



ZIMBABWE

**Ministry of Primary and
Secondary Education**



Geography Module Level II Volume 1



Lifelong and
Continuing Education
2020

Introduction

The last thirty years have seen resurgence in Open Distance learning as a pedagogical approach and this trend is envisaged to continue. The knowledge-based society that we live in has enabled learning to take place anywhere or everywhere. The concept of a classroom without walls continues to grow in Zimbabwe. Due to the demand for open distance learning, the Ministry of Primary and Secondary Education has revamped its non-formal education department to embed distance learning as a tool for learning in order to address the learning needs of the growing numbers of out of school learners or school drop outs that cannot access formal education systems. The module is written in a simple manner with lots of friendly and interactive activities to make learning interesting and easier for the out of school learners. The module develops critical thinking skills, problem solving skills among other 21st Century skills. It is the Ministry's hope that out of school learners are going to take advantage of this module and benefit immensely in advancing their learning endeavours.

Acknowledgements

The Ministry of Primary and Secondary Education (MoPSE) wishes to acknowledge Primary Secondary and Non-Formal Education (PSNE) department for coordinating this programme and the Curriculum Development and Technical Services (CDTS) department. Special mention goes to Chabikwa Blessing – Education Research Officer (CDTS) the team leader who compiled, edited and proof read the Module. The writing of this Non- Formal Level 2 Geography Module was made possible by the contributions from the following dedicated and hardworking Senior Teachers who authored units of this module:

- Frank Phiri of Inyathi High School in Bubi district, Matabeleland North
- Edith Mushayavanhu of All Souls High School in Mudzi district, Mashonaland East
- Erasmus Chiketa of St Johns Chikwaka High School in Goromonzi district, Mashonaland East
- Maryline Muchena of Uzumba High School in Uzumba district in Mashonaland East.

- MoPSE would also want to extend special mention to Mr. Frank Phiri for being both the author and the artist for the illustrations and designs in the module, without him, the work was going to be compromised.
- Above all special consideration goes to UNICEF for providing funding for this Module.

How to use this module

This module is meant to be a distance learning tool. It is designed in such a way that you can study the topics on your own and go and write examinations. An attempt has been made to simplify the language so that that you understand every concept clearly. As you read the module, however, you may still find words that are new to you. We have made a list of *key words* at the beginning of each unit. The whole module also has a glossary at the back. Check the new words there. In some cases, the words may not be in the module glossary or keys words. When this happens, it will be best to consult your dictionary and other such books that may help you understand what we are saying to you.

The module is divided into units. Units are what you can call topics. In this module there are 25 units. Each of these units can be read independent of other units. However, we strongly recommend that you read related units together. Check for related topics in the module as they are grouped into *themes*. The themes and related topics that you will find in this module are as follows:

Theme	Units	Description of the theme
1	1 to 4	Weather and climate
2	5 to 8	Landforms
3	9 to 12	Natural resources, Energy and Power
4	13	Geographic Information Systems
5	14 to 16	Mining and Environmental management
6	17 to 18	Agriculture
7	19 to 20	Industry and tourism
8	21 to 24	Population Geography
9	25	Transport and trade

You will also find that the module has *in-text activities*. These are small task that we will engage you in so that you fully get the ideas being discussed. You are therefore encouraged to do all these. Do not hurry to go through the text by omitting these in-text activities. They will be very useful for understanding the geographical concepts we have in the module.

Meanwhile, the module also has *activities*. Activities are exercises that are meant for you to check your understanding as you read through different topics. The activities generally come after every main topic within the unit. The activities in the module have answers. You are expected to check your answers against those provided at the back of the module. The activities can be done in the module in the spaces provided. Watch out for *tips* as you read the module. These are short hints and guides on some of the issues you will meet in the module. The tips will offer you ways of doing something, clues to an answer and even point you to the next concept. In the same

way, the module has ways of emphasising points to you. Important points are italicised or made bold.

At the end of each unit there is a *summary* of the whole unit. The summary is in point form. It lists the main ideas discussed in the module. You are advised to use the summary to revise the ideas of each unit. After the summary there is a *unit test*. The unit test is a set of questions that you must answer in order to test yourself on all concepts covered in the module. Meanwhile, each theme ends with an *end of theme assessment*. This consists of exam type of questions. These questions are multiple-choice and structured questions for you to test your understanding of the module. Moreover, in order to help you check how much you have understood from a unit there is a check list. Use the check list to evaluate how much of the unit you have understood. The check list will help you evaluate the *objectives* that are listed at the beginning of the unit. We also included a recommended list of textbooks that you can refer to in order to deepen your understanding of the concepts covered in each unit. It is our hope that you find using this module easy to use and interesting. As you read it learn and enjoy.

This module has been subdivided into two volumes, that is, Volume 1 Volume 2. You are advised to study Volume 1 first before going to Volume 2.

Wish you the best!

Table of Contents

Introduction	i
Acknowledgements	ii
How to use this module	iii

UNIT 1: AIR MASSES AND AIR MASSES AFFECTING ZIMBABWE AND SOUTHERN AFRICA **1**

1.1	What is an air mass?	2
1.2	Classification of air masses	3
1.3	Air masses affecting Zimbabwe	5
1.4	The Inter Tropical Convergence Zone (ITCZ)	7
1.5	Air masses outside the tropics	9
	End of Unit Assessment	12

UNIT 2: FRONTS, TEMPERATE DEPRESSIONS, FRONTAL SYSTEMS AND TROPICAL CYCLONES **14**

2.1	Temperate Depressions	15
2.2	The effect of temperate depressions on the weather of Zimbabwe	20
2.3	Tropical Cyclones	22
2.4	Effects of tropical cyclones	26
2.5	Mitigation against impact of tropical cyclone	26
	End of Unit Assessment	30

UNIT 3: CLIMATE TYPES ON A GLOBAL SCALE AND INTERPRETATION OF CLIMATIC DATA **32**

3.1	What is climate?	33
3.2	What are the factors that influence climate?	33
3.3	Types of climate	36
3.4	Climatic data	46
3.5	The importance of the Mean and the Range in Climatic studies	49
	End of Unit Assessment	50

UNIT 4: HUMAN INFLUENCE ON CLIMATE **52**

4.1	Human Influence on Climate	53
4.2	Climate Change	60
4.3	Nature: Causes and Effects of Climate Change	60
4.4	Adaptation to Climate Change	62
4.5	Mitigation against Climate Change	62
	End of Unit Assessment	64

UNIT 5: PLATE TECTONICS	66
5.1 The Continental drift theory	67
5.2 Plate tectonics	69
5.3 Folding and resultant landforms	77
5.4 Faulting and resultant landforms	82
5.5 Volcanoes and earthquakes	87
End of Unit Assessment	98
UNIT 6: LANDFORMS RESULTING FROM WATER ACTION AND RIVER PROCESSES	100
6.1 Seasonal nature of rivers in Zimbabwe	101
6.2 Processes operating along a river channel	102
6.3 Factors influencing the rivers energy	106
6.4 Landforms resulting from river processes	107
End of unit assessment	115
UNIT 7: LANDFORMS RESULTING FROM WIND ACTION IN ZIMBABWE AND AFRICA	118
7.1 Characteristics of arid and semi-arid regions	119
7.2 Distribution of arid regions	120
7.3 Distribution of Semi-arid regions	122
7.4 Wind action processes and resultant landforms	123
End of unit assessment	131
UNIT 8: HAZARDS ASSOCIATED WITH LANDFORMS DEVELOPMENT AND DISASTER RISK MANAGEMENT	133
8.1 Volcanoes as hazards	134
8.2 What are tsunamis and their effects?	136
8.3 Earthquakes as hazards	137
8.4 Mass wasting	138
8.5 Flooding	141
8.6 Disaster risk management of volcanoes, earthquakes, flooding and mass wasting.	142
End of unit Assessment	144

UNIT 9: ECOSYSTEMS: WETLANDS AND SOILS IN THE TROPICS	147
9.1 What are the Importance of wetlands?	148
9.2 The benefits of wetlands	150
9.3 What are the soil components?	150
9.4 Soil forming processes	152
9.5 Soil types	158
9.6 Soil profile	159
9.7 Soil properties	161
9.8. Soil mineral content	166
End of Unit Assessment	167
UNIT 10: BIOGEOCHEMICAL CYCLES	168
10.1 What is Nutrient Cycling?	169
10.2 The Nitrogen cycle	171
10.3 What measures can be used to conserve the ecosystem?	173
10.4. Restoration methods	176
10.5 What are the Importance of Ecosystems?	176
End of Theme Assessment	177
UNIT 11: NATURAL RESOURCES – CONSERVATION OF RESOURCES AND WILDLIFE MANAGEMENT	179
11.1 What are natural resources?	180
11.2 Conservation methods (Fish and Water)	182
11.3. Types of wildlife management	187
11.4 What is Human and Wild life conflict	191
11.5. What is CAMPFIRE?	196
End of Unit Assessment	199

Unit 1 Air masses and air masses affecting Zimbabwe and Southern Africa

- 1.1 What is an air mass?
- 1.2 Classification of air masses
- 1.3 Air masses affecting Zimbabwe
- 1.4 The Inter Tropical Convergence Zone (ITCZ)
- 1.5 Air masses outside the tropics

Introduction

You have probably experienced a sudden change in air temperature as you walked through an area in your locality. What do you think caused the sudden change? It was air masses. In this unit you are going to learn about air masses. You will learn about what air masses are. Moreover, you will cover air masses that affect the weather of Zimbabwe. Once you master the air masses affecting Zimbabwe, you will also learn about air masses affecting the weather of Southern Africa.



Objectives

After going through this unit, you should be able to:

- describe an air mass
- classify air masses
- describe types of air masses and their characteristics
- describe weather associated with air masses affecting Zimbabwe and Southern Africa
- explain weather conditions associated with the Inter-Tropical Convergence zone



Key Words

Air mass	a large body of air that has humidity and temperature characteristics that are horizontally uniform.
Source Region	an area that is physically uniform over which air masses develop.
Humidity	amount of water vapour contained by an air mass.
Latitude	the angular distance measured north and south from the equator.
Convergence zone	a low-pressure belt where winds from different and opposing pressure belts meet.
Divergence zone	a high-pressure belt from which winds are blowing away.



Time

You are expected to take an average of **10 hours** to go through this unit.



Study skills

- You have to note that this unit is about air. Can you see air? Of course, not! You can only see the effects of air as it blows as wind. As a result, you will need a good sense of **imagination** to describe the processes we will cover in this unit.
- You are also advised not to move on to the next unit before you fully understand the content of this unit.

1.1 What is an air mass?

You have already come across the definition of the term air mass in the key terms section. What did we say it means, by the way? If you have forgotten, you have to refer to the key words section always. We said an air mass is **large**. This means that a single air mass covers hundreds of kilometres. We also said it has **horizontally uniform** temperatures and humidity. This means that the air temperature is similar in different areas at the same altitude. Study the diagram below that illustrates the size of an air mass and the uniform temperature characteristics.

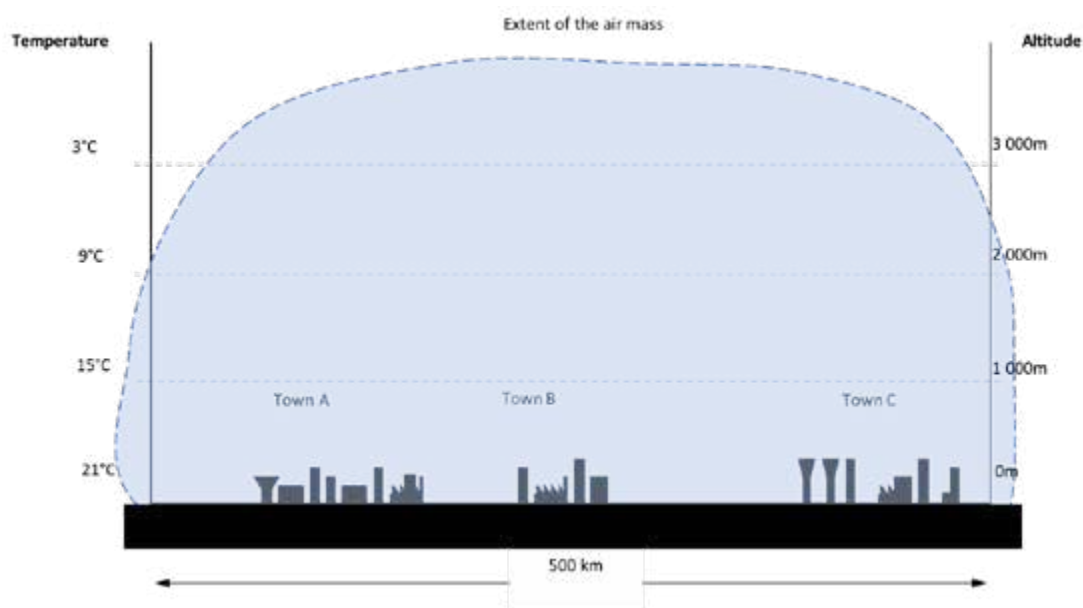


Figure 1.1 The extent of an air mass and the uniform temperature and humidity

Now that you have understood what an air mass is, let us move on to look at how air masses are classified.

1.2 Classification of air masses

Air masses are classified according to source regions. Do you remember what a source region is? We defined a source region as an area that is physically uniform over which air masses develop. There are different types of source regions. Study the major types of source regions that are shown in Table 1.1.

Table 1.1 Source regions and their examples

Type of Source Region	Example
Ocean	Indian Ocean
Cold Plain	Antarctica and the Arctic area
Deserts	Sahara
Plains	Canadian Plains

As we have illustrated above, source regions vary in terms of whether they are water bodies or landmasses. Landmasses are continents or parts of continents. They are different from the seas or oceans. Notice also that they vary in terms of whether they are cold or warm. You have to, therefore, notice that an air mass that forms over a cold surface will become cold. Similarly, the one that settles over a warm area will become warm. Consider the effect of the following types of source regions:



Activity 1.1 The effect of source regions on air masses

Answer the question below by filling-in the spaces in the table provided below.

What is the effect of the source regions in the table below on air masses settled over them?

Source Region	Effect on the air mass
e.g. A cold surface	Low temperatures
- An ocean source region	
- A landmass source region	

You can check whether you answered the questions correctly from the separate answer book that goes with this module.

