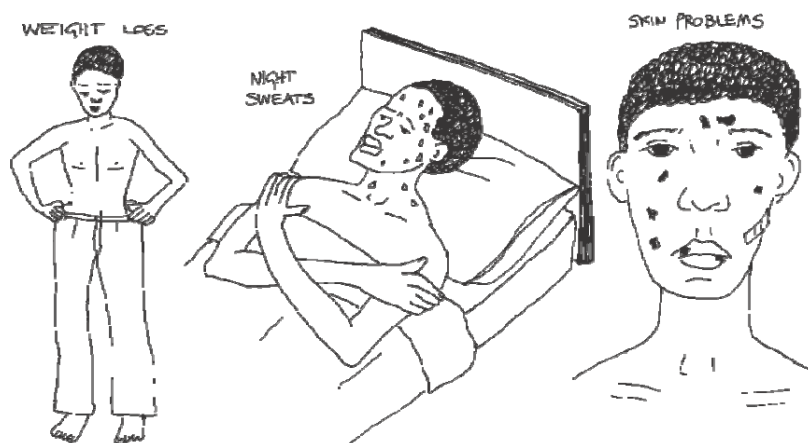


Fig 2: HIV/AIDS symptoms

The symptoms of AIDS and the condition of the patients differ from person to person. However, some of common symptoms are the following:

- Skin disorders
- lymph nodes
- Swollen glands in the neck and armpits
- Unexpected loss of weight
- Extreme tiredness
- Night sweats and fever.

You have learnt about what HIV and AIDS means, how it is transmitted and its symptoms. We must now discuss the ways to prevent the spread of HIV and AIDS. Read this section carefully because it is not only meant to give you information to answer questions but also to improve your behaviour.

3. 0 Ways of Preventing the Spread of HIV and AIDS

HIV/AIDS is acquired through human behaviour and it can therefore be prevented by change of behaviour. HIV is not spread through air, food or water. Changes in human behaviour can be brought about through educating people about the dangers of their actions. In this case people should be taught about the dangers of practicing unsafe sex. They must be made to change their sexual behaviour. Figure 3 shows some ways of protecting yourself from HIV infection.

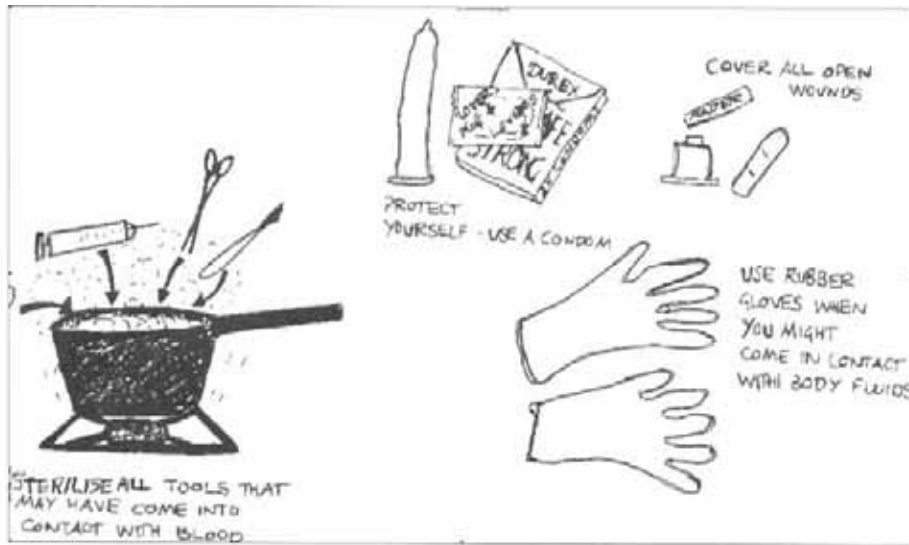


Fig 3: Protection from HIV infection

Try activity 3 to find out how much you already know about prevention of HIV infection.



Activity 3

List three ways of preventing HIV:

Feedback

I hope in your list you have the following:

- *Abstaining from sex*
- *Having sex with one partner that is HIV negative*
- *Practicing safe sex*
- *Using protective clothing*
- *Avoid using and sharing piercing instruments*
- *Checking HIV status*

Let us now discuss each one of them

HIV and AIDS can be prevented by:

- **Abstaining from sex:** (Be faithful) HIV is passed through sexual intercourse. So the only way to be absolutely certain of not getting HIV or passing it on to someone is by not

having sexual intercourse. Abstaining from sex can be very difficult for people who are already sexually active (mostly 15 to 45 years of age).

- **Having sex with one partner who is not infected:** If a person knows that they are not infected they can avoid getting infected by having sex with only one faithful partner who is also known to be uninfected. However, even if a person is already infected to avoid spreading HIV/AIDS, it is important to practice safe sex by using condoms during the sexual intercourse with the partner.
- **Practising safe sex by the proper use of a condom:** To avoid contracting HIV/AIDS, we must always use condoms during sexual intercourse. When a condom is used correctly it can greatly reduce the risk of passing HIV or getting other sexually transmitted diseases. Note that a condom does guarantee to avoid contracting HIV/AIDS or other sexually transmitted diseases. It does however significantly decrease the possibility of contracting them. Remember, if you have another sexually transmitted disease you must get it treated immediately.
- **Avoid using skin-piercing instruments:** such as blades and needles which have been used by others. If you cannot avoid using them, then insist on having them sterilised.
- **Using protective clothing:** If you intend or are pregnant seek advice from a health centre, clinic or hospital because you may pass on the virus to the unborn baby. Also, use hand gloves to avoid touching infected body fluids.

If you have any cuts or wound cover them up with waterproof plasters or cloth, especially when you are involved in sports such as soccer or netball.

If you are attending to HIV/AIDS patients, always use rubber gloves and avoid getting into contact with infected blood.

- **Knowing your status:** You can go for special HIV/AIDS tests, which can determine whether you have contracted the HIV virus, or not. In Botswana there are free testing centres called Tebelopele that provide this service. You will have to be counselled before and after undergoing this test. If the test has not found any signs of HIV in the blood, you will be told that you are HIV negative.

Look at figure 4 which shows a young lady going for counselling before testing for HIV. It is important to know that it takes time for the signs of HIV to show in your blood. If the test is negative it means the HIV has not been detected in your blood. However, it does not mean that you may not contract it in future. If you become sexually reckless or do not take precaution to avoid contracting the HIV, you may contract it. On the other hand if the test result shows positive it means you have contracted the HIV virus.

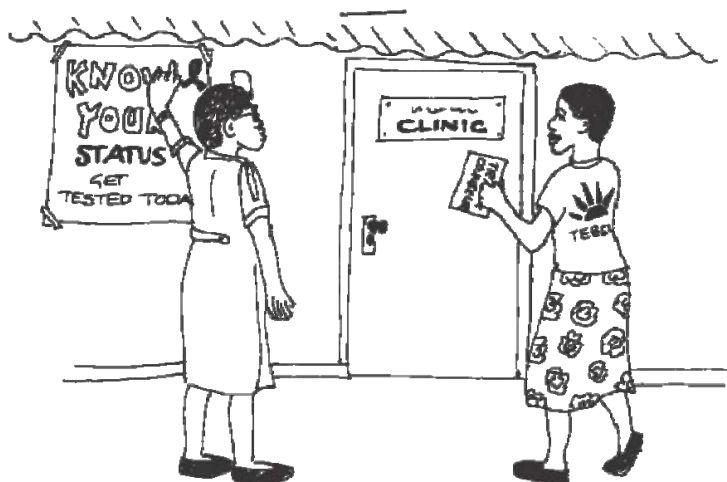


Figure 4: HIV/AIDS testing

Now try activity 4 to see how much you have learnt about how one can avoid HIV and AIDS infection.



Activity 4

1. What is meant by practicing safe sex? [2 marks]
2. What is abstinence? [2 marks]
3. Why is it important to insist on using sterilised needles and syringe? [2 marks]
4. Why should pregnant mothers ask for advice from health centers and clinics? [2 marks]
5. What protective measures should you take when attending to HIV/AIDS patients? [2 marks]

Feedback

Your answers may have included any of the following responses:

1. *Safe sex means having sexual intercourse using a condom. This is also known as protected sex.*
2. *Abstinence means staying without having sexual intercourse. This is highly recommended for very young people, particularly for those who are not yet married.*
3. *The purpose of sterilisation is to kill germs or any infections. Non sterilised syringes and needles may pass on the HIV to you if an HIV infected person has used them. Sterilisation will kill the virus.*
4. *To avoid passing on HIV infection to their unborn children and going to clinics. They may get a drug (anti-retroviral), which can reduce the chances of passing on HIV to their unborn children.*
5. *You can use rubber gloves when handling the patient's body fluids. Hands must be thoroughly washed. Avoid direct contact with body fluids such as blood.*

I suppose you now appreciate the importance of preventing the spread of HIV and AIDS and all the issues discussed are meant to change your behaviour. We will now review the way the HIV and AIDS is spread around the country and establish areas mostly affected.