Now we are going to take you through the geographical terms used in the classification of air masses. In Geography classification is important as it simplifies the things that we study. You must also note that classification helps to organise geographical topics so that they are easy to follow. It also shows differences in the things that we study. Air masses that form over landmasses are called **continental** air masses. Meanwhile, those that form over the ocean are called **maritime** air masses. Continental air masses

are **dry** while maritime air masses are **wet**. As you might have already figured it out yourself, dry means the air mass has low humidity while wet means it has high humidity.

You have to note, however, that the location of the temperature of the air mass is affected by the source region. These source regions are located according to latitude. Study Table 1.2 below that shows the location of source regions and the temperature of the air mass they cause to develop.

Table 1.2 The Location of Source Regions and their Temperature characteristics

Source Region	Latitudinal Location	Temperature Characteristics
Equatorial (Also described as Tropical)	Between 5°S and 5°N	Warm
Tropical	5°S to 30°S and 5°N to 30°N	Warm
Temperate	30°S to 66°S and 30°N to 66°N	Cold
Polar	66°S to 80°S and 66°N to 80°N	Cold
Arctic/ Antarctic	85°S to 90°S and 85°N to 90°N	Cold

1.2.1 Naming air masses

By now you should be aware that air masses are classified according to their humidity and temperature characteristics. We will then move on to the naming of air masses. Air masses are named according to their source regions and temperature characteristics. For example, an air mass that develops at 20°S over an ocean will be called the **Tropical maritime** air mass. This term can be written in short as **Tm**.

Do you notice that the term **Tropical maritime** has been built from the fact that 20°S is in the **Tropical** zone? Moreover, the fact that the air mass forms over an ocean gives it the **maritime** description. So, when you put the two terms together you get the term **Tropical maritime**. Notice too, that we can readily figure out the facts that this particular air mass is **warm** and **wet**. The term *tropical* tells us that it is *warm* while the term *maritime* tells us that it is *wet*. Now, try to name and give the characteristics of the following air masses:



Activity 1.2 Naming air masses and identifying the characteristics

Answer in the spaces provided below.

- (a) What name is given to an air mass originating from a land mass in the tropics?
(b) Describe the temperature and humidity characteristics of the air you named in (a) above.
- (a) Name the air mass that originates from an ocean around 70°S.
(b) Describe the temperature and humidity characteristics of the air masses you named in (a) above.

1.3 Air masses affecting Zimbabwe

Now that you can name and describe air masses, let us move on to focus on the movement of air masses. It is a fact that air masses move. As they move, they affect the weather of the areas they come into contact with. For example, a cold air mass will cause the temperatures of the areas it passes through to drop and be cold. Likewise, a wet air mass will bring a lot of moisture into the areas it comes into contact with. As a result of the moisture rainfall would occur.

Did you know that there are four main air masses that affect our weather in Zimbabwe? Take a look at Figure 1.2 below that shows the air masses affecting Zimbabwean weather. We are confident you know and often see the effects of these air masses over Zimbabwe:

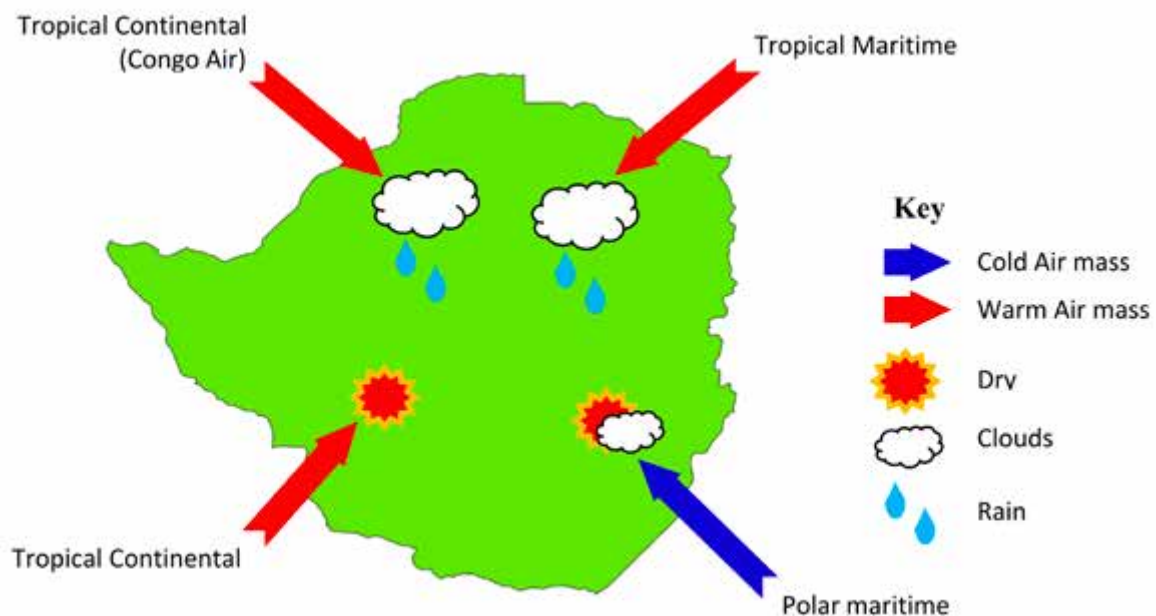


Figure 1.2 The Air masses affecting Zimbabwe and their effects on weather

You have seen that the weather of Zimbabwe is affected by the following air masses:

- Tropical maritime (Tm) from the north east originating from the Indian ocean
- Tropical continental (Tc) from the west and south west originating from the Kalahari and Namib deserts.
- The Congo Air – Tropical continental (Tc) originating from the Equatorial areas around the Democratic Republic of the Congo. That is why it is called the Congo Air.
- Polar maritime from the Indian ocean in the mid latitudes.

Study Table 1.3 shows you the air masses affecting Zimbabwe and the effects they have on the weather.

Table 1.3 Weather caused by air masses over Zimbabwe

Air masses	Effect on the weather of Zimbabwe	Time of the year for dominance
Tropical maritime	Brings rain and warm temperatures	Summer months
Congo air	Brings high rainfall and high temperatures	Summer months
Tropical continental	Brings dryness and high temperatures	Early summer
Polar maritime	Brings low temperatures and cloudy skies with little rainfall at times.	Winter months

1.3.1 Air masses affecting the weather of Southern Africa

We are now going to expand our focus area and look at Southern Africa. We believe that by now you know the countries that are in Southern Africa. Can you try to list all the countries in Southern Africa? If, however, you are not sure of them you do not have to panic. The map shown in Figure 1.3 below has these countries. Remember there are other countries that are islands like Madagascar, the Seychelles and Mauritius. These are mostly affected by tropical maritime air masses.



Figure 1.3 The Air masses affecting Southern Africa and their effects on weather

As you were studying Figure 1.3 you must have realised that the air masses affecting Southern Africa are from the oceans. The ones from the south (that is, south east and south west) are cold and wet while the ones from the north (north-east and north-west) are warm and wet.

You also have to realise that air masses **change in characteristics** as they move from their source regions. For example, the Polar Maritime from the south-west moves across a cold sea and loses its moisture over the cold Atlantic Ocean. By the time it enters Namibia it is dry. Remember that in Namibia there is the Namib desert. The air mass is then warmed up by the desert conditions, by the time this air mass gets into Zimbabwe it would have changed into a tropical continental air mass.

1.4 The Inter Tropical Convergence Zone (ITCZ)

In the previous topic we looked at the movement of air masses. In this section you will discover that once the air masses begin to move, they are called global winds. What are global winds? I hope you got it right. Global winds are the horizontal movement of air masses over long distances and across countries and continents. Examine Figure 1.4 which shows you the global winds:

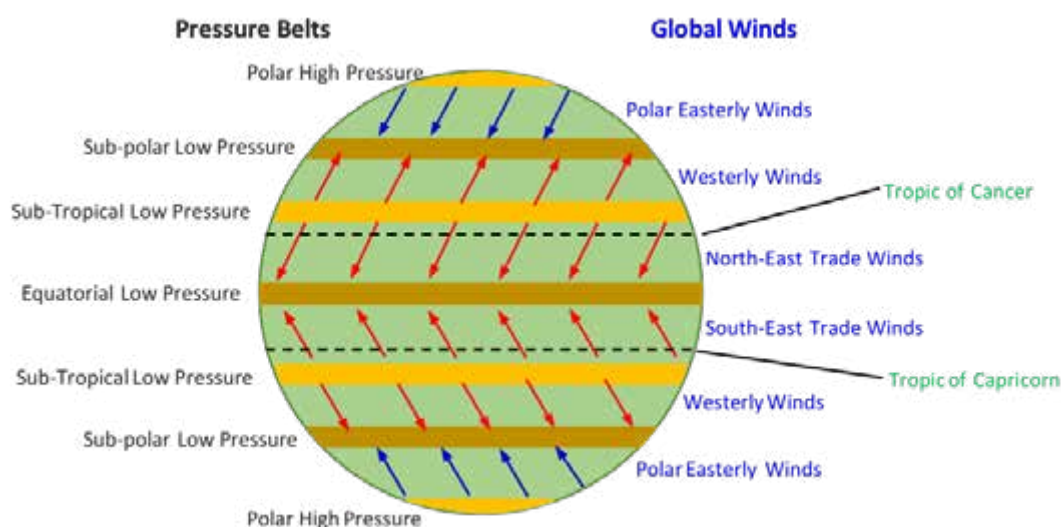


Figure 1.4 Global winds and the controlling pressure belts

Take note that the low-pressure belts in Figure 1.4 are convergence zones of air masses. On the other hand, the high-pressure belts are the divergence zones of the air masses. Remember that the terms convergence zone and divergence zone were defined in the key words section.

You are now ready to learn about the ITCZ. You have to understand the individual words in the term inter-tropical convergence zone. The term inter-tropical means between the tropics. For you to remember this well, you have to refer to level 1 work on lines of latitude. In that level you learnt about the Tropics of Cancer and Capricorn.

When you put the terms **inter** and **tropical** together, they mean a convergence zone of winds that lies between the tropics of Cancer and Capricorn. Now refer

again to Figure 1.4. Which convergence zone lies between the tropics of Cancer and Capricorn? If you said the Equatorial low pressure belt, you are very right! This is the general position of the ITCZ. Now identify the winds that converge at this pressure belt. I am sure you got the winds right as the north-east trade and the south-east trade winds.

Another point you have to get is that when global winds converge, they bring the rainfall to the area of convergence. In this case, they cause high temperature because the winds are tropical. Moreover, they bring rainfall to areas around the convergence zone.

Now, remember these important concepts we have established about the ITCZ;

- the ITCZ is the equatorial low-pressure belt.
- the north-east trade winds converge at the ITCZ.
- the ITCZ is associated with high temperatures
- the ITCZ is associated with high rainfall.

1.4.1 The changing positions of the ITCZ

Figure 1.5 below shows you the positions of the ITCZ in January (Figure 1.5a) and in July (Figure 1.5b). You have to understand that the ITCZ moves from time to time. Around January it is in the southern hemisphere while in July it is in the northern hemisphere.

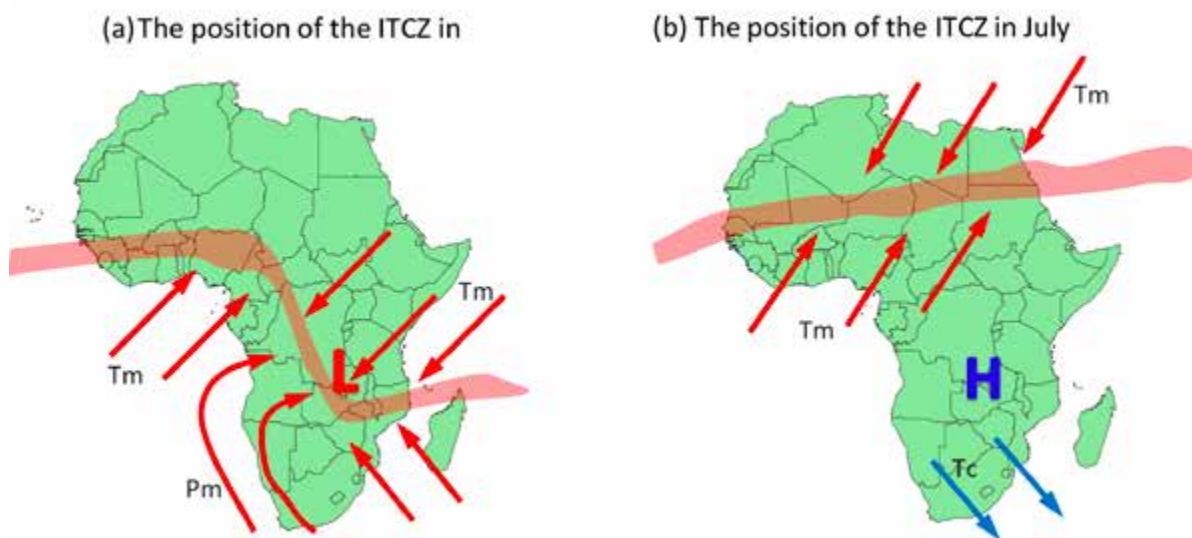


Figure 1.5 The Positions of the ITCZ in January and in July with wind and pressure patterns

Always remember that as the ITCZ moves, it brings high temperatures and high rainfall to the area it passes through. In so doing it also causes seasons. This results in the warm, rainy season when it is close but its absence brings a dry cool to cold season. In Zimbabwe the warm, wet season is the summer while the dry, cool season is the winter.

So, now you are able to explain why the winter season has little or no rainfall in Zimbabwe.

Now that we have covered the nature, movement and weather associated with the ITCZ, see whether you have understood everything on the ITCZ. Attempt the questions below.



Activity 1.3 The Inter-tropical Convergence Zone

Answer in the spaces provided below:

1 (a) Name the air masses that converge at the ITCZ.

(b) Describe the weather that is associated with the ITCZ.

2. If you were a **meteorologist** (a weather scientist) in your locality what advice would you give to farmers to prevent problems associated with the ITCZ.

1.5 Air masses outside the tropics

We are sure you are aware that we have only discussed about air masses that are in the tropics. You should, therefore understand that there are other air masses that occur outside the tropics.