4.0 The General Distribution of HIV/AIDS in Botswana

Do you remember the date of the first identified HIV and AIDS patient in Botswana? It was in 1985 when one case was reported. From that time to the year 2000 the number of reported cases have increased to the present level of about 242 000 cases. This figure is not exact, as many

HIV/AIDS cases are not reported. Many people do not know their status. The figure is based mainly on hospital records of pregnant mothers who are checked for HIV/AIDS infection. This means that there are many more people who are infected with HIV in Botswana who may die within the next few years.

Information from health centres indicates that HIV is present in all geographical areas of Botswana. All districts are experiencing an increase in the number of people who are infected by HIV/AIDS regardless of the geographical location and the population size. The rapid increase is therefore, not limited to any particular part of the country.

The group, which is most at risk, are the sexually active persons between the ages of 15 and 45 and infants under two years. Study the figures showing the prevalence of Sexually Transmitted Diseases per age group in Botswana given in Table 1.

Table 1: Prevalence of STDs per age group in Botswana

Diagnosi	Total	>1Year	1-4 years	5-14 years	15-44 years	45+
Syphillis	20835	73	51	915	18393	1403
Gonorrhoea	75635	50	155	3495	64007	7928
Other STD	1240	0	11	16	1165	59

Source: HIV/STD Unit Report, 1999.

The table shows that the age group that is mainly affected by all STD are the sexually active group between 14 and 45 years old. It is this group which is at great risk of contracting HIV/AIDS. In Botswana, 75% of the reported AIDS cases have been individuals between the age of 20 and 49. Because HIV takes an average of 9 years to develop into AIDS, this means that most individuals are infected while they are still teenagers. These are the most economically productive people. The loss of large numbers of people in this group could badly affect the economy of Botswana.

The table also shows that a large number of children are affected by STD during pregnancy or birth.



5.0 Summary

In this topic you have learnt that HIV is the Human Immunodeficiency Virus, which causes AIDS. AIDS is the Acquired Immunodeficiency Syndrome. HIV is found in body fluids such as semen and vaginal fluids. It is transmitted through unprotected sexual intercourse with an infected person, through infected blood entering into a person's blood stream and from mother to baby during pregnancy or at birth. AIDS cannot be contracted through touching, kissing (provided there is no exchange of infected blood through a cut in the mouth), hugging, or sharing of toilets.

Abstaining from sex or having safe sex by correctly using condoms can prevent the spread of

HIV/AIDS. The contraction of HIV/AIDS can also be prevented through avoiding the use of unsterilised cutting and piercing instruments such as razor blades, scissors for haircut, needles and injections. When attending to people with HIV infected people must use protective gloves.

It is not possible to tell whether an individual has HIV/AIDS or not just by looking at the person. HIV/AIDS tests are carried in the hospitals if people want to know their status after careful counselling. In Botswana, records show that HIV/AIDS is increasing in all the areas regardless of whether they are villages, towns or cities. The most affected groups are the sexually active and the babies who are infected during pregnancy. This is likely to affect Botswana's economic development.

Now that you have finished Topic 8, attempt the self-assessment exercise 8 given at the end of the unit under assignment section. If you fail to get all the questions right read over the relevant section of the topic again.

Once you have completed the exercise, proceed to Topic 9, the last topic of this unit.

Topic 9: The Impact of HIV/AIDS in Botswana

Introduction

HIV and AIDS continue to have a widespread impact on all aspects of life. In the previous topic, you learnt about HIV/AIDS, how it can be contracted and ways of avoiding contracting the virus. We have noted that the most affected groups are those aged between 14 and 45 and that these are the most economically productive age group. It means that HIV/AIDS is having social and economic impact on Botswana. In this topic you will learn how HIV/AIDS will impact on Botswana's economic and social activities.

Topic objectives

On completion of this topic you should be able to:

- interpret HIV/AIDS statistics
- account for the distribution of HIV/AIDS in Botswana
- explain the impact of HIV/AIDS on Botswana's economy
- discuss national strategies for reducing the impact of HIV/AIDS on families.

1.0 Interpreting HIV and AIDS Statistics

To understand the socio-economic impact of HIV and AIDS in Botswana you must first be able to carry out research. Remember, in Unit 10 on research methods, you learnt various methods of data collection, interpretation and presentation. Data may be presented in text or as statistical data. In this topic you will need to apply that knowledge which you learnt in Unit 10. To start with, you must understand that statistical data is important in that:

- It provides information on the geographic spread of HIV infection
- It also helps in monitoring trends of HIV epidemic over time
- It provides information for estimates and future projection of HIV/AIDS in the country
- It also provides data for planning and mobilising resources for controlling the epidemic.

Now that we know what is used to interpret the HIV and AIDS statistics, we will look at the prevalence of the pandemic in Botswana. Here it will show the geographic spread of HIV infection and provide us with information of what is really happening in different regions.

We have noted the importance of statistical data. This will lead us to the study of how and when the virus was first discovered in Botswana. We will look at how many pregnant women are affected and assisted.

2.0 HIV Prevalence in Botswana

The Aids epidemic started spreading around 1980 in North America, Western Europe and Sub-Saharan Africa. A report published in mid-2000 revealed that an estimated 2.4 million people are infected by HIV/AIDS each year. In Botswana the first case was reported in 1985 and Botswana now ranks as one country with the highest infection rate in Africa. Other heavily infected

countries are Zimbabwe, Zambia and South Africa.

Infection rate continues to increase in Botswana. Data on HIV infection is obtained from pregnant mothers attending Ante-Natal Clinics at the surveillance sites in various parts of the country. In addition, HIV, infection is monitored amongst men attending clinics at same sites for the treatment of sexually transmitted diseases. There are 8 sites involved in the data collection procedures in Botswana and these are Francistown, Gaborone, Serowe/Palapye, Mahalapye, Kgatleng, Chobe, Lobatse and Kgalagadi.

You now understand the prevalence of HIV in Botswana. In the sub-section that follows we will focus on HIV prevalence among pregnant women.

2.1 HIV Prevalence among pregnant women

The prevalence of HIV among women is determined by analysing blood samples taken from pregnant women who attend ante-natal clinics. The table below shows some of the analysis.

Table 1: HIV Prevalence among women

SITE	SAMPLE SIZE	PREVALENCE (%)
Francistown	576	42.70
Gaborone	480	37.08
Serowe/Palapye	268	41.79
Mahalapye	362	32.04
Chobe	120	50.83
Kgalagadi	257	21.78
Kgatlang	271	29.52
Lobatse	252	31.4

Source: Adopted from HIV/STD Unit Report, 1999.

Table 1 shows that almost 4 in every 10 pregnant women tested were found to be HIV positive. In other words, 41% of the women tested for HIV infection were found to have the HIV. This means that 4 in every 10 women will probably die of HIV/AIDS. The area with the highest rate of infection from the Table is Chobe. Can you think of the reason why Chobe should have such a high infection rate? Probably the explanation could be that as a tourist centre Chobe is a meeting area for people from different countries and therefore, chances of spreading HIV/AIDS is increased. Also there is well developed transportation network connecting Zambia, Zimbabwe to Botswana facilitating movement of people. Kgalagadi seems to have the least infection rate. A possible explanation would probably be that attitudes in rural areas towards sexual activities are still relatively conservative. Also most of the roads in the region are not tarred to make it easy for movement of people. In addition, attraction of people from elsewhere to the region is still poor because the region is still mostly communal. You however, understand that these figures change every time as people change their behaviour and practice safe sex.

Some areas have high rate of infection because:

- They have high population of sexually active age groups. For instance in towns there are younger working people than in communal areas where mainly the old people live
- They have high risk behaviour population groups.

In all parts of Botswana, there has been an increase in the rate of infection among women over the years as shown in Table 2 below.

Table 2: The infection rate of women from 1992-1999 (as % of sample)

Site	1992	1993	1994	1995	1996	1997	1998	1999
Francistown	23.7	34.2	29.7	39.6	43.1	42.9	43.0	42.7
Gaborone	14.9	19.2	27.8	28.7	31.4	34.0	39.1	37.1
Lobatse	-	17.8	-	37.9	-	33.7	-	31.3
Serowe/Palapye		28.2	32.0					

Source: HIV/STD Unit Report, 1999

However, the figures seem to have stabilised in 1998 and 1999. Can you suggest a reason why the figures are now going down? Probably they are going down because more and more people are becoming conscious of the dangers of HIV/AIDS and are beginning to change their behaviour by abstaining, using condoms and sticking to one partner.

We have discussed the prevalence of the virus and how much it affects women, showing more women in urban areas affected more than those in rural areas. Let us review the status of men now and see how they are affected compared to women.