Such air masses are mostly cold air masses. They occur in the temperate and polar areas where temperatures are low. You have to note that these air masses are polar maritime, polar continental, Antarctic maritime and Antarctic continental. Let us exemplify these air masses outside the tropics with air masses affecting Cape Town. In Cape Town summer months start around September and continue to March. You will realise that in these months, the air mass that affects the Cape Town area is the Polar maritime. This air mass is cold and therefore brings little or no rainfall. Note that even though it is a maritime air mass it brings very little rainfall due to its low temperatures. Study Figure 1.6 which shows you the Cape Town area and its summer airmass.

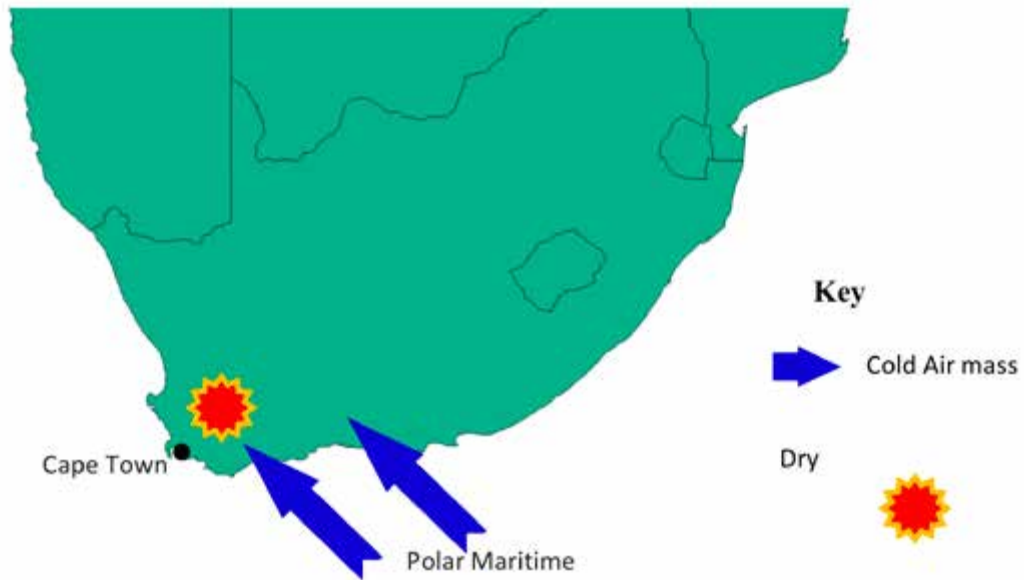


Figure 1.6 Polar maritime air mass affecting Cape Town area in the summer months

You will notice, however that in the winter season, there is rainfall. The winter months start in from May to early August. During these months the air mass affecting the Cape is the Tropical Maritime. You will find that winds blow from the north-west. These winds are warm and bring rainfall. This is illustrated for you in Figure 1.7.

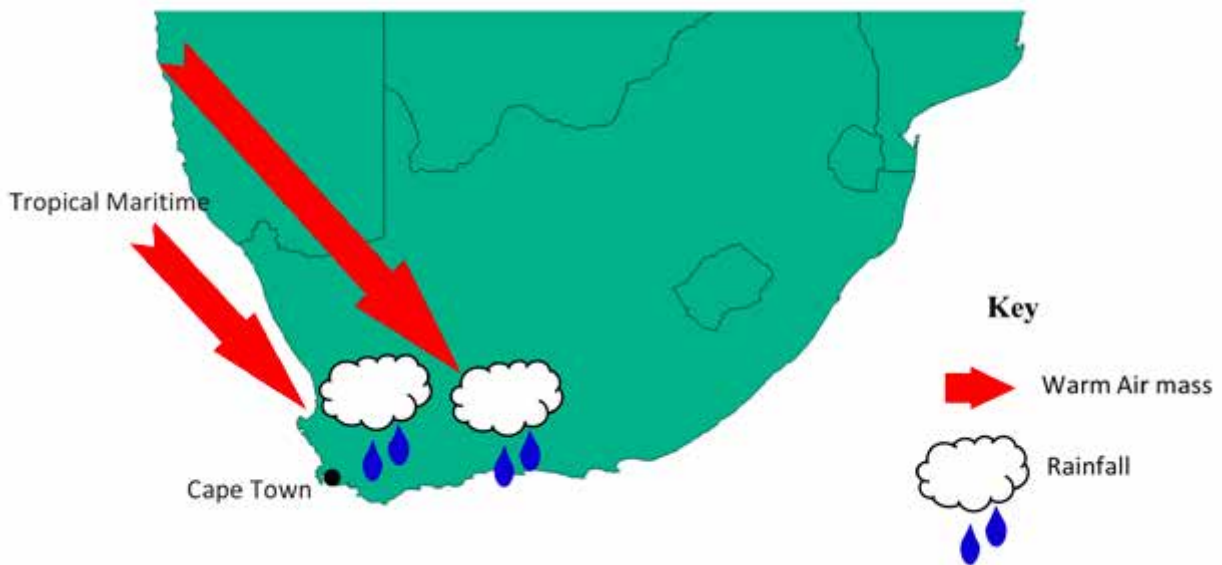


Figure 1.7 Tropical maritime air mass affecting Cape Town area in the winter months.



Activity 1.4 Airmasses outside the Tropics

1. Identify the airmasses that affect the Cape town area.
2. Describe and explain the characteristics brought by these airmasses?
3. Analyse the differences between airmasses affecting Zimbabwe and those affecting the southern tip of Africa.

Well done, you have come to the end of this unit. It is my hope that you have understood all the concepts in this unit. It is now time to remind you of all that we covered in this module. Go over the points in the summary below and check if you have understood the concepts listed there:



Summary

Here is your reminder of the what we covered in this unit.

- The first thing we dealt with was the concept of what an air mass is. We highlighted that an air mass is a large body of air with uniform temperature and humidity at every altitude.
- We further took you through the classification of air masses. Remember that we said air masses are classified according to the source regions and according to humidity characteristics. We said source regions give the air mass its temperature identity.
- After that we took you through the naming of air masses. In this section we highlighted to you that air masses are named by source region first and then the humidity status. Remember that we gave you the example of the Tropical maritime.
- You also covered the air masses affecting the weather of Zimbabwe. These air masses were revealed as the Tropical maritime from the north-east, the tropical continental from the north-west. The north-westerly air mass is called the Congo Air. We also mentioned the Tropical continental from the Kalahari and the Namib deserts. The other air mass we mentioned is the Polar maritime from the south-east.
- We observed that the air masses from the north bring rainfall while the ones from the south are drier. You must have also understood that the south-easterly air mass brings cold temperatures over Zimbabwe. Meanwhile, it must have also

been clear to you that the Tropical continental from the south-west brings high temperatures over Zimbabwe.

- After Zimbabwe and its air masses we took you to Southern Africa. We observed that Southern Africa is affected by Tropical maritime air masses from the north-east and the north-west. These bring warm temperatures and rainfall into the region. Figure 1.3 illustrated to you that the air masses entering the region from the south-east and south-west bring colder temperatures and little rainfall.
- Lastly, we covered the ITCZ and other air masses. You were taken through the definition of the ITCZ. You also studied the weather associated with the ITCZ. Moreover, you described the positions of the ITCZ in January and in July.
- What you learnt in this unit is a foundation for what you will cover in the next unit.

Now because you have gone through this unit, check how much you understood by attempting the questions below. Note that question 4 is a research assignment.



End of Unit Assessment

The following questions are meant for you to find out how much you have understood the concepts of this unit.

1 Study the Table 1.2 below that shows source regions that develop over them.

Source Region	Air mass	Characteristics
Tropical ocean	(a)	(b)
Antarctic landmass	(c)	(d)
(e)	Tropical continental	Dry and warm

2 Explain how the Congo air is a tropical continental air mass and yet brings high rainfall to Zimbabwe.

3 Evaluate the effect of the following human activities on air masses

- (a) Deforestation
- (b) Urbanisation
- (c) Global warming



Research Work

Small-scale air masses

- 4 Check around your locality and find areas that
- could be local source regions
 - explain why these areas could be source regions for local air masses.
 - Describe the type of characteristics they are likely to give to the local winds.



Progress Check list

Now let us go through the objectives we listed at the beginning of the unit and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet to achieved. Then for any that you put an X against, find the section dealing with it in the unit and go over it again.

Objectives Are you now able to	Check Box
• describe an air mass	
• classify air masses	
• describe types of air masses and their characteristics	
• describe weather associated with air masses affecting Zimbabwe and Southern Africa	
• describe weather conditions associated with the Inter-Tropical Convergence zone	

Further reading

You may want to deepen your understanding of the concepts covered in this unit. The following is a list of some of the texts you may look for and read.

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 2 Fronts, Temperate depressions, frontal systems and tropical cyclones

- 2.1 Temperate Depressions
- 2.2 The effect of temperate depressions on the weather of Zimbabwe
- 2.3 Tropical Cyclones
- 2.4 Effects of tropical cyclones
- 2.5 Mitigation against impact of tropical cyclone

Introduction

Have you ever noticed that when you pour milk into black tea, that the two never readily mix? You have probably watched the milk spread through the black tea before stirring to speed up the process. Well, when two air masses with different properties meet, they behave more or less like your tea and milk. They take quite some time to mix. You have to note that such a time may be a couple of days to a week. While the two air masses negotiate their mixing, fronts form. In this unit you will learn about frontal systems. You will learn also about how frontal systems affect weather. Moreover, you will go through tropical cyclones and the weather they cause.



Objectives

After going through this unit, you should be able to:

- describe factors influencing the development and distribution of temperate depressions
- describe weather associated with different types of fronts
- discuss the distribution and development of tropical cyclones
- explain weather hazards associated with tropical cyclones



Key Words

Front	A front is a zone where two different or similar air masses meet.
Depression	A depression is a low-pressure system where winds converge. Note that it is also called a cyclone.
Hazard	A hazard is a potential danger to human life, property and the environment.

Cross-section	This is a view of a geographical feature from the side along an imaginary line cutting through the feature.
Condensation	Condensation is the changing of water vapour into liquid water in the atmosphere due to temperature loss.

Time

You are expected to take an average of **10 hours** to go through this unit.



Study Skills

- You should make sure that you have understood the concepts of Unit 1 because they are the foundation for what you will learn in this unit.
- Moreover, take time to cover this unit with understanding because it is also important for you to understand the next unit.

2.1 Temperate Depressions

In the last unit you covered air masses, their characteristics and movement. Let us move on and study what happens as air masses move and come into contact with each other. We will first look at the meeting of two air masses that have different temperature characteristics. I mean that one air mass is warm and the other is cold. It should be clear to you that the warm air mass comes from the tropics while the cold air mass comes from the polar areas. The zone that these air masses meet over is the temperate area.

Tips

- Remember that we said that the temperate areas are those that lie around 40° to 70° of latitude in both northern and the southern hemisphere.
- Again, remember what we said in the previous unit about convergence of air masses. We said that the warm air mass from the sub-tropical high-pressure belt converges with the cold air from the polar areas.

Thus, you will realise that in southern hemisphere the warm air is from the north and the cold air is from the south. Figure 2.1 below shows you the area in southern Africa where the warm and cold air masses meet.

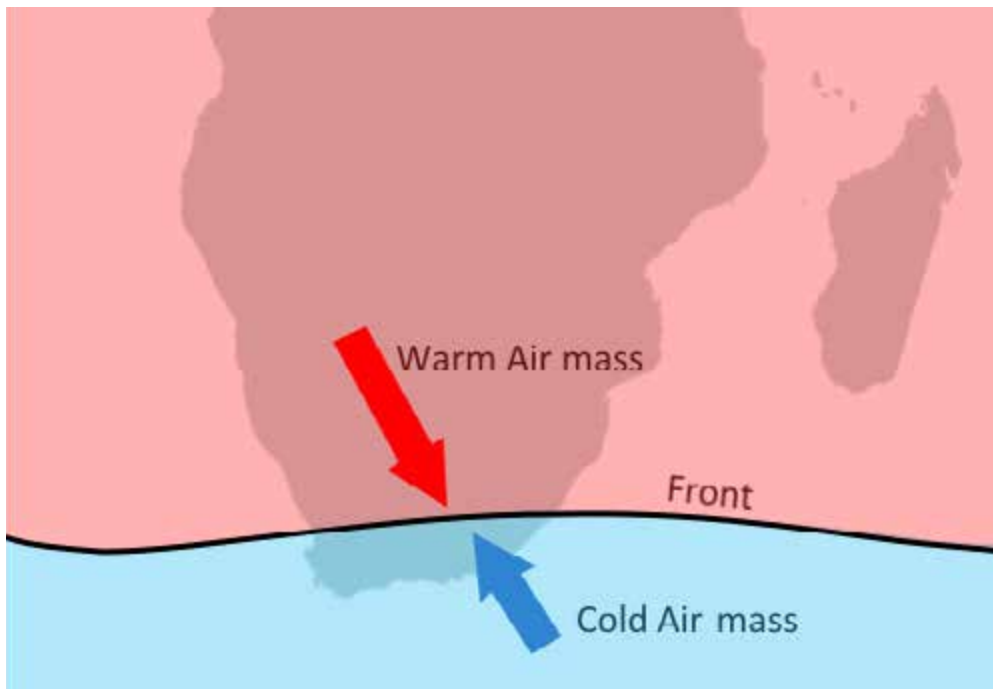
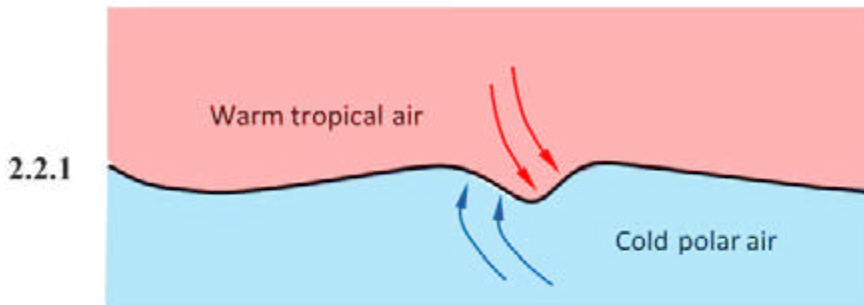


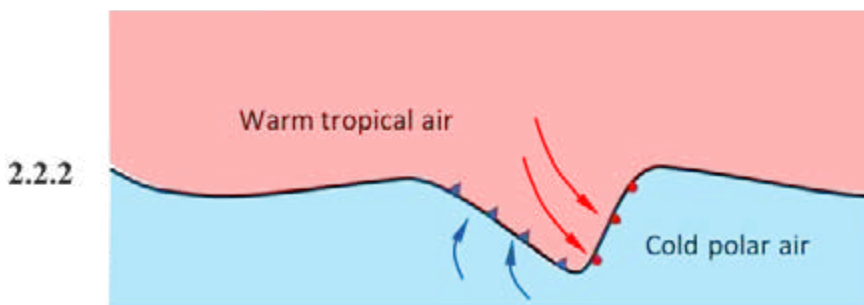
Figure 2.1 The meeting of warm and cold air forming a front

As you have seen in Figure 2.1, warm air and cold air usually meet around the southern parts of South Africa. It is important for you to understand that when the two air masses meet, a bulge results. A bulge is a swelling of the warm air into the cold air forms as the two air masses rotate as they start the mixing process. Figures 2.2.1 and 2.2.2 shows you the development of the bulge.



In 2.2.1 we have the warm air advancing into the cold air. Meanwhile a rotation of the air develops.



We also have pressure dropping at the point of the bulge.




In 2.2.2 we have the bulge deepening. The pressure further decreases too.

We have fronts now fully developed. The fronts are the cold and warm front

Figure 2.2.1 and 2.2.2 showing the development of a temperature depression

You now have to learn about some symbols that are used to show fronts on maps. The symbol  means cold front. The symbol  means warm front. The deep bulge, the warm front and the cold front are called the temperate depression.

In the key words section, we defined the term *front* for you. Now we are going to look at the different types of fronts. A cold front is the boundary between cold and warm air where cold air is moving into the warm air. Meanwhile a warm front is the boundary between the warm air and the cold air where the warm air is moving into the cold air.

You are probably wondering how all this ends. Does the air finally mix? Yes, it does. The air masses finally mix. When they mix the warm air is lifted off the surface. This leads to the formation of an **occluded front** forms. The symbol for the occluded front is .



Activity 2.1 Fronts, their formation and effects

1. Describe how fronts form.
2. Describe the temperature, pressure and rainfall changes that occur as a temperate depression passes through an area.

2.1.1 Weather associated with the fronts

We have to study the fronts and understand them because they affect the weather of areas that they come into contact with. We will examine the weather associated with the fronts in the form of a table. Therefore, study Table 2.1 in order to get this weather.

Table 2.1 The weather associated with the fronts

Front	Pressure	Temperature	Clouds	Rainfall
Cold	High	Low	Cloudy with cumulus type of clouds including the cumulonimbus. Fog also forms.	Heavy rainfall with thunder and lightning
Warm	Low	High	Cloudy with stratus family of clouds including the nimbostratus cloud	Light but continuous rainfall.
Occluded	Dropping	Lowering	Partly cloudy and clearing gradually	Little or none

You have to further understand that the temperate depression moves as the air masses rotate around the low pressure. All temperate depressions move from west to east.

2.1.2 The formation of rainfall at the cold and warm fronts

As you have seen in table 2.1 above that fronts are associated with rainfall, we are now going to discuss the formation of rainfall at a cold front or at a warm front. You have to note the fact that rainfall at both fronts form more or less the same way. When water is heated on the earth's surface it evaporates. Evaporating water always rises as you might have seen when boiling water over a fire or stove. So, likewise the water that evaporates from the earth's surface rises in the form of water vapour. The water vapour reaches high altitudes where it then condenses.

You should remember that condensation is the changing of water vapour into liquid due to loss of temperature. When water vapour condenses it forms clouds. Once clouds are formed, then you have rainfall. Now let us take a short pause and check if you are getting what we have covered in this sub-topic. Attempt the questions in Activity 2.2 and check your progress.



Activity 2.2 Weather associated with temperate depressions

1. Distinguish the weather experienced at a cold front from that of the warm front. Use the table below to answer this question.

Weather element	Cold front	Warm front
Rainfall		
Temperature		
Atmospheric Pressure		

2. Describe the hazards that are associated with the cold front.

2.1.3 Temperate depression diagrams

Note that there are two types of diagrams that are used to illustrate temperate depressions. One is a map view while the other is a cross-section. A map is simply a view of the temperate depression from above. Do you know what a cross-section is? We defined this term in the key words section. You may visit that section if you want to remind yourself what the term means. Figures 2.3 and 2.4 show the temperate depression map view and the temperate depression cross-sectional view. Please note that the cross-section is derived from the map view.

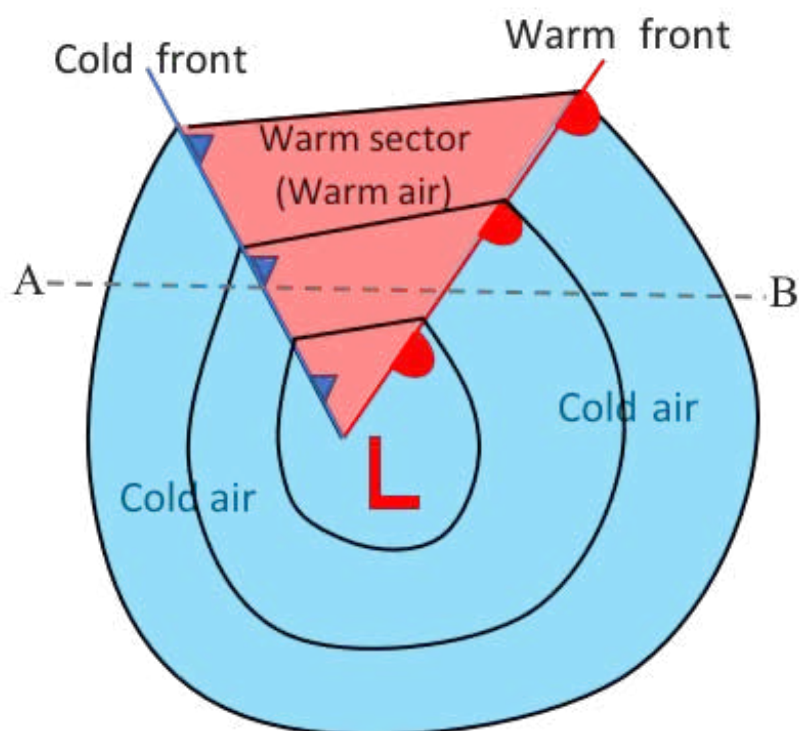


Figure 2.3 shows a map of the temperature depression

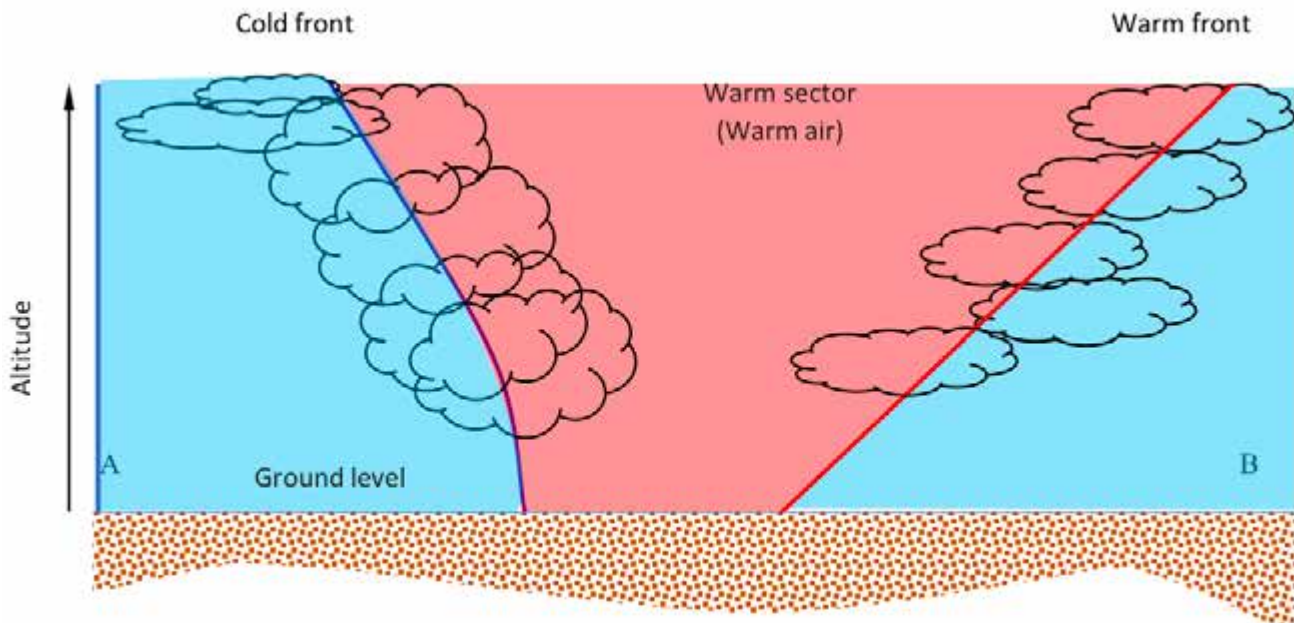


Figure 2.4 shows a cross-section of the temperate depression

We are sure that you noticed the difference between the two diagrams. The map view (Figure 2.3 shows pressure decreasing towards the centre of the temperate depression. Atmospheric pressure is shown to you through isobars. Isobars are lines on map that show areas of the same pressure. Meanwhile Figure 2.4 show a view of the temperate depression from the ground level to the sky.

Now let us look at the examples of places that are nearest to Zimbabwe that lie in the path of the temperate depressions. You must have heard of Cape Town before. It is a city in the south-western coast of South Africa. Cape Town has its rainfall in the winter season due to the passage of cold and warm fronts of the temperate depressions. Another such place in South Africa is Port Elizabeth.

2.2 The effect of temperate depressions on the weather of Zimbabwe

You could now be wondering why we bother studying a weather system that at most seems to affect the southern parts of South Africa. You, however, need to note that temperate depressions do affect the weather of Zimbabwe. Their effect is summarised below:

- Some temperate depressions can be large enough to actually have the cold and warm front reach Zimbabwe. In so doing, you will appreciate that they then affect the weather over Zimbabwe. In this case the warm front will bring you warm temperatures and continuous rainfall. The cold front will bring you low temperatures and short-lived rain that is accompanied by thunder and lightning. This is, however rare because the fronts are closest to Zimbabwe in winter.

- Temperate depressions with their frontal system, also affect your weather when clouds are blown into Zimbabwe. The clouds that form over South Africa can be blown into Zimbabwe. This process is called *cloud advection*. Such clouds, you must understand, bring little rainfall due to the fact that they lose their moisture as they move across South Africa.

We have been looking at temperate depression which are also known as mid-latitude depression. This simply means that temperate areas are also known as mid latitudes and that is where the temperate depression form. We are now changing focus to look at another low-pressure weather system – the tropical cyclone. Before we move on let us take yet another pause to check your progress. Answer the following questions and follow up on anything that you have forgotten in the topics we have covered so far.



Activity 2.3 Temperate depression diagrams and weather

1. In the space below draw the following fronts
 - (a) occluded front
 - (b) warm front
2. Study the diagram below that shows a temperate depression passing through towns A, B and C.

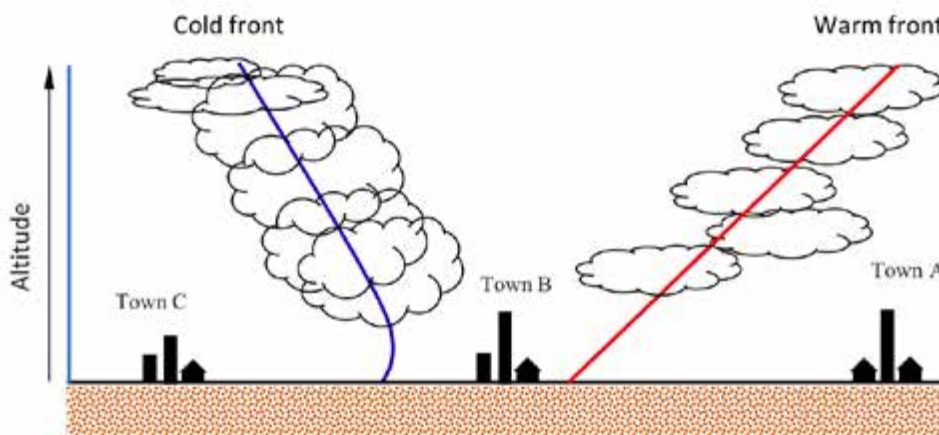


Figure 2.5 Temperate depression

- (a) Describe the weather at each of the three towns

	Town A	Town B	Town C
Temperature			
Pressure			
Rainfall			
Cloud cover			

2.3 Tropical Cyclones

You have most likely heard of tropical cyclones from the weather reports and indeed from main news reports. In March 2019, Zimbabwe was hit by one of its worst tropical cyclones. Do you know what it was called? You are very correct if you said Cyclone Idai. So, what are tropical cyclones? How do they form? What is their impact on humans? You will learn on the tropical cyclone next; to answer the questions I have just asked. We will even answer several other questions that were not listed above.

2.3.1 What is a Tropical cyclone?

Let us start by defining the term *tropical cyclone*. A tropical cyclone is a large storm that develops around low pressure in the tropics. Its size differs but can reach sizes of 500 kilometres in diameter. They are associated with heavy rainfall, thick clouds and strong winds. How does a tropical cyclone look like? The answer to this question is what you are going to learn next.

2.3.2 The aerial view of a tropical cyclone

You will appreciate the fact that a tropical cyclone is generally circular in shape. When viewed from above, it has thick clouds that are spiralling towards the centre. The centre is actually a hole called the eye. Figure 2.5 shows you the view of the tropical cyclone from above.



Figure 2.6 An aerial view of the tropical cyclone

2.3.3 The cross-section of a tropical cyclone

If you were to cut across the tropical cyclone and expose its interior, you would see a three-part structure. You would see the eye in the middle. After the eye on both sides you would see the vortex. Then after the vortex there would be the outer part of the tropical cyclone. Figure 2.6 shows this cross-section of the tropical cyclone. Each of the three sections of the tropical cyclone are described for you in detail in Table 2.2 below.