2.2 HIV infection among men with STDs

Data collected from men infected with STDs (Table 3) show an increase in infection rate from 1994 to 1999. Francistown and Gaborone for instance, have an average rate of increase of 22% from 1994 to 1999.

Table 3: Infection rate of men from 1994 to 1999

Site	1994	1995	1996	1997	1998	1999
Francistown	29.7	50.70	54.60	60.00	60.37	62.00
Gaborone	27.8	34.90	44.10	38.80	54.18	50.6

Source: HIV/STD Unit Report, 1999

What the figures indicate is that out of every 10 men treated for STD, 6 were HIV positive in Francistown in 1999. The implications are that large numbers of people will still die of HIV/AIDS. Statistics indicate that almost all the geographical areas in Botswana have high infection rate among men. Table 4 shows infection distribution among males in Botswana according to Geographical location.

Table 4: HIV/AIDS infection among men with STD by geographic location

Site	Prevalence %
Francistown	62.0
Gaborone	50.6
Serowe/Palapye	57.6
Mahalapye	52.7
Chobe	56.3
Kgalagadi	48.1
Kgatleng	51.6
Lobatse	44.1

Source: HIV/STD Unit Report, 1999

From Table 4 which area has the lowest infection rate? Which area has the highest infection rate? Probably you are correct. Lobatse has the lowest infection rate while Francistown has the highest infection rate. What is most important here is to note that generally all the areas have very high infection rates ranging from 44% to 62%.

This activity requires you to recall some of the information you have learnt but do not just recall it but apply it and understand what it means.



Activity 1

1. Name **three** countries in Africa, which have HIV infection rates of over 10% of the whole population.
[3 marks]
2. Give any **two** reasons why some areas have higher infection rates than others.
[2 marks]
3. Study the following table showing age group prevalence of HIV infection among pregnant women.

Age Group	HIV Prevalence (%)
15 - 19	27.52
20 - 24	46.94
25 - 29	46.82
30 - 34	54.54
35 -39	39.47
40 -44	26.32

- (a) Which age group has the highest HIV infection? [1 mark]
- (b) Explain why the age group you have named in (a) has the highest infection. [1 mark]
- (c) Explain why the 40 – 44 age group has the least infection.
4. Study the graph figure 5 below, showing trends in HIV infection prevalence rate among men with STD in Gaborone and Francistown.

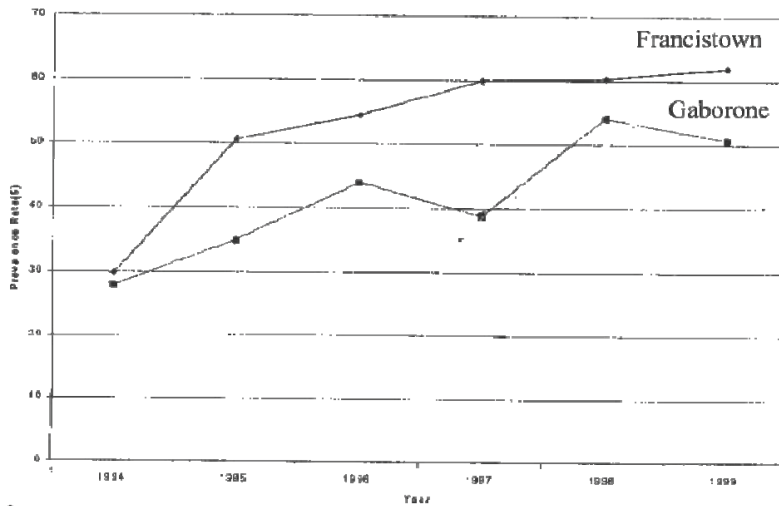


Fig. 5 :HIV Infection prevalence rate among men with STD in Gaborone and Francistown.

Source: HIV/STD Unit Report, 1999.

In your own words describe the HIV infection trends among men in Gaborone and

Francistown between 1994 and 1999.

[3 marks]

5. Do you know the status of your community concerning HIV and AIDS? How can you tell whether people in your community are less or more affected by HIV and AIDS?

[4 marks]

Feedback

Your answers may have included any of the following responses:

1. *Any **three** of the following countries have HIV infection rate over 10% of their population: Zambia, Mozambique, Swaziland, Zimbabwe, Botswana, Malawi, South Africa and Uganda.*
2. *Some countries have higher infection rate for the following reasons:*
 - (i) *The presence of a high population of high risk groups such as prostitutes, drug addicts, migrant workers etc.*
 - (ii) *Unavailability of information on HIV/AIDS.*
 - (iii) *Negative attitudes among the population on safe sex.*
3. (a) *The age group of 30 – 34 has the highest infection rate.*

(b) *This is the childbearing group, which forms the largest group under surveillance in hospitals. It is also the most sexually active. The HIV/AIDS would have matured and can be detected at that age.*

(c) *They are less sexually active and form a small fraction of women under surveillance.*
4. *In 1994 the infection rate was 28%. By 1996, it had increased to 43% almost doubling within a period of two years. There was a decline in the infection rate in 1997 and an increase in 1998. However, 1999 saw a slight decline in the infection rate. In Francistown the infection rate was 30% in 1994 and increased rapidly to 5% in 1995. The rate of increase was less rapid from 1995 to 1997 (60%). In 4 years the infection rate had doubled that is from 30% to 60%. Between 1997 and 1999 there was a slight rise in percentage rate of increase – from 60% to only 62%.*
5. *You may not know exactly what the status of your community is but by the increase or the decrease in funerals of affected people indicates whether your community is getting better/ living positively, taking their medication or not.*

We have examined how men are affected by the HIV and AIDS and what their infection rates are. Now we will evaluate what happens to the country when the virus spreads rapidly. Read about the challenges that the Botswana government faces in trying to reduce the spread of AIDS and care for those affected.

3.0 Impact of HIV on Botswana's Economy

There are many ways in which HIV/AIDS affects Botswana's economy. The HIV/AIDS impact is felt at all levels including the Government, the private sector and by individuals.

3.1 Impact on the Government

The government has spent a lot of money in combating the spread of HIV and AIDS. Other issues

include loss of skills, support for orphans and others. Below is a more detailed description of these concepts.

- **Increases the health costs.**

Increase in the number of HIV infected people would mean an increase in medical costs for the Government. The Government would have to provide medicine and support services for those infected with HIV/AIDS. There would be an increase in the number of patients in hospitals thus stretching hospital facilities and increasing the demand for more money and more support staff. Money, which would have been used for other development would have to be used to fight against HIV/AIDS. This in turn would slow down development.

- **Loss of skills**

The Government's effort at providing the country with skilled manpower would be reversed. As more productive skilled personnel such as teachers, police, soldiers, lawyers, administrators die of HIV/AIDS, the Government will be compelled to train more people to replace the sick and the dead. These in most cases would be in-experienced thus reducing productivity. They may be infected as well as also fall sick and/or die.

- **Support for orphans**

As many people die there will be an increase in the number of orphans. Many children will lose their parents. The government will need a lot of money to support the orphans. Currently there are over 65 000 AIDS orphans in Botswana who are under age 15. This will mean that the state may provide food, clothing shelter and education to these orphans.

- **Governmental support for the sick**

The government will have to pay out large sums of money as terminal benefits of the workers who will either be sick or dead.

These are just a few impact of the HIV/AIDS epidemic. Can you think of many more effects of HIV/AIDS on the state finance? You can ask your family members or friends and then compile a comprehensive list for yourself. Impact on the private sector is our next focus.

3.2 Impact on the Private Sector

As we have already said, HIV/AIDS infection is highest among the economically productive age group. In Botswana, the private sector has been earmarked as a leader for economic development. HIV/AIDS epidemic will make it difficult for the private sector to achieve this objective as it seems to affect mainly the young and sexually active individuals. This means that productivity will be reduced in the private sector. Figure 3 shows how the HIV/AIDS epidemic affects the private business.