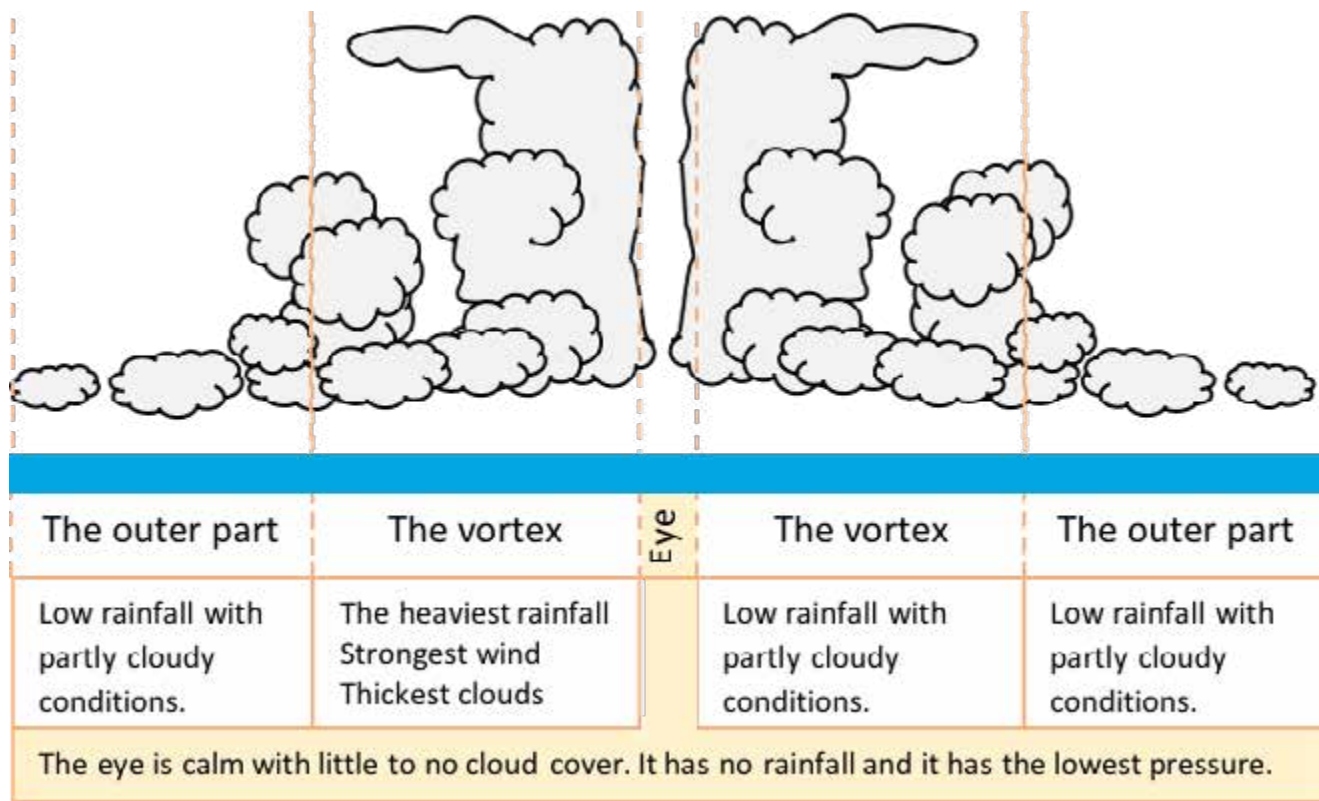


Figure 2.7 A cross-section of the tropical cyclone

Table 2.2 The weather of a tropical cyclone

	Part of the tropical cyclone		
Weather	Eye	Vortex	Outer part
Rainfall	Little or none	Heaviest up to 250mm/hour	Heavy and decrease as distance from the eye increases
Pressure	Lowest	Low	Increases as distance from the eye increases
Wind-speed	Calm	Strongest up to 200 km/h	slower
Cloud cover	Little to none	Heavily overcast	Decrease with distance from the eye.
Temperature	Generally high but is caused to drop by cloud cover.		

2.3.4 Conditions necessary for formation of tropical cyclones

You must understand that for a tropical cyclone to form there are certain conditions that must be present.

- There must be convergence of two air masses. Because the location is in the tropics, the air masses that converge are both warm and moist.
- There must be a constant supply of water vapour. So, the ideal surface is an ocean.
- The temperature of the ocean water must be high at 27°C up to a considerable depth.
- There must be very little eddying of wind. Eddying is short, circular movement.

It is important for you to understand that without these conditions tropical cyclones cannot develop. That is why they do not always form. Moreover, that is why you will find that they form only in the tropics. You also cannot find them forming within 5° north and 5° south of the equator. They cannot form beyond 25° of latitude in both hemispheres.

2.3.5 The distribution and movement of tropical cyclones

Take note of the fact that different people call the tropical cyclone by their local names. When they occur in the Indian Ocean, we call it a *cyclone*. In the northern Pacific Ocean, they call it a *typhoon*. In the Atlantic Ocean, they call it a *hurricane*. Meanwhile around Australia in the Southern Pacific Ocean, they call it the *willy willies*.

Do you remember what we said about the movement of the temperate depression? We said that a temperate depression moves from west to east. You must remember that the tropical cyclone moves opposite to that. This means that it moves from east to west. As a result, the tropical cyclones will affect the eastern coasts of continents. Note also that tropical cyclones move following a curved pathway. When they turn, you may find it interesting that they turn towards the poles. They curve as if to redouble their track.

Now it must therefore be clear to you why Mozambique and Zimbabwe are affected by tropical cyclones. Figure 2.8 shows you the global distribution of tropical cyclones.

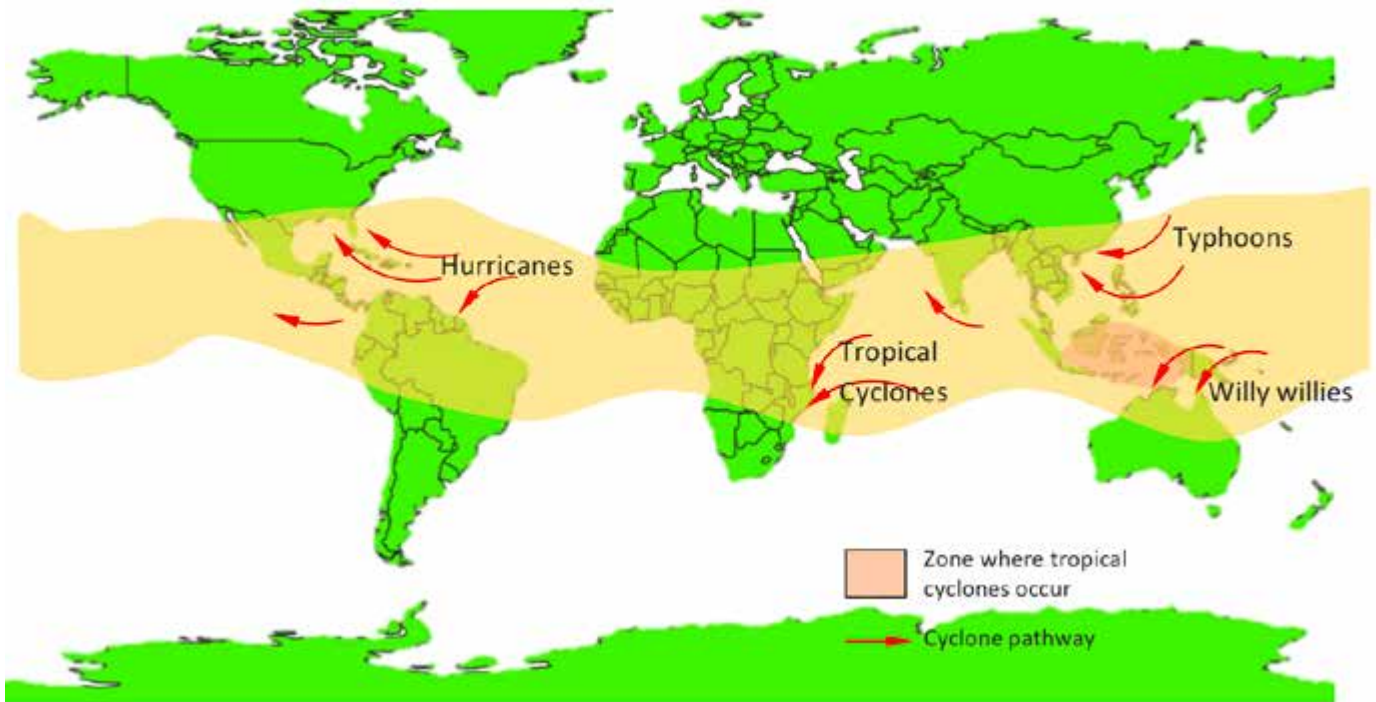


Figure 2.8 The global distribution of tropical cyclones

Interesting facts

You have probably wondered how tropical cyclone get to have names that sound human! This is done by the specialists called meteorologists that study weather and tropical cyclones. They allocate these names in alphabetical order. Each sequence of the alphabet continuous throughout one year.

When another year begins the names start again at A. You may have also noticed that cyclones are often given names of women. Yet you might have heard of Cyclone with names of males as well. The women names are an old tradition started by sailors who were home sick missing their wives!



Activity 2.3 Temperate depression diagrams and weather

1 State the name by which tropical cyclones are called in each of the following countries.

- (a) Japan
- (b) United States of America

2 Explain three conditions necessary for a tropical cyclone to form.

3 What is the danger that can be caused by winds of 250km/h due to tropical cyclone?

2.4 Effects of tropical cyclones

Perhaps you are like most people in that you know the effects of tropical cyclones more than all we have looked at so far. We are sure because of Cyclone Idai in March 2019, you are aware of the effects of tropical cyclones. We are, however going to classify the effects into social, economic and environmental. Table 2.3 below classifies for you the effects of tropical cyclones.

Table 2.3 Effects of tropical cyclones

Social Effects	Economic Effects	Environmental Effects
<ul style="list-style-type: none"> • Trauma • Loss of life • Destitution • Homelessness • Famine • Spread of diseases like cholera 	<ul style="list-style-type: none"> • Destruction of buildings, roads, bridges, communication lines • Cost of rescue • Cost of famine and disease alleviation • Loss of property • Cost of repair work 	<ul style="list-style-type: none"> • Destruction of trees • Excessive soil erosion • Creation of gulleys • Mud slides, Land slides • Destruction of habitats for animals. • Death of animals • Flooding

Note that Zimbabwe is in the pathway of tropical cyclones. The shortest distance between Zimbabwe and the Indian Ocean where tropical cyclones form and occur is only 220 kilometres. You have to appreciate that some tropical cyclones can be as large as 500 kilometres across! This means that such systems can reach Zimbabwe with all their strength.

In the past Zimbabwe has been affected by Cyclone Eline in February 2000 and Cyclone Idai in March 2019. You may also be interested to know that the effects of these tropical cyclones were felt as far as Binga in the far north-west of Zimbabwe.



Activity 2.4 Effect of tropical cyclones

Consider any recent tropical cyclone that affected Zimbabwe, describe the economic and social effects.

2.5 Mitigation against impact of tropical cyclone

What do you remember as the response to any effect of a tropical cyclone that has happened in Zimbabwe? You will probably remember that one of the immediate actions taken is rescue. Yet, you must understand that the first thing that must be done is to be done long before the cyclone occurs. The mitigation can be divided into action taken before, during and after that cyclone.

- (a) Before the cyclone
- Training of rescue teams so that they are ready years, months or days before any cyclone happens.
 - Setting up early warning systems. Early warning systems, you will understand can be sent through Whatsapp, SMS messages, television and radio messages. In some communities, loud sirens are sounded. All these are for warning us to run away on time.
 - Building safe shelters. What do you think safe houses are for? Of course, they are for giving people temporary shelter during or after the cyclone. Safe houses are built on high ground where people find refuge.
 - Education of people on tropical cyclones. You will appreciate that people respond better to help if they are informed about the tropical cyclones. Education also includes giving knowledge on disaster resilient structures.
 - Building artificial levees. Levees could be built out of sand bags. They block water from flooding into people's homes.
 - Budget for rescue and famine, water shortages and repairs.
- (b) During the tropical cyclone
- Evacuation of those not yet evacuated.
 - Remaining in shelters.
 - Tracking the cyclone and anticipation of its paths and therefore its impact.
- Note that these measures depend on the safety of the area since the tropical cyclone will still be going on.
- (c) After the cyclone
- Rescue efforts. Are you aware that the rescue teams in most of the time consists of volunteers and the army? Well, those are the major groups of people who carry out rescue.
 - Delivery of water and food to shelters. Taking toll of the damage and deaths.
 - Repair of damaged infrastructure. You will appreciate that when people lose their homes, there is need to mobilise resources and rebuild.
 - Counselling of the bereaved and of those who lose their property. Do you know psycho-social support? It is giving encouragement and emotional and psychological help to traumatised people. Counselling provides this psycho-social support.
 - Financial and food support to affected people as they try to get their lives back on track. After cyclone Idai in Chiredzi people were being given US\$13 per head per month. This was meant to support the livelihood of the people until they got back to their feet.

Let us take yet another pause and check our progress. Attempt the task below. Follow the instructions as they are given.



Activity 2.5 Mitigation against tropical cyclones

Study the clues below that are meant to help you complete the puzzle below. See how many of the words you can find within the puzzle. Where you have forgotten the answer to the clue go back to the topics and look for the answer.

Note that the words run only across and downwards. There are four clues each and the first one has been done for you. The words occur in the order of the clues. Enjoy and learn!

Clues across

- A psychological effect of tropical cyclones
- The side of continents that is affected by tropical cyclones.
- The nature of the track followed by a tropical cyclone
- A precaution taken when a tropical cyclone is spotted far away is the early _____
- A barrier built to keep off flood water caused by a cyclone.

Down clues

- A measure taken soon when it is safe to help those affected.
- An environmental effect of cyclones.
- Meteorologists _____ tropical cyclones in order to see where they are headed.
- One of the social effects of tropical cyclones.

T	R	A	U	M	A	D	D	I	V
R	W	E	S	T	E	R	N	M	R
E	A	S	T	E	R	N	E	Y	W
S	C	U	R	V	E	D	V	F	I
C	F	H	A	D	Y	J	O	A	L
U	L	P	C	D	F	M	T	M	L
E	O	G	K	J	E	S	U	I	Y
X	O	S	W	A	R	N	I	N	G
C	D	Z	Y	N	E	Y	N	E	A
T	S	I	G	L	E	V	E	E	S

Well done, you have completed this unit. It is my hope that you have understood the concepts that we covered here. If there is some work that needs to be done visit those topics and read them again. Otherwise, for now let us check our progress by reminding you what we covered.