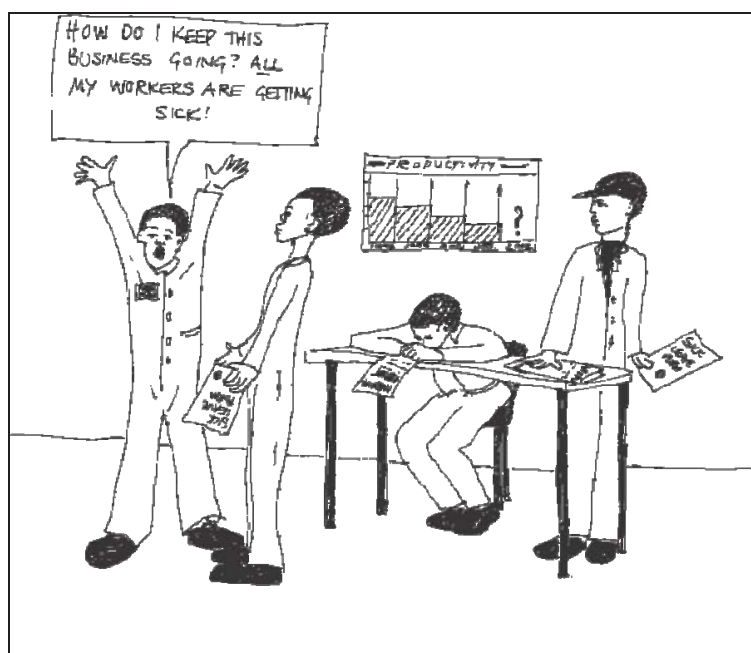


Fig 3: impact of HIV/AIDS on the private sector

Here are some of the effects of the HIV/AIDS epidemic on the private sector:

- **Absenteeism**
An increase in the infection may result in an increase in the number of workers going on sick leave as they become sick with HIV/AIDS related diseases. This would affect productivity within the private sector.
 - **Loss of skilled personnel**
An increase in the infection rate and death rate will lead to shortages of skilled personnel. These people will have to be replaced by less experienced personnel resulting in negative impact on productivity and profitability.
 - **Increased costs**
An increase in the death rate could translate into increased costs in medical care, insurance payouts and workers' benefits. Companies will have to pay out large sums of money as terminal benefits and gain less profit.
 - **Conflicts at work place**
The increase in HIV/AIDS may mean a corresponding increase in the number of people isolated at work because of their HIV/AIDS status. This will lead to rejection and lack of motivation at work and a decline in productivity.
- HIV/AIDS also has a huge impact on the social life of people. Let us now find out how.

3.3 Social impact

Before we discuss the social impact of HIV and AIDS, attempt activity 2 to reflect on what you already know about this.



Activity 2

Explain any two ways in which HIV and AID impacts on our social life.

Feedback

I hope you were able to explain at least one. Let us discuss the answers as listed below.

- *There will be an increase in the number of orphans in the country. What are orphans? These are children who have lost both parents. Some children have lost both parents due to the pandemic. What do you think happens to these children? You are absolutely correct if you said they become homeless. In 2010 the total number of orphans was already 50 000 in Botswana.*
- *HIV pandemic has placed huge burden on both households and the government. The orphans may become dependents of other households as they get adopted. In some cases grand parents may find themselves bringing up large numbers of orphans. Do you think grand-parents cope? NO! They do not cope because taking care of children is a huge responsibility which demands a lot of time, money and most of all energy which old people don't have.*
- *It may result in the individual, particularly those who are HIV+ being rejected by the family. We have already discussed how some HIV+ people are stigmatised. There are some people who are still ashamed of their HIV+ relatives and they avoid interacting with them.*
- *HIV pandemic has increased poverty for most households. The individual and the family can become poorer as the breadwinner is no longer able to work and earn money.*
- *It may result in family break-ups as they argue over who would have brought the virus to the family. Married couples may point fingers at each other for bringing the virus into the family and this may also result in domestic violence or instability within the family.*

We have identified several problems affecting Botswana due to the HIV and AIDS scourge. The government and the people of Botswana are trying by all means to deal with the problems facing the nation. Let us take a look at the attempts the government is making to reduce the spread of HIV and AIDS.

4.0 National Measures Taken to Reduce the Spread of HIV and AIDS

Do you know of any activities going on in your community as an attempt to reduce the spread of HIV and AIDS? We know there are activities carried out by the Home Based Care Committees and other non-governmental organizations. On the other hand the government has taken initiative in the following;

- The Government has formed a National Committee on HIV/AIDS, which is co-ordinated by the Ministry of Health.
- All school curriculums from the primary to the tertiary include HIV/AIDS education.
- The Government is intending to reduce the mother to child infection by introducing anti-retroviral drugs to expectant mothers.
- A report on the situation of orphans in Botswana has been produced which will identify the orphans and their problems, and make recommendations on how to solve some of their problems.

- A massive national education campaign on AIDS and safe sex has been launched to try and stem the HIV/AIDS epidemic.
- Some countries such as United State of America have contributed to Botswana and other countries resources to fight against HIV/AIDS.
- Botswana supports international research on the development of a vaccine for HIV/AIDS.
- A support system for Home Based Care has been introduced to alleviate patient pressure in hospitals for the terminally ill.
- Free distribution of condoms exists in most workplaces in public places.



5.0 Summary

In this topic, we have learnt that statistics collected on pregnant women and men suffering from STDs indicate that the most HIV infected age group is that between 15 and 44 years. These are the people that are most economically active and their sickness and death will impact negatively on productivity. HIV and AIDS will also impact on National Development as the Government diverts funds intended for development to medical care for those infected. The government will lose skilled manpower and pay large sums of money as terminal benefits to the sick and the dead. The private sector will also lose in terms of profits, productivity and skilled manpower as more people become sick and absent and eventually die.

However, the Government has taken steps to spread knowledge about AIDS through schools, newspapers and any public forum. As HIV/AIDS takes its toll many children will lose their parents, and grandparents will lose their children. The surviving extended family will have to provide a supportive role to increasing number of orphans and the terminally ill.

Now that you have finished topic 9, the last topic of this unit, attempt the self-assessment exercise 9 given at the end of the unit under the Assignment section. Thereafter, if you fail to get all the questions right read over the relevant section of the topic again.

Once you have successfully completed the exercise, read the unit summary below and then proceed to the tutor marked assessment found at the end of the unit.

Unit Summary



To sum up this unit go through the following points:

- In this unit you have learnt the definitions of concepts important in the study of population. These include population (de facto and de jure), population pressure, optimum population, population explosion, population density, population distribution, fertility rate, mortality rate, over-population, under-population and population growth.

- With the aid of maps we have looked at the world's population distribution patterns. We have looked at different climatic regions and you have noted how climate influence population distribution.
- We have discussed factors influencing population growth such as birth and death rates, migration and other factors.
- We also described the growth of the world's population and its consequences. You learnt that different countries have different population growth rates.
- We evaluated the impact of rapid population growth on the available resources. You now understand why there is population pressure on the natural resources. This is mainly because the resources are not enough to sustain the life.
- You learnt how to interpret population pyramids of developing and developed countries. You can now describe the population structure and characteristics of a country by interpreting the pyramid.
- We described and explained the different stages of the Demographic Transition Model. You can now explain any country's position in the Demographic Transition Model – as in the case of Botswana.
- We discussed population density and distribution with the aid of a map and a case - studies drawn from Botswana.
- We differentiate between types of migration. For example, local, regional and international, internal and external, temporary and permanent. We also assessed population movements and evaluated their impact on available resources, and on both rural and urban areas. Finally, we discussed government efforts to curb rural-urban migration.
- In the last two topics we looked at how HIV and AIDS pandemic impact on various aspects of population. First we defined HIV and AIDS then looked at its prevalence. We also assessed the demographic and socio-economic impact of HIV/AIDS particularly in Botswana. Finally, we discussed efforts being taken to address the HIV/AIDS problems in country - case study: Botswana

Now that we are at the end of the unit, I am going to ask you a couple of questions in regards to what we have learned to see if you can answer them.

1. Suggest four ways by which the government may attempt to control overpopulation

Possible answers:

- use of contraceptives
- incentives
- abstinence
- reproductive health and Family planning programs
- education/ awareness campaigns
- policies/laws/regulations

2. Choose any example of an international migration, explain the push and pull factors that caused people to migrate

Possible answers:

Examples of international migrations

- Zimbabwe to Botswana and South Africa
- Somalia to Kenya
- Turkey to Netherlands

Push Factors

- High unemployment rate
- Primitive conditions
- Desertification
- Famine or drought
- Political fear or persecution
- Slavery or forced labor
- Poor medical care
- Loss of wealth
- Natural disasters
- Death threats
- Lack of political or religious freedom
- Pollution
- Poor housing
- Landlord/tenant issues
- Bullying
- Discrimination
- Poor chances of marrying
- Condemned housing (radon gas, etc.)
- War

Pull Factors

- Job opportunities
- Better living conditions
- Political and/or religious freedom
- Entertainment
- Education
- Better medical care
- Attractive climates
- Security
- Family links
- Industry
- Better chances of marrying

Source of information: http://en.wikipedia.org/wiki/Human_migration



Assignment

Self-Assessments

The assignment section comprises of self-assessment exercises related to each topic in this unit. Remember that these exercises should be done on completion of a related topic. For example, self-assessment Exercise 1 should be done after successfully completing Topic 1. Check for the correct answers at the end of these exercises. You are advised to take 30 minutes on each exercise.

Self-assessment Exercise 1

Answer all the questions in the spaces provided.

1. Explain the meanings of the following terms:
 - (a) population pressure: [2 marks]
 - (b) optimum population: [2 marks]
 - (c) under population: [2 marks]
 - (d) population density : [2 marks]
 - (e) Population census: [1marks]
2. Carefully study figure 3 and answer the questions that follow:

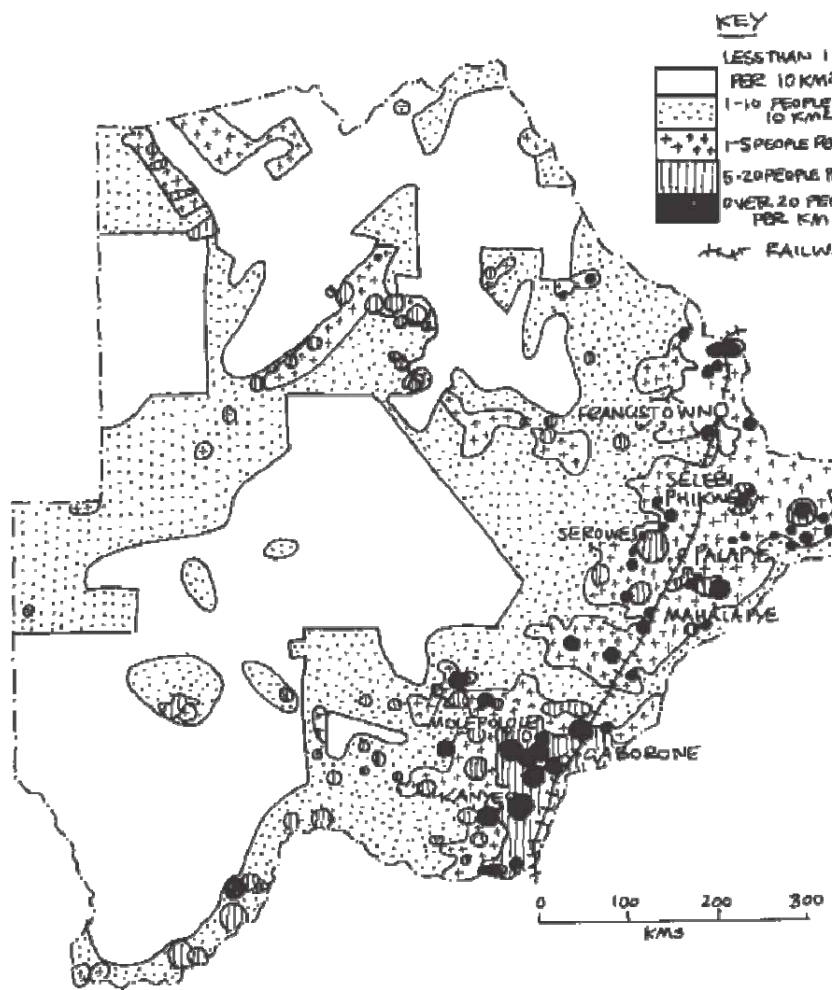


Fig 3 : Population distribution, 1991

Source: May, D. (1998): Geography of Botswana; page 188

- (a) Which settlements of the country are densely populated?
[2 marks]
 - (b) Which areas of the country are sparsely populated?
[2 marks]
 - (c) Discuss any **five** factors that may have influenced the population distribution shown in figure 3.
[4 marks]
3. Study Fig.4 showing population growth of Botswana from 1904 to 1991 and answer the questions that follow:

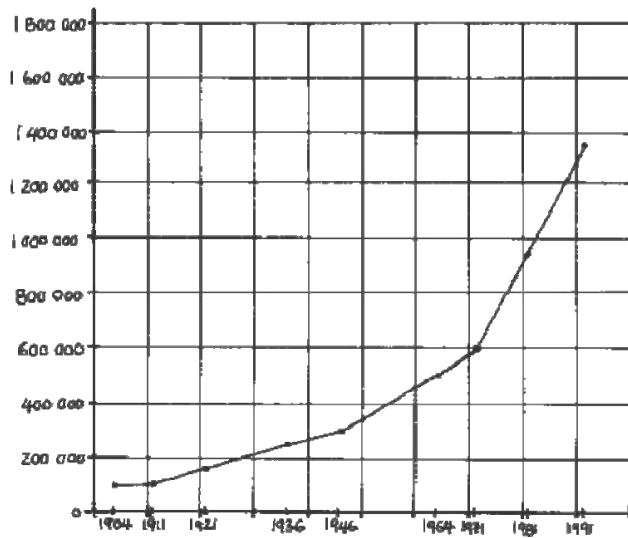


Fig. 4 : Population growth of Botswana 1904 to 1991.

Source: May, D. (1998): Geography of Botswana; page 186

- (a) Describe the trend of the population from 1911 to 1991.
[2 marks]
- (b) What **two** factors may have led to this trend?
[2 mark]
- (c) Between 1904 and 1911 the population was low and stable.
Suggest **two** reasons why this was so.
[2 marks]

Self-assessment Exercise 2

1. Explain the meaning the following terms:
- (a) Population growth: [1mark]
- (b) Birth rate: [1 marks]
- (c) Death rate [1mark]
- (d) A populations' natural increase [marks]
2. Study figure 2 below showing the world population since 1000 BC then answer the questions that follow:

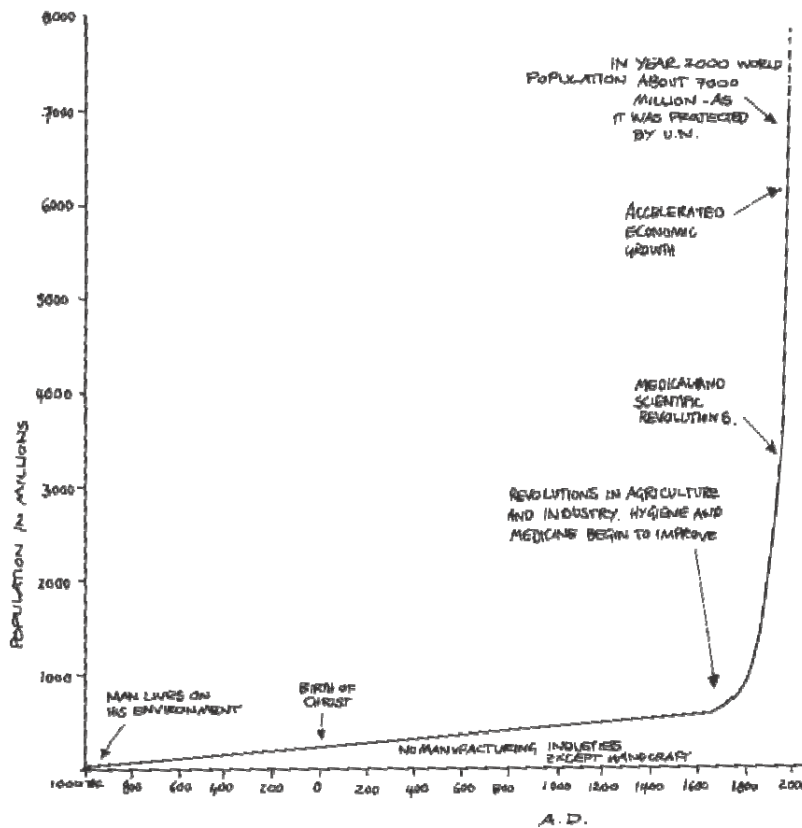


Fig. 2: World population since 1000 BC

- Describe the population growth from 1000 BC to 1600 AD?
[1 mark]
- Explain your answer in 1(a) above. [2 marks]
- What happened to the world's population from 1700 AD onwards?
[1 mark]
- Give **three** reasons for your answer in 2 (c) above. [3 marks]
- According to the graph what was the total world population supposed to be in the year 2000?
[1 mark]
- In which year did the world's population reach 6 billion?
[1 mark]
- What is the population growth trend shown by figure 2?
[1 mark]
- Describe the problems likely to occur if the world population continues to follow the trend shown in figure 2?
[4 marks]
- Explain how migration may contribute to a rapid population growth. [2 marks]

Total = [16 Marks]

Self-assessment Exercise 3

1. Explain the difference between renewable and non-renewable resources. [2 marks]

2. Explain how the following resources may be affected by population growth:
 - (a) Air [2 marks]
 - (b) Water [2 marks]
 - (c) Land [2 marks]
 - (d) Minerals [2 marks]