Summary

- Remember that this unit is on temperate depressions and tropical cyclones.
- In this unit we described the characteristics of a temperate depression.
- We covered frontal systems. That is where we covered warm, cold and occluded fronts.
- We examined the weather associated with the frontal systems. We stressed the point that the cold front has short-lived rainfall that is accompanied by thunder and lightning. Meanwhile we taught you that the warm front brings continuous and light rainfall.
- We also made the point that temperate depressions occur in the mid latitudes. We further pointed out that even if Zimbabwe is not in the mid latitudes, it is still affected by the depressions.
- Our journey took us to tropical cyclones. Here we taught that tropical cyclones are large low-pressure storms that occur in the tropics.
- We illustrated and described the structure of the tropical cyclone. We further looked at the movement of the tropical cyclone.
- We also saw that in different oceans of the world tropical cyclones are called by different names.
- We also saw that Zimbabwe, even though it is land-locked, is in the pathway of tropical cyclones that land in Mozambique first.



End of Unit Assessment

1. Compare and contrast temperate depression and that of tropical cyclones in terms of their nature and weather they cause. State one point for each area given.

	Temperate depression	Tropical cyclone
Movement		
Structure		
Latitude		
Rainfall		
Cloud cover		
Effects		

2. Raise arguments for and against the view that Zimbabwe is deeply affected by tropical cyclones due to poverty rather than the strength of the cyclones.
3. Explain how technology can be used to reduce the impact of tropical cyclones.

Research Work

From newspapers, magazines and other sources of information you can get, find out how much damage was done by the last destructive tropical cyclone in Zimbabwe.

Focus on these:

- (a) Loss of life
- (b) Damage to property
- (c) Agricultural damage



Progress Check list

Now let us go through the objectives we listed at the beginning of the unit and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet to achieved. Then for any that you put an X against, find the section dealing with it in the unit and go over it again.

Objectives	Check Box
Are you now able to	
<ul style="list-style-type: none">describe factors influencing the development and distribution of temperate depressions.	
<ul style="list-style-type: none">describe weather associated with different types of fronts	
<ul style="list-style-type: none">discuss the distribution and development of tropical cyclones	
<ul style="list-style-type: none">explain weather hazards associated with tropical cyclones	

Further reading

You may want to extend your knowledge even further. If that is the case, the books listed below are recommended for you.

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 3 Climate types on a global scale and interpretation of climatic data

- 3.1 What is climate?
- 3.2 What are the factors that influence climate?
- 3.3 Types of climate
- 3.4 Climatic data
- 3.5 The importance of the Mean and the Range in Climatic studies

Introduction

Have you ever heard people saying that Gweru is cold and Beitbridge is warm? Maybe you have used statements such as “this place is cold or this place is very hot”. Well, such statements are usually based on a few days’ visit to the said places. Sometimes we conclude about a place being hot or cold because of one day’s experience. You will see in this unit that climate takes a longer time to describe. In this unit we are going to cover major global climates. Our focus will also fall on the data that characterises each climate. We will use this data to draw graphs. We will further perform calculations to analyse climate data. We are sure the unit will be interesting to you.



Objectives

After going through this unit, you should be able to:

- explain the basis for climatic classification on a global scale
- describe characteristics of world’ s climatic regions
- describe the climate of Zimbabwe
- interpret climatic graphs and tables



Key Words

Latitude

the angular distance that is used to locate places and is measured from the equator. The equator is the 0° of latitude.

Ocean current

a stream of warm or cold water that flows slowly deep within an ocean.



Time

You are expected to take an average of **10 hours** to go through this unit.

3.1 What is climate?

Earlier on, we asked you whether you have described a place or places as cold or hot? You might have heard people describing some places as cold or hot. Whenever you do that you are attempting to describe the climate of a place. Of course, it takes much more than a few visits to a place to describe its climate accurately. This is so because **climate is the average weather conditions of a place measured after a long period of time of over 30 to 40 years and usually for extensive area.** This means that for us to conclude that Gweru is cold or Beitbridge is warm we must compile records of temperature for 30 to 40 years of the respective areas.

In Level 1 you covered weather elements. So, you must be aware that there are quite a number of weather elements to consider when weather is mentioned. These elements are also the elements of climate. Yet you will notice that there are two which we use to describe climate. These two are temperature and rainfall. All the other elements are implied when mentioning temperature and rainfall. In actual fact, other weather elements are influenced by temperature and rainfall in most cases.

3.2 What are the factors that influence climate?

You probably are aware of the fact that climate varies from place to place. However, are you aware of the reasons why climate is different in different places? Can you list some of the factors that determine climate? If you cannot, do not worry because in this section we will discuss what causes the differences in climate over the earth's surface. We will consider the influence of altitude, latitude, ocean currents and the location within landmasses or close to oceans. Altitude, latitude and ocean currents are some of the factors that determine climate. Did you get them correct?

3.2.1 The influence of altitude on climate

We hope you still remember the definition of altitude from what we covered in level 1 of this module. We said altitude is the height above sea level. When we measure the height of a mountain or of clouds, we are actually measuring altitude. We are sure at one point you have heard the saying "*the higher you go the cooler it becomes*". When you or another person mentioned this statement, you were actually summarising the influence of altitude. It is true that as altitude increases, temperature decreases.

This means that higher places have cooler temperatures. As a result of these places being high, they also tend to have relief rainfall. You will remember that relief rainfall develops on the windward side of the highland while the leeward side is dry due to descending dry cool air. The wind ward side is the slope that faces the wind while the leeward side is the slope that faces away from the wind. Figure 3.1 shows you the effect of altitude on temperature and rainfall.

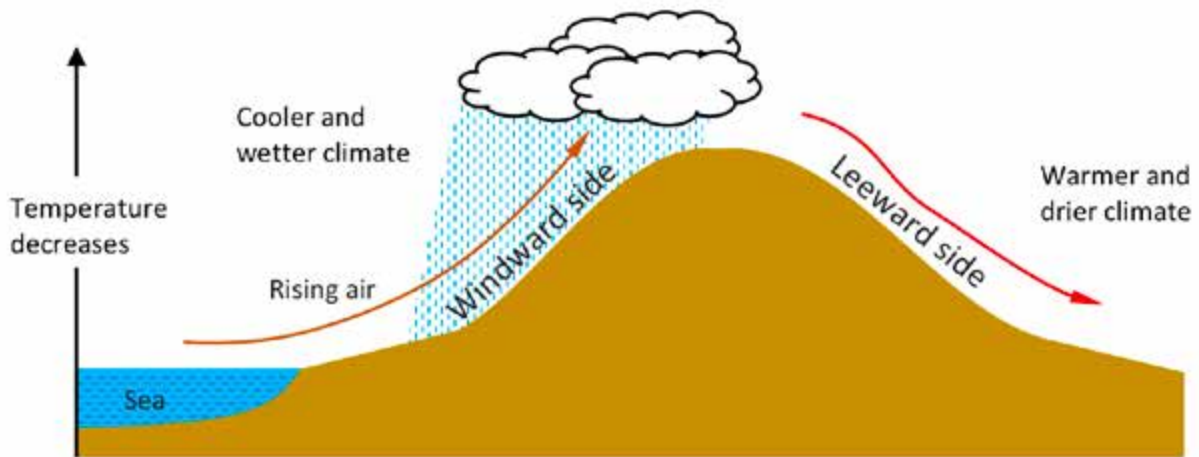


Figure 3.1 Effects of altitude on temperature and rainfall

Let us now look at some Zimbabwean examples. In Zimbabwe, Nyanga is a good example of a high-altitude place. In Nyanga it is much cooler than most places in Zimbabwe. It is also wetter than all other places. Meanwhile, when you consider Beitbridge or Binga they are low altitude areas with very warm temperatures. This example illustrates the influence of altitude on the climate of Zimbabwe.

3.2.2 The influence of latitude on climate

We hope you will not confuse altitude and latitude. In the key words section, we define latitude as the angular distance that is used to locate a place. It is measured from the equator. The highest latitudes are the south and the north poles at 90°S and 90°N respectively. In simpler terms, latitude is the distance from the equator.

Note that the equator is warm. So, places that are around the equator have high temperatures. Moreover, such places also have high rainfall. In Unit 1 you learnt about the ITCZ, it is this low-pressure belt that causes high rainfall. The equatorial areas also receive high amounts of solar energy called *radiation*. Once the radiation is high temperatures are also high. High temperatures increase evapotranspiration which also increases the amount of rainfall received.

You will notice that as latitude increases, the temperatures drop. Thus, around the poles the temperatures are at their lowest around the globe. Generally, rainfall decreases towards the poles. The exceptions are the mid latitudes that are influenced in their rainfall by temperate depressions. Do you remember temperate depressions? They bring frontal systems associated with rainfall though they are far away from the equator. Zimbabwe has fair amounts of rainfall. This is because it is in the tropics which are near the equator. The summers in Zimbabwe are warm and wet. Even our winter is described as being mild to cool.

3.2.3 The influence of ocean currents on climate

Most people tend to think that ocean water is static. We hope you are not one of those people too. You will discover that oceans are far from being stationary. Oceans are in constant motion mixing the water that is differently heated. It is the different heating that causes all the oceans you might know to have currents that move within them.

We are sure you have already seen that there are two types of ocean currents. There are cold ocean currents and warm ones. You can also easily see that cold ocean currents flow from the poles towards the equator. Warm ocean currents flow from the equator towards the poles. As these ocean currents flow, you will appreciate that, they affect the climate of land areas next to them. As they flow warm ocean currents bring warm temperatures to landmasses next to them. On the other hand, cold ocean currents bring cold temperatures to areas next to them.

We draw our examples outside Zimbabwe since we are landlocked. A good example of the effect of ocean currents is the comparison of Massinga in Mozambique and Walvis Bay in Namibia. These two places lie along the Tropic of Capricorn. So, in terms of temperatures and rainfall we expect them to be the same. Yet, as you will discover, they have differing climates due to ocean currents. Massinga is warmer and wetter than Walvis Bay.

As you might know, Mozambique is to the east while Namibia is in the west. Next to Massinga there is the Agulhas ocean current which is warm. This current then brings warmer temperatures and wetter climate to Massinga. Our neighbour to the west, Namibia, is brushed by a cold ocean current – the Benguela current. This brings cooler temperatures. It also causes loss of moisture over the sea as fog. This then causes Walvis Bay to be drier. Figure 3.2 illustrates this southern Africa example for you.

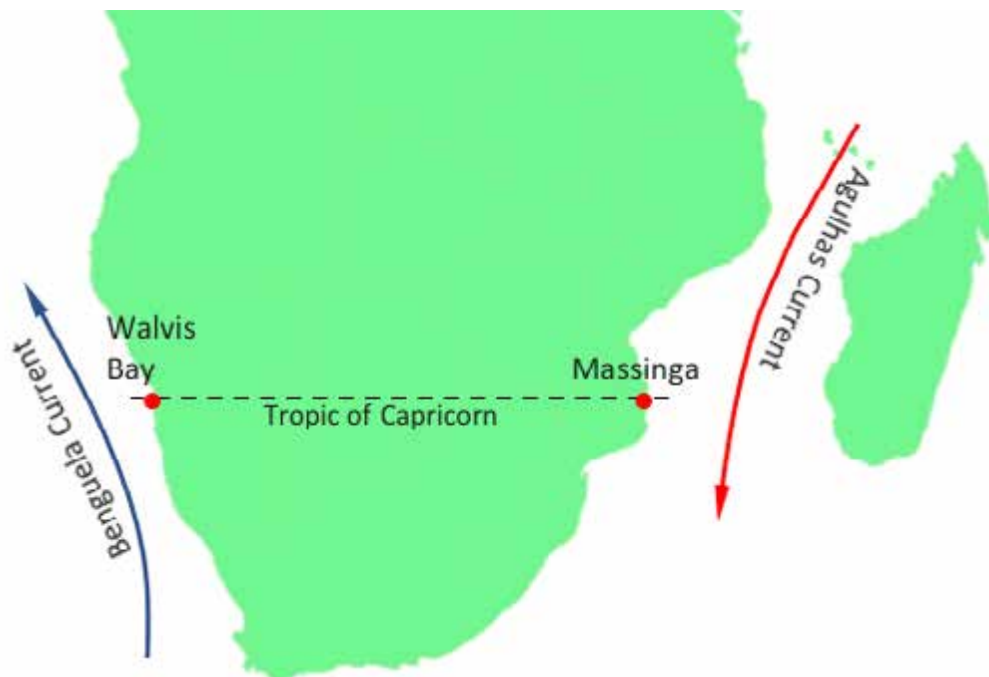


Figure 3.2 The location of Walvis Bay and Massinga next to different ocean currents

3.2.4 The influence of location in the interior of landmass on climate

Let us now move to look at the influence of location of a place. We, of course, mean location in relation to proximity to seas. The places that are close to seas are much cooler than those located in the middle of landmasses. You will notice that even those place that are close to warm ocean currents are still cooler than the places that are further inland. Near oceans there is cool air that blows inland from the surface of the sea which is much cooler during the day than the land. This cool air is called a sea breeze. Figure 3.3 illustrates the influence of location on climate.



Figure 3.3 Dakar (Senegal) is closer to the sea and therefore cooler than N'Djamena (Chad) which is further inland. N'Djemena is in the Sahara Desert.

So far you have gone through the definition of climate and the factors influencing climate. Let us check how much you understood in the following questions.

- 1 Define the term *climate*.
- 2 Distinguish between latitude and altitude.
- 3 Explain how ocean currents influence climate.

There are other factors that influence climate that you will come across in your further reading. These mainly deal with human activities. We are going to deal with human influences on climate in the coming unit. Now we will look at the main types of climate that we have on the globe.

3.3 Types of climate

We are going to examine tropical, temperate and polar climates. For each type of climate, we are going to take you through the following aspects:

- (a) Latitudinal location and geographic location
- (b) Main climatic characteristics
- (c) The rainfall-temperature graph

Make sure you notice the differences in each type of climate.

Perhaps you are wondering why we are not including vegetation as is done in some studies of climate. Our approach from the syllabus is that climate has to do with the average weather conditions. These average weather conditions themselves influence quite a number of things on the earth's surface. Such things, you will notice, are not for this unit. You will cover vegetation under the Ecosystems unit.

3.3.1 The Tropical continental climate

We will begin our journey through the different climates of the world starting with home. Zimbabwe generally has a tropical continental type of climate. It must be easy to follow that we are a landlocked country and we are in the tropics.

(a) Latitudinal location of the tropical continental climate

Our country Zimbabwe lies within the tropics. The type of climate that we have is also found in other countries. It stretches from 5° to 25° in both hemispheres. This, you will notice, is why we describe it as tropical. Figure 3.4 shows you the location of this climate in Africa.

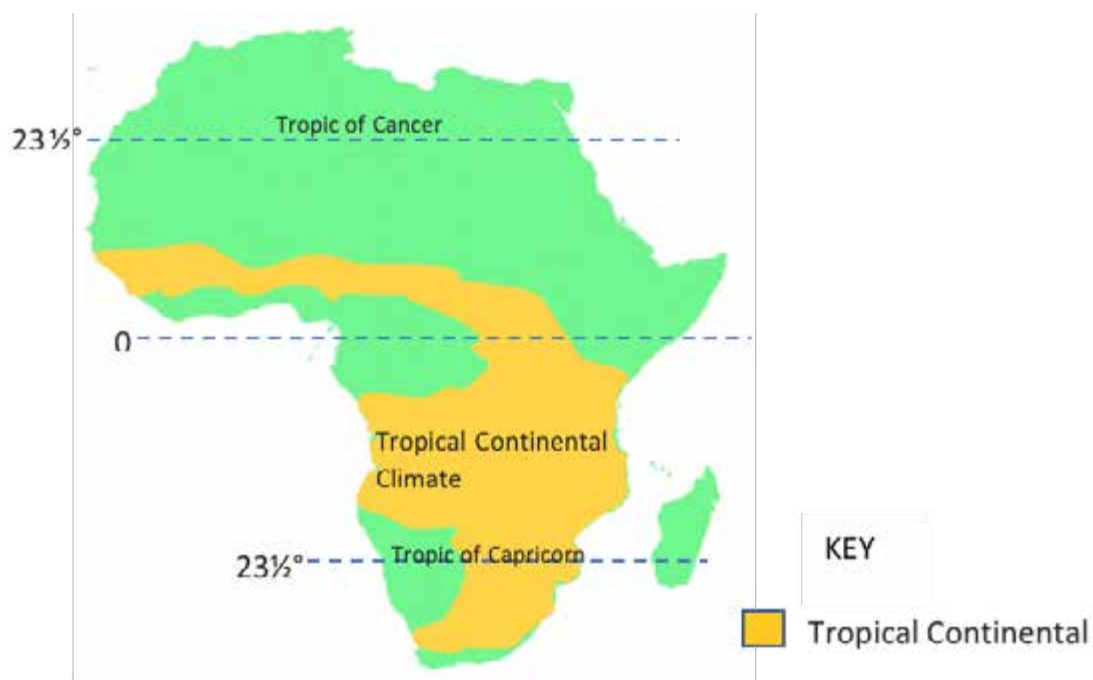


Figure 3.4 The distribution of the Tropical continental climate in Africa

(b) Climatic characteristics

As we mentioned earlier on in the unit, the major factors that indicate the nature of a type of climate are rainfall and temperature. Therefore, the characteristics of climate that we will look at here are rainfall and temperature. In the tropical continental climate, there are wet summers and dry winters.

From your experience of Zimbabwean weather, you will have noticed rainfall occurs in the summer season. The rainfall is of the tropical continental climate and is highest in areas that are closer to the equator. As you move away from the equator towards the 25° boundary the places become drier. As a result, you will notice that rainfall

ranges from as low as 400mm to above 1200mm per year. Meanwhile, take note that the temperatures also range from just below 15°C to just above 20°C in terms of the average annual temperatures. In short, you can state the tropical continental characteristics as:

- Summers are warm and wet
- Winters are cool and dry.

(c) The tropical continental temperature-rainfall graph

The illustration shown below, Figure 3.5.1 shows the annual trends in rainfall and temperature for Harare as a typical wetter area of the tropical continental climate.

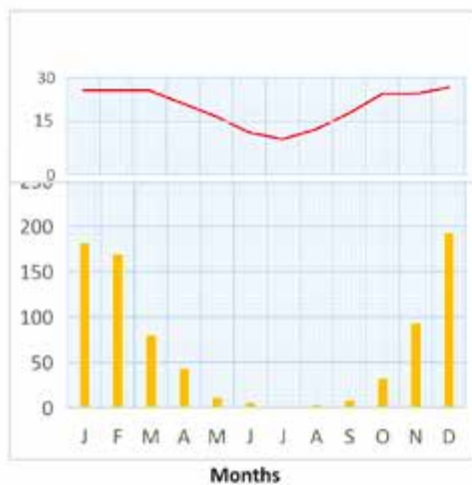


Figure 3.5.1 The tropical continental climate graph – Harare: Southern Hemisphere

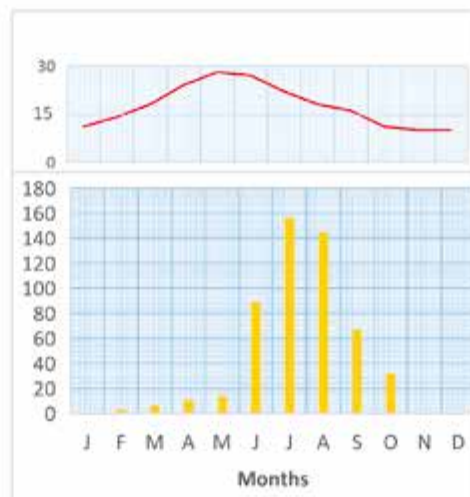




Figure 3.5.2 The tropical continental climate graph – Northern Hemisphere

Key
 Rainfall
 Temperatures

You must also take note of the fact that countries that are close to the sea have a wetter climate that is called the *tropical maritime climate*. One example of such a country is our neighbour Mozambique. Note also that the types of climate have the same names as air masses.



Activity 3.2 The tropical continental climate

1 Where does the tropical climate derive its name from?

2 Describe the characteristics of the tropical continental climate.

3.3.2 The Equatorial Climate

Do you remember your studies on the equatorial low-pressure belt in the previous Unit? It is good if you still remember. If you have forgotten you may need to visit the previous unit and refresh your knowledge.

a) Latitudinal location

As with the equatorial low-pressure belt we referred to above, the equatorial climate is located between 5°S and 5°N of the equator. You have to realise that this climate is present in both hemispheres. You may say that it spreads closely around the equator. Figure 3.6 shows you where this type of climate is found in Africa.

b) Climatic characteristics of the equatorial type of climate.

In what ways do you think the equatorial climate differs from the tropical continental? In this section we will answer this question in detail and show you the major differences. In the equatorial climate temperatures are high through throughout the year. They are always around 26°C. The variations are experienced in March and September when the ITCZ passes through the equatorial areas. You must note that the equatorial climate has no seasons.

Meanwhile, you will find that the rainfall is also high throughout the year in the equatorial. The annual rainfall fluctuates around 2000mm. Similar to the temperature, rainfall is higher during March and September. The reason for this is the same reasons that we gave for the temperature variations. The ITCZ brings greater rainfall in those months. To remember the main climatic characteristics of the of the equatorial region, remember the following:

- High rainfall throughout the year
- High temperatures throughout the year

Another way of summarising the characteristics is through a graph.

c) The Equatorial climate graph

Study the graph below, Figure 3.7 shows you the annual rainfall and temperature for a typical equatorial climate.

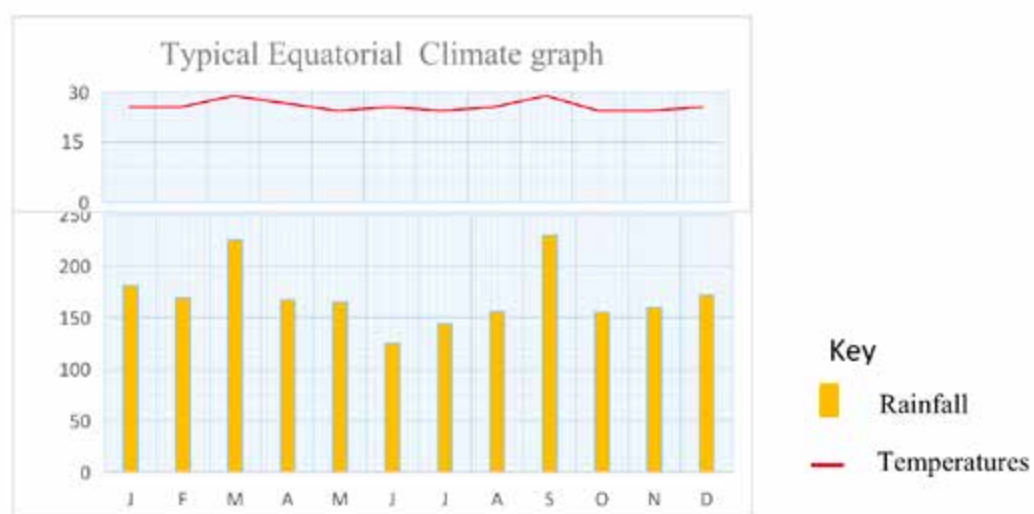


Figure 3.7 The Typical Equatorial climate graph

3.3.3 The Mediterranean climate

Let us now turn our focus to the Mediterranean climate. This type of climate is named from the Mediterranean Sea that lies between Africa and Europe and it is mainly found in the areas around that sea. You can look up the Mediterranean Sea in an Atlas if you are not sure where it is located.

a) Latitudinal location of the Mediterranean climate

If you look at the Mediterranean Sea, you will notice that it occurs beyond the tropics. That is where this type of climate is found. It is found between 30° and 40° north and south of the equator. Figure 3.8 shows you the location of the Mediterranean climate in Africa.

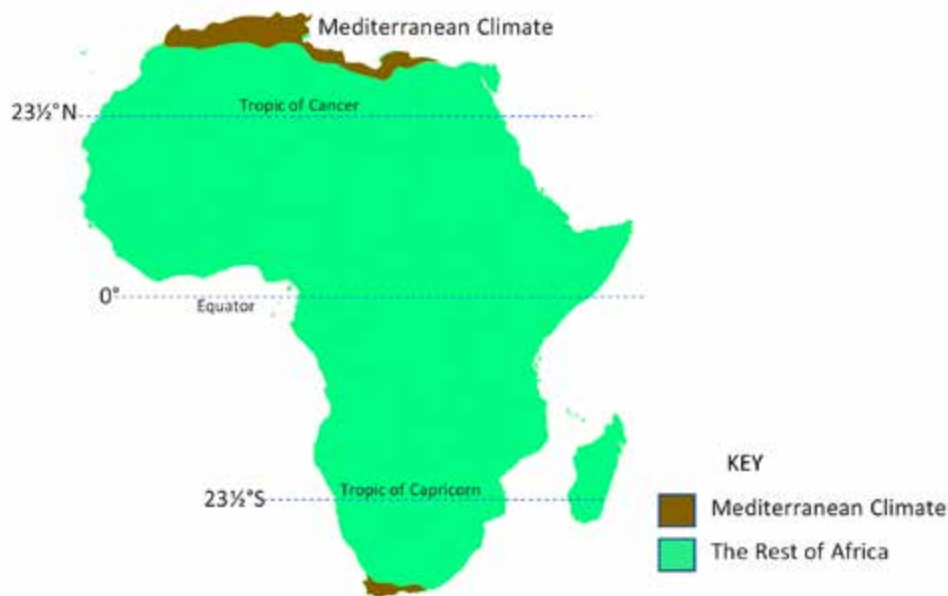


Figure 3.8 The location of the Mediterranean type of climate in Africa

You must have noticed that Figure 3.8 shows that the Cape Town area in South Africa also has the Mediterranean climate. Note that the name Mediterranean climate is derived from a type of climate that is typical of areas around the Mediterranean Sea. However, this type of climate can also be found in areas with similar conditions even though they are far from the Mediterranean climate. Other places include the northern parts of Egypt, Libya, Tunisia and Algeria.

b) The climatic characteristics of the Mediterranean climate

Take note that the Mediterranean climate is characterised by generally high rainfall and cold to mild temperatures. The average annual temperatures are around 15°C. Meanwhile, the rainfall is high. It reaches 1500mm per year. The average rainfall is around 500mm. The rainfall is mainly in winter. The temperate depression we covered in the previous unit are the major cause of this high rainfall. The summers are dry. The characteristics for the Mediterranean climate can be summarised as follows:

- Summers are dry
- Winters are wet

Let us now move on and look at the graph for the Mediterranean climate.

c) The Mediterranean climate graph

You have to be careful with these graphs. It is sometimes confused with the tropical continental graph. The tip here is for you to pay particular attention to low temperatures accompanied with rainfall. Figures 3.9.1 and 3.9.2 show you the two graphs for the southern and the northern hemispheres.