3. How do Batswana benefit from each of the following resources?
 - (a) Wildlife [2 marks]
 - (b) Vegetation [2 marks]

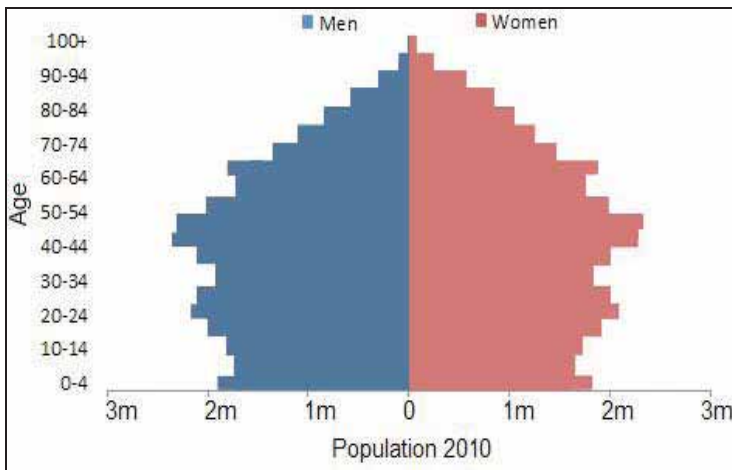
4. (a) Write down **two** natural resources which you think are mostly affected by rapid population growth in the world. [2 marks]
(b) Suggest **two** ways in which the resources you mentioned in 4 can be protected. [4 marks]

Total = [20 Marks]

Self-assessment Exercise 4

Carefully study the following population pyramids and answer the questions 2 (a) to (d):

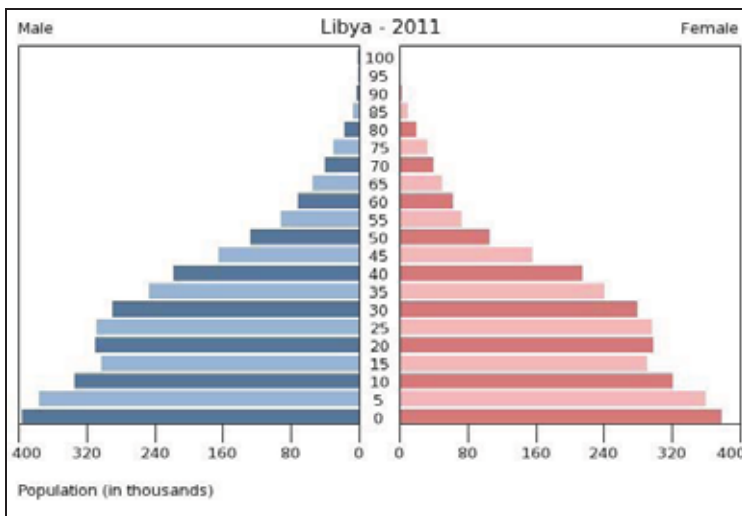
Pyramid A



Source: <http://en.wikipedia.org/wiki/File:Uk.pop.pramid.2010.jpg>

Retrieved – 06/06/11

Pyramid B



Source: <http://en.wikipedia.org/wiki/File:LibyaPopulation2011.jpg>

Retrieved – 06/06/11

1. (a) Define the following concepts:
 - (i) Population [1 mark]
 - (ii) Life expectancy [1 mark]
 - (iii) Dependency ratio: [2 marks]

2. (a) Say which of the pyramids A or B is for a developing country and which one is for a developed country.
[2 marks]
- (b) Describe the population structure of pyramid B.
[4 marks]
- (c) What effects might the population structure you described B have on the present economic development that country.
[3 marks]
- (d) Make a comparison of population structures shown by pyramids A and B. [4 marks]
3. Life expectancy in some developed countries is 74 years. Explain what is meant by this statement
[1mark]
4. How is life expectancy like in developing as compared to that of developed countries?
[1mark]
5. Suggest reasons for the answers you have given in (4) above
[3 marks]

Total = [25 Marks]

Self-assessment Exercise 5

Please answer all the questions in the space provided.

Study figure 1 on page 54, which shows changes in the birth and death rates in a country over a long period of time.

- (a) In which stage was there a period of decline in the total population? [1 mark]
- (b) Give **one** reason for your answer in (a)
- (c) Why was there a great increase in population in stage 2? Use only evidence from figure1.
[2 marks]
- (d) Describe the development which caused this increase in stage 2. [4 marks]
- (e) Why does the rate of increase in population become less in stage 3? [5 marks]
- (f) Describe the population structure of countries which have reached stage 4. [4 marks]
- (g) In which stage on Fig.1 would you place Botswana?
[1 mark]
- (h) Give reasons for your answer in (g). [4 marks]
- (i) Give **three** examples of countries that have reached stage 4.
[1 mark]

Total Marks =25

Self-assessment Exercise 6

Answer all questions in the spaces provided.

1. Define the following terms:
 - (a) Internal migration [1mark]
 - (b) External migration [1mark]
 - (c) Forced migration [1mark]
 - (d) Voluntary migration [1 mark]
 - (e) Push factors [1mark]
 - (f) Pull factors [1 mark]
2. Figure 3 is a map of Africa showing towns/cities A,B,C,D and E, carefully study it and answer the questions that follow:

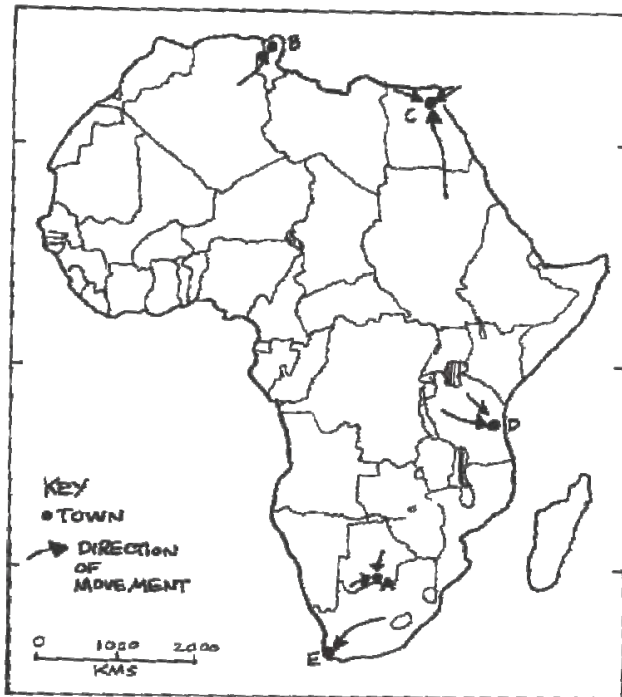


Fig. 3: Internal migration of population in Africa

Arrows show movement from all over the country to A, B, C, D & E.

(a) Name the towns/cities

- A _____
B _____
C _____
D _____
E _____

- (b) What type of migration is shown in figure 3?
 _____ [1mark]
- (c) Give at least **six** reasons why people would move in the pattern shown in figure 3. [6 marks]
- (d) If the population movement continues to take place as shown in figure 3 explain what is likely to happen to the resources available? [7 marks]

Total = [25 Marks]

Self-assessment Exercise 7

Answer all the questions in the space provided.

Study figure 3, which shows movements of people in a developing country in Africa, and answer the questions that follow.

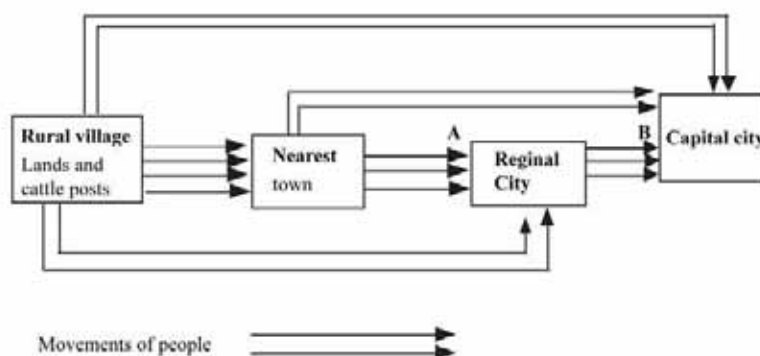


Fig. 3: Movements of people in a developing country in Africa.

The number of lines is proportional to numbers of people moving.

- (a) (i) What kind of movement is shown on figure 3? [1mark]
- (ii) What would be the reasons for the temporary movement of people along the route labelled A? [4 marks]
- (ii) Why would people move permanently along the route B? [4 marks]
- (b) According to figure 3 many people migrate from rural areas to urban areas.
- (i) Which major areas attract many migrants?

[1marks]

(ii) Why do the places you named in (b) (i) attract many migrants? [5marks]

(iii) What effects might this migration have on the population left in the rural areas?
[4 marks]

(v) Describe the problems in urban areas caused by the movement of people from the rural areas
[6 marks]

Total = [25 Marks]

Self-assessment Exercise 8

Write your answers in the space provided against each question.

1. What is HIV? [1 mark]
2. What is AIDS? [1 mark]
3. Name **three** common ways of transmitting HIV/AIDS.
[3 marks]
4. Name any **two** piercing instrument that may transmit HIV when used without sterilisation. [3 marks]
5. Explain how HIV affects the body once a person becomes infected. [2 marks]
6. Mention **four** ways of preventing the spread of HIV/AIDS.
[4 marks]

Total =[14 marks]

Self-assessment Exercise 9

Write your answers in the space provided against each question.

1. Name three countries that has a high prevalence of HIV/AIDS. [2 marks]
2. Give 3 reasons why a place would have a high prevalence of HIV/AIDS. [2 marks]

3. (i) Which area had the highest prevalence of HIV/AIDS?
(ii) Why do you think there has been somewhat of a slowdown in the prevalence of HIV/AIDS? [2 marks]
4. Give 3 examples of the impact of HIV/AIDS on the economy of Botswana. [2 marks]
5. Give 3 things that have been done to prevent the spread of HIV. [2 marks]

Total =[10 marks]

Answers to Assignment

Exercise 1

1. (a) When there are too many people in a country/an area to the extent that the available resources and services provided cannot sustain all the people living here.
(b) When the population size in an area/a country allows sustainable utilisation of the available natural resources and services leading to improved living standards of all the people.
(c) When the population of an area/ a country is far less than the resources available and does not fully use the natural resources.
(d) The number of people per unit area/per square kilometre.
(e) The enumeration or the counting of people in a particular place within a specific period of time.
2. (a) Urban areas and major villages, cities and towns OR the eastern part of the country
(b) Kgalagadi Desert, Okavango Delta, Chobe area.
(c) Factors influencing population distribution includes rainfall distribution, temperatures, soils, employment, accessibility, pastures, pests and diseases, land set aside for the management of wild animals and forests.

Use the following points to mark your discussion

- Areas suitable for agriculture are more populated. These are areas with fertile soils and high amount of rainfall and good pastures for livestock. In Botswana, the eastern part is more populated because of these resources.
- Cities, towns and major villages are also more populated because of more employment opportunities from the administration institutions, mining industries, manufacturing and processing industries and social amenities.
- Some parts of Botswana are thinly populated because they are

prone to diseases such as malaria. The Chobe area is a good example of an area prone to diseases which affect both people and livestock.

- Areas such as the Kalahari are thinly populated because they have poor soils, inadequate rainfall, extreme low winter temperatures and high summer temperatures and poor pastures. These areas are not suitable for agriculture which is the livelihood of most people in Botswana.
 - Some areas are thinly populated because they have been set aside for wildlife. Examples of such areas are the Kalahari Game Reserve. Other areas are reserved for forests while others are set aside for future use.
3. (a) A slow and steady increase from 1911 to 1946.
- A fast increase from 1946 to 1971.
 - A very rapid population growth from 1971 to 1991.
- (b) High birth rates/ rising birth rates and declining /low death rates.
- (c) During this time, death rates almost equalled birth rate, as medical technology was not advanced many people died from different diseases.

Exercise 2

1. (a) Population growth is an increase of births over deaths resulting in positive population growth.
- (b) Birth rate means the number of live births per 1000 people in a given year.
- is called the **natural increase**.
- (c) Death rate describes the number of deaths per 1000 people in a given year.
- (d) A populations' natural increase is the difference between the number of births and the number of deaths. This can be calculated for any area or country for as long as you know the total births and deaths in a year for that area or country. The formula is as follows:

Total births - total deaths = natural increase

- 2.
- (a) The world population grew very slowly.
- (b) This was caused by several factors including :
- **Famine** or shortage of food due to poor environmental conditions such as drought. During the early years people depended on their environment for food. They lived as hunters and gatherers.
 - **Infectious diseases** also claimed the lives of many people. There was lack of knowledge about disease and even their cure.

- **Lack of clean water and poor hygiene** also claimed many lives.
 - Most people died before reaching sexual maturity and this had a negative impact on the birth rates
- (c) There was a population explosion from 1700AD onwards
- (d) The rapid population growth rate was caused by the following factors:
- The Agricultural Revolution had increased food. Higher yields were experienced due to improved agricultural practices. Nutrition value also increased and this led to higher life expectancy and higher birth rates as people matured earlier to have children. The industrial revolution also introduced new machines which increased food supply.
 - There were also some marked improvements in public health which reduced mortality.
 - There was an increasing number of children entering the reproductive stage as food and water supply increased and also hygiene improved.
- (e) According to the graph the total world population was supposed to be 8 billion in the year 2000.
- (f) In the year 2000 world's population had reached 6 billion.
- (g) Fig.2 shows a very low population experiencing a very slow growth from a 1000 BC to 1600 AD. Population explosion is experienced from 1700 onwards, indicating a sharp rise in population growth.
- (h) Problems likely to occur if the world population continues to follow the trend shown in Fig. 2 are as follows:
- Poor standards of living
 - Lack of food/hunger
 - Shortage of educational facilities
 - Shortage of health facilities/diseases
 - High levels of unemployment
 - Famine
 - Pressure on the available resources like land and water/depletion of resources etc.
 - Poverty
 - Lack of clean water
 - Lack of housing
- (i) Migration may contribute to a rapid population growth. This happens when people move from rural to urban areas to look for employment and other opportunities like business. Movement of people caused by wars and natural disasters may cause rapid population growth of

receiving areas.

Exercise 3

1. Renewable resources are replaceable with time they replace themselves e.g. vegetation/trees. Non-renewable resources are not replaceable once they are finished nothing can be done to replenish them.

2. (a) Air : as population grows so does industrialisation, industries emit gases which pollute the air into the atmosphere.

(b) Water: as population increases water may become inadequate particularly in arid and semi-arid environments/ shortage of water/lack of water.

(c) Minerals: as population increases minerals may get finished as the government will try to meet people's demands by mining more minerals and sell them.

(d) Land: as population increases the land for agriculture is used for with time the total low available becomes insufficient

3 (a). Wildlife- tourists come into the country to view, photograph, and hunt some animals and they pay some money to do all these. The money paid is used to build schools, hospitals etc in different parts of the country.

(b) Vegetation: trees are cut to construct shelter, fences and for furniture making, for commercial purposes. Some trees are also used for their medicinal value, some produce edible fruits. Trees are also used for shade and as windbreakers.

4 (a) Air, land and vegetation.

(b) Air can be protected by using other alternative energy sources like the solar energy.

Land: reduce birth rates through offering incentives and through the use of contraceptives and education.

Vegetation: plant more trees to replace the removed ones; control tree cutting.

Exercise 4

1. (a) (i) The age-sex composition of a population.

(ii) The average number of years a person is expected to live.

(iii) The number of non-working dependants in a population for every 100 workers.

2. (a) A is for a developed country and B is for a developing country.

(b) The pyramid has a broad base showing a youthful population and high birth rates. There are more females than males. The pyramid narrows towards the top showing high death rates and a short life

expectancy. There is a high dependency ratio.

(c) The governments might have to spend large amounts of money in catering for the youthful populations by building more schools and creating employment opportunities by setting up more industries. In addition the few elderly people will have to be supported with pensions/very large amounts of the governments' budgets have to provide for the dependents.

(d) Pyramid A has a narrower base than pyramid B. This shows that A has a more aging population than B. A has a broader base than B meaning that, B has many young people than A. A has a broader top showing that more people reach old age than in B/ longer life expectancies than in B. B has narrower top than A/shorter life expectancies than in A.

3. That the average number of years a person is expected to live is 74 in the developed countries.

4. Life expectancy for developing countries is lower than that of developed countries.

5. Medical science is advanced in the developed countries so many diseases which used to claim people's lives can be cured whereas in the developing countries medical science is less developed and many people die before the can reach old age. There are better standards of living in the developed than in the developing countries.

Exercise 5

(a) Stage 3

(b) Because both birth and death rates are declining.

(c) Because birth rates remained high while death rates declined rapidly.

(d) Improvement in medical science: vaccinations, increased hospitals and clinics, specialist doctors, introduction of new medical drugs and scientific investigations like the invention of the X-ray, improvement in sanitation and water supply. Increased food production and improved diets. Improved transport facilities enabling the transportation of food, medicine and doctors to where they are most needed.

(e) People plan their families: various contraceptives are used, some people opt for sterilisation (e.g. vasectomy in men tubal ligation in women) in some places abortion is legal so some people opt to commit abortions, and government incentives also play a role. Improvement in the status of women, most of them are career women so have no time to be mainly child-bearers. Increased desire for material possessions like luxurious cars, holidays and smart bigger homes. Increased industrialisation and use of machines meaning that few labourers are needed. Improvement in medical science means a reduction in infant

mortality rate leading to less pressure to have many children.

(f) They have smaller proportions of their population in the pre-reproductive age groups and larger proportions in the post reproductive groups, birth rates, death rates and infant mortality are low. Life expectancy high.

(g) Stage 2

(h) Stage 2 because of the following: birth rates continue to remain high, death rates are declining, as a lot of diseases are curable except for HIV/AIDS related diseases. Improved sanitation and clean piped water is supplied. Increased food production and improved diets. Improved transport facilities enabling delivery of food, doctors and medical supplies.

(i) USA/Sweden/UK or Britain/Norway/France/Italy/Spain/Greece.

Exercise 6

1. (a) Movement of people within Botswana /within Africa to find work or for other reasons.

(b) Movement of people to cross international boundaries to find work or for other reasons.

(c) Forced movement done against one's will e.g. slave trade, forced resettlement by government.

(d) Movement by personal choice.

(e) **Push factors:** conditions that make life so uncomfortable that people move either a temporarily or permanently to a new area.

(f) **Pull factors:** conditions that make life pleasant and attract people from their original homes.

2. (a) **A.** Gaborone **B.** Tunis **C.** Cairo **D.** Dar-es-salaam and **E.** Cape Town.

(b) Internal migration of people in Africa or, within countries in Africa.

(c) Education/schools, for better health services, for business/markets, improvement in the standards of living, for seeking jobs

(d) Shortage of land, shortage of water, unequal distribution of resources, shortage of food resource, underutilization of resources in some areas, shortage of schools/ hospitals/clinics in the receiving areas, lack of accommodation etc.

Exercise 7

(a) (i) Rural-urban movement or migration

(ii) Shopping, banking, visiting relatives/friends, medical services commuting to work, taking remittances home, selling farm produce.

(iii) For better employment opportunities, marriage, better administration, better education, better houses with electricity, better

medical facilities, higher wages, improved transport/roads, improved standards of living, improved recreational facilities, clean water supply/piped water, improved sanitation.

(b) (i) Major cities

(ii) Due to pull factors which include:

Jobs/employment, better educational facilities, better medical services, better supply of goods and services/transport/communication, markets, recreational facilities/entertainment/cinemas.

(iii) Old people, very young children and often women remain behind and this leads to low agricultural production, lack of labour on the fields, social strain, marriage break-ups, sex ratio imbalance, low living standards, depopulation of the rural areas, less development in the rural areas and greater dependency on the few working people.

(iv) Overcrowding, unemployment, increase in crime and other social ills like rape, prostitution and juvenile delinquency, shortage of land, water shortage, traffic congestion, shortage of housing, development of shanty towns/slum areas on the fringes of urban centres, pressure on the available services often indicated by long queues and poor sanitation.

Exercise 8

1. HIV is a tiny virus called Human Immunodeficiency Virus.
2. AIDS is the short form for Acquired Immune Deficiency Syndrome.
3. Ways of transmitting HIV are through unprotected sexual intercourse, blood transfusion and direct transmission from mother to unborn child during pregnancy or at birth.
4. Razor blades, scissors, needles, syringes etc.
5. When a person becomes infected with HIV, the virus attacks and weakens the body's defence system. Once the system has been weakened opportunistic diseases attack and eventually kill the person.
6. Abstaining from sexual intercourse, practising safe sex by using a condom, use sterilised piercing instruments, have sex with only one uninfected partner.

Exercise 9

1. Any three of the following: Zambia, Mozambique, Zimbabwe, Botswana, Malawi, South Africa and Uganda.
2. (i) The presence of a high population of high risk groups such as prostitutes drug addicts, mobile workers etc.
(ii) Unavailability of information on HIV/AIDS.
(iii) Negative attitudes among the population on safe sex.
- 3.

(i) Francistown

(ii) There are many reasons which can be given including : the effects of accelerated campaigns against HIV/AIDS, increase in knowledge about HIV/AIDS, practice of safe sex, changes in attitudes etc.

4. (i) Increase in costs: Government has to provide more facilities, support staff and finances for the increased numbers of HIV/AIDS infected people in hospitals. Terminal benefits for individuals who are HIV/AIDS infected will have to be paid out by the Government and the private sector in the form of benefits and insurances. Families will have to pay more to support the sick.

(ii) **Loss of skill:** Both the private sector and the Government will have to train more people to replace those either dead or weakened by HIV/AIDS. These will not be as experienced as those they would be replaced resulting in reduced productivity.

(iii) **Support of orphans:** The government will have to put in a lot of finance to support the orphans in the form of food, clothing and shelter. Extended families will have to offer more assistance to orphans. Grandparents will have to look after some of the orphans; this task will make them poorer.

5. Any three of the following: The Government has formed a National Committee on HIV/AIDS, which is co-ordinated by the Ministry of Health.

- All school curriculum from the primary to the tertiary levels include HIV/AIDS education.
- The Government is intended to reduce the mother to child infection by introducing anti-retroviral drugs to expectant mothers.
- A report on the situation on orphans in Botswana has been produced which will help identify the orphans and their problems.
- A national massive education campaign on HIV/AIDS and safe sex has been launched to try and stop the HIV/AIDS epidemic.
- Some countries such as USA have contributed resources to fight against HIV/AIDS.
- Botswana support international research on the development of a vaccine for HIV/AIDS.
- A support system for Home Based Care has been introduced to alleviate patient pressure in hospitals for the terminally ill.

Assessment



Assessment

Instructions to Learners

This assessment must be done on completion of the unit. Submit or post it to your study centre. You will need 1 hour to work on the assessment.

Instructions to Students

1. Answer **all** the questions
2. Write all your answers in the space provided
3. Marks for all questions are shown in square brackets
4. You may take **1hour** to do this assignment

-
1. Write down what you understand by the following terms:

- (a) Over-population

(1marks)

- (b) Under-population

(1marks)

- (c) Natural increase

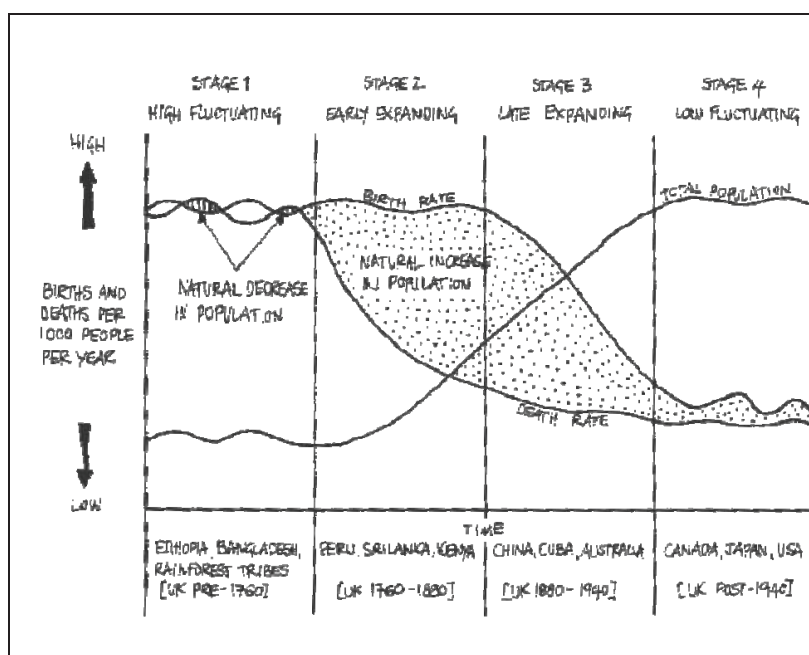
(1marks)

(d) Optimum population
(1marks)

(e) Birth rate
(1marks)

(f) Death rate
(1mark)

2. Study the diagram below, which shows changes in the birth and death rates in a country over a long period of time.



(a) In which stage was there a period of fall in the total population. Give one reason for your answer
(3marks)

(b) Why was there a great population increase in stage 2? Use only evidence from the diagram (3marks)

Answers to Unit 13 Assignment

1. (a) Overpopulation: when there are too many people and less resources to sustain everyone's life or maintain an adequate standard of living

(b) Under-population: when there far more resources in an area or a country than they can be used by the number of people living there.

(c) Natural increase: the difference between birth and death rates.

(d) Optimum population: when the number of people in an area matches the available resources such that adequate standard of living is fully maintained

Birth rate: the number of live births per 1 000 people per year

Death rate: the number of deaths per 1 000 people per year

2. a) (i) Stage 3, birth rates decline rapidly and death rates continued to drop/decline

(ii) Birth rates remain high when death rates decline rapidly

(iii) Improved medical care: vaccinations, hospitals, doctors, discovery of new drugs and new scientific inventions

- Improved sanitation, clean water supply/piped water
- Improved food production both in quality and in

quantity

- Improved transport to transport food and doctors to wherever they are needed
- A decrease in child mortality

(vi) High unemployment levels, shortage of food shortage of land, high crime rates (rape, theft/burglary, murders etc). juvenile delinquency, low wages, land disputes

(v) It goes down/falls/reduces/declines fast because both death and birth rates are declining.

(iv) A small proportion of the population falls within the pre-reproductive age of 15 years and below:

- A large proportion of population falls within the post reproductive age (most people have grown past the child bearing years)
- Very few people within the child bearing age, as a result there are low birth rates

(b) Stage 2: It is generally characterized by declining death rates and rising birth rates. Except for HIV/AIDS problem, Botswana has a high standard of health services and hence low death rate and high birth rate.

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