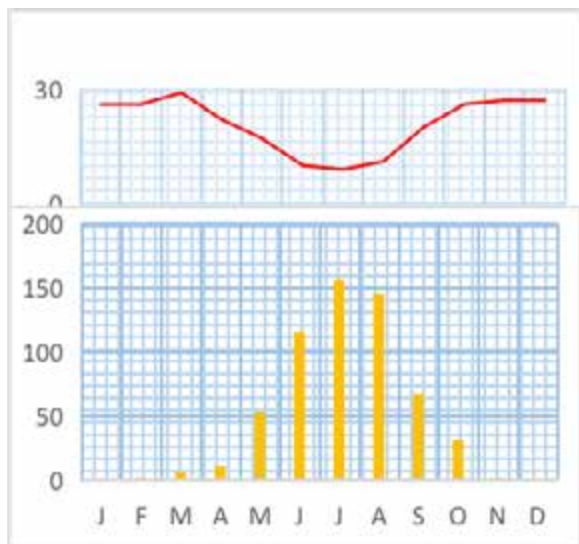


Figure 3.9.1 Mediterranean climate graph – Southern Hemisphere

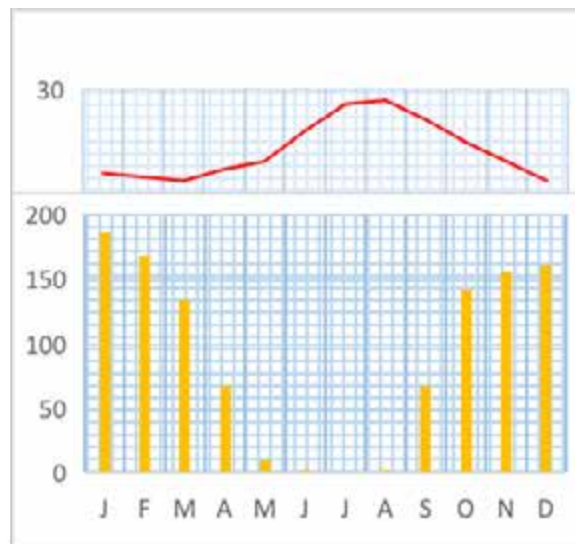
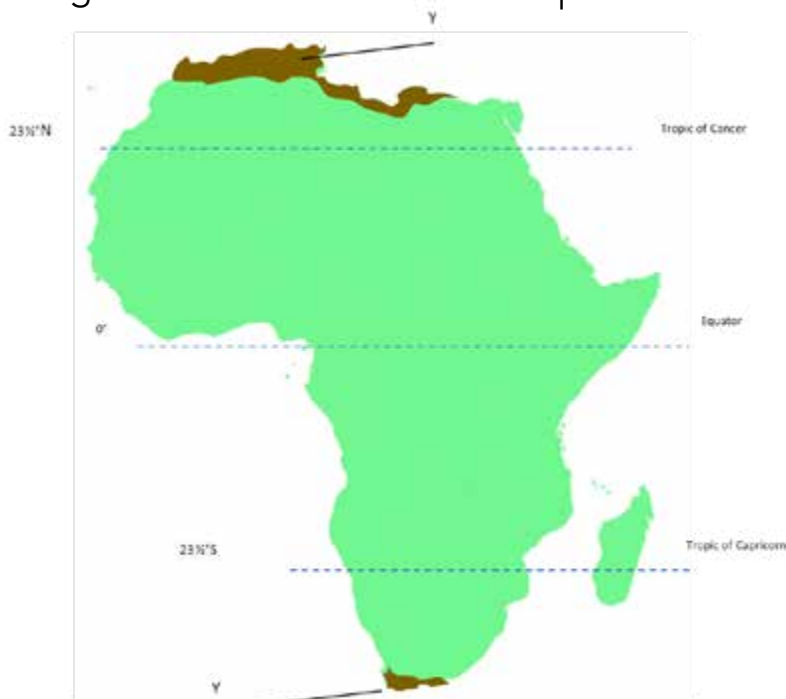


Figure 3.9.2 Mediterranean climate graph – Northern Hemisphere



Activity 3.3 The Equatorial and Mediterranean climates

1 Study the diagram below and answer the questions that follow



- | |
|--|
| (a) Name the type of climate labelled Y in the diagram above. |
| (b) Describe the climatic characteristics of the climate labelled Y in the diagram above. |
| (c) Using the characteristics you described in (b) above suggest human activities that are suitable for the Mediterranean climate. |

3.3.4 The Desert climate

Our journey through the different climates of the world now takes us to the desert. We are sure you know what a desert is. Can you define a desert in your own words? A desert is a dry and very hot part of the earth's surface that experiences less than 250mm of rainfall per year.

a) The latitudinal location of the desert climate.

Mention any two deserts that you know by name? Perhaps you mentioned the Kalahari, the Namib or the Sahara deserts. They are deserts found in Africa. Identify the names of the countries where the mentioned deserts are found. These deserts lie in the tropics and just outside the tropics. You have already dealt with the area that lies just outside the tropics. In the previous unit we studied the sub-tropical pressure belt. Deserts form around this subtropical belt. So, based on your coverage of the pressure belts, you will notice that deserts form around 30° of latitude.

Take note of the fact that there are several factors that cause the formation of deserts. Among these factors is sinking air in the sub-tropical areas, location in the middle of a large landmass, location in the rain shadow of a large mountain and the influence of cold ocean currents. Note that a *rain shadow* is the area on the leeward side of a large mountain that receives very little or no rainfall at all due to sinking of cool dry air from the mountain.

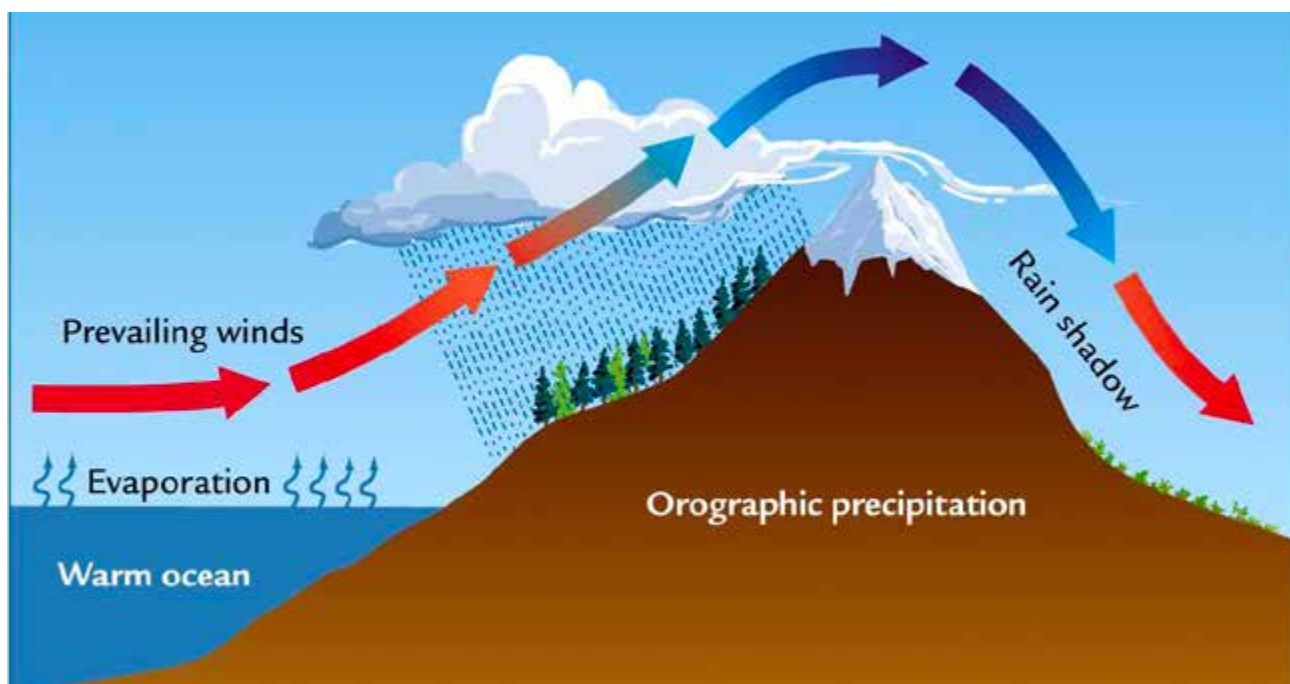


Figure 3.10 The Rain shadow effect

You must understand that deserts also form due to sinking air in the sub-tropical areas. You must understand that this sinking is different from that discussed above. The sinking air is from the atmospheric circulation of air. Note that the air rises in the equatorial areas and sinks at the sub-tropical areas. At ground level this sinking air moves away from the area. You must understand that because this moves away from the area it causes the area to become dry. The dryness means little or no rainfall that occurs.

Moreover, you will find that the location of places like N'Djamena in the interior of a large landmass leads to the formation of deserts.

Again, for you to understand the location of deserts like the Namib, you have to recall the effects of cold ocean currents like the Benguela current. Such currents cause deserts to be located in the western coast of continents. Most of these currents flow in the western sides of continents. Figure 3.10 shows you the location of the deserts in Africa.

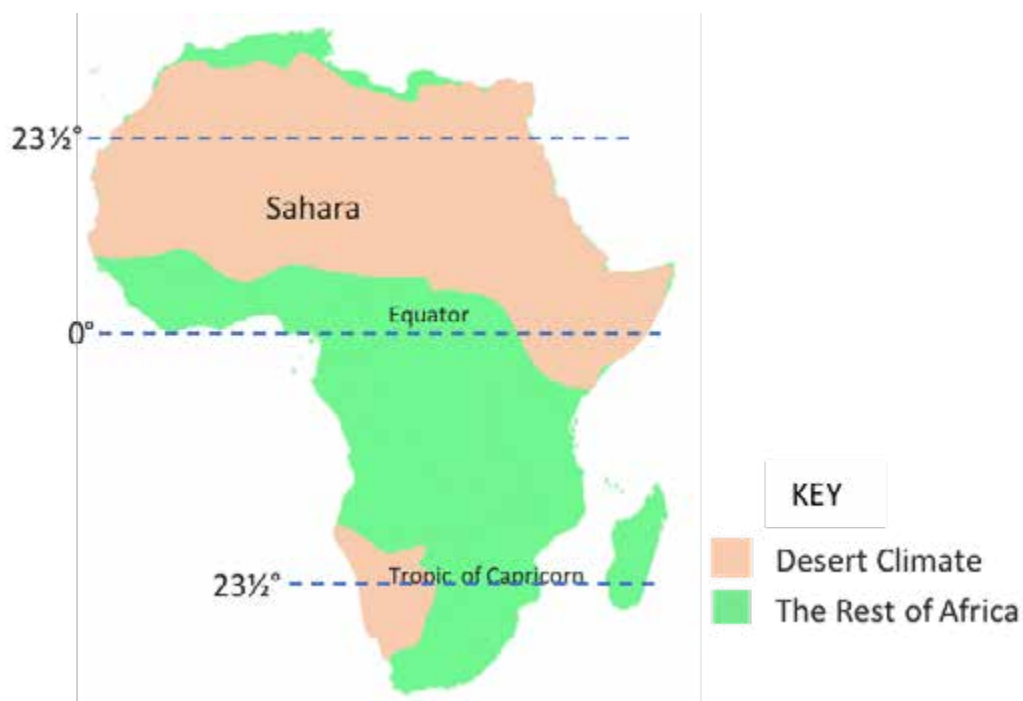


Figure 3.11 The location of the Desert type of climate in Africa

a) The climatic characteristics of deserts

You have heard people say a desert is very hot. This is a correct description of a desert. They are characterised by very high temperatures in the day throughout the year. These temperatures can be as high as 45°C. The nights are cold due to lack of cloud cover which helps to trap heat when present. The temperatures go down a little during the winter months in the different hemispheres.

By now, you must be aware that a desert has very little or no rainfall. This causes the extreme drying of the area. Such drying is called *aridity*. The annual rainfall is below 250mm. The remarkable thing you might have noticed is that 250mm can fall in one month in the equatorial areas. That confirms the point that deserts are very dry.

b) The graph for the desert climate

When you compare the desert climate graph, it looks like it is an incomplete graph due to the absence of rainfall. Figure 3.12 illustrates for you the desert climate graph.

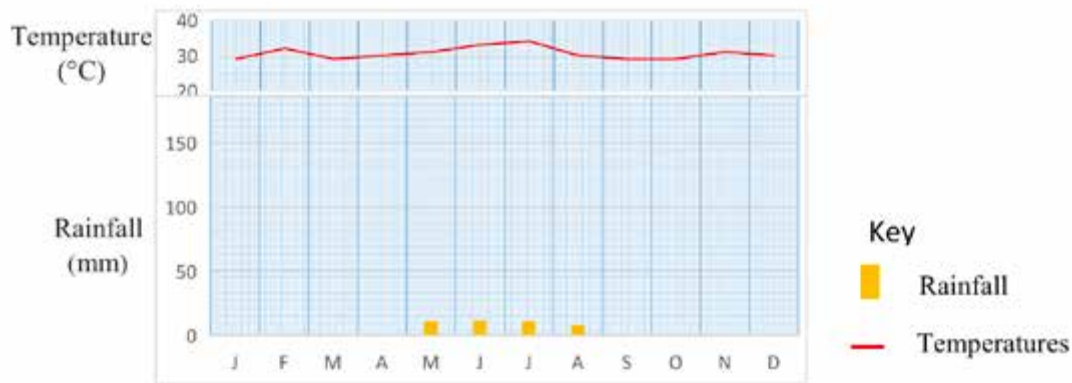


Figure 3.12 The Desert type of climate graph



Activity 3.4 The Desert type of climate

1 Describe problems that people settled in deserts experience due to the climatic characteristics you have studied.

2 Suggest solutions to the problems you mentioned in 1 above.

3.3.5 The Tundra type of climate.

All along we have been going around the tropics and sub-tropics. Now let us take our journey to the polar areas. We will explore one type of climate there. We will look at the tundra climate. Note that the tundra climate is a cold climate that is found on high latitude areas – around 80° south and north.

a) Latitudinal location of the tundra climate

This type of climate is located far away from all the types we have looked at so far. It is located within the Antarctic circle and around the arctic circle. This means that it is located at around 80° south and north. In the northern hemisphere this zone is frozen ocean but in the southern hemisphere there is the continent of Antarctica. Thus, you will notice that the countries like Norway, Sweden, Finland and Canada also have the tundra climate.



Figure 3.13 The location of the Tundra type of climate on the globe

b) Climatic characteristics of the tundra climate

You must note that the tundra climate is a very cold place? There are few people who live in places with this type of climate. This is because the temperatures are very low in this type of climate. They fluctuate around 0°C . This occurs throughout the year. There is very little variation in the temperatures. The summer temperature ranges between 0°C and 10°C . The winter is very cold and the temperatures range between -30°C and 0°C .

You would find that there is snow instead of rainfall. This is because of the low temperatures. The precipitation (the fall of solid or liquid water from the sky), is also in small amounts. The area is near the polar high-pressure belt. The pressure is therefore, high in that area. The precipitation also fluctuates around 250mm. An interesting fact is that some of the areas in the tundra can stay in the dark for over four months! If that happens in the northern hemisphere, we will be having up to four months of continuous day time. You may summarise the tundra climate as:

- Summers are cold with continuous daytime and precipitation.
- Winters are very cold, dark with little precipitation

How do you think the conditions described above affect human activities? If you said it is too cold for people to do their work, you are correct. Moreover, the ground is frozen all the time. So, crop cultivation is impossible. You must also notice that the crops would freeze. Note, again, that the long dark season would mean that there is very little work that is done. Energy requirements would be too high and expensive. This is because these areas require a lot of heating and lighting.

c) The tundra climatic graph

You are probably going to see the resemblance between the tundra type of climate graph and the desert climate graph. The areas with the tundra climate are also known as cold deserts. Why? As you have guessed, because they have very little rainfall. Study Figure 3.13 that shows the climatic characteristics of the tundra climate in graph form.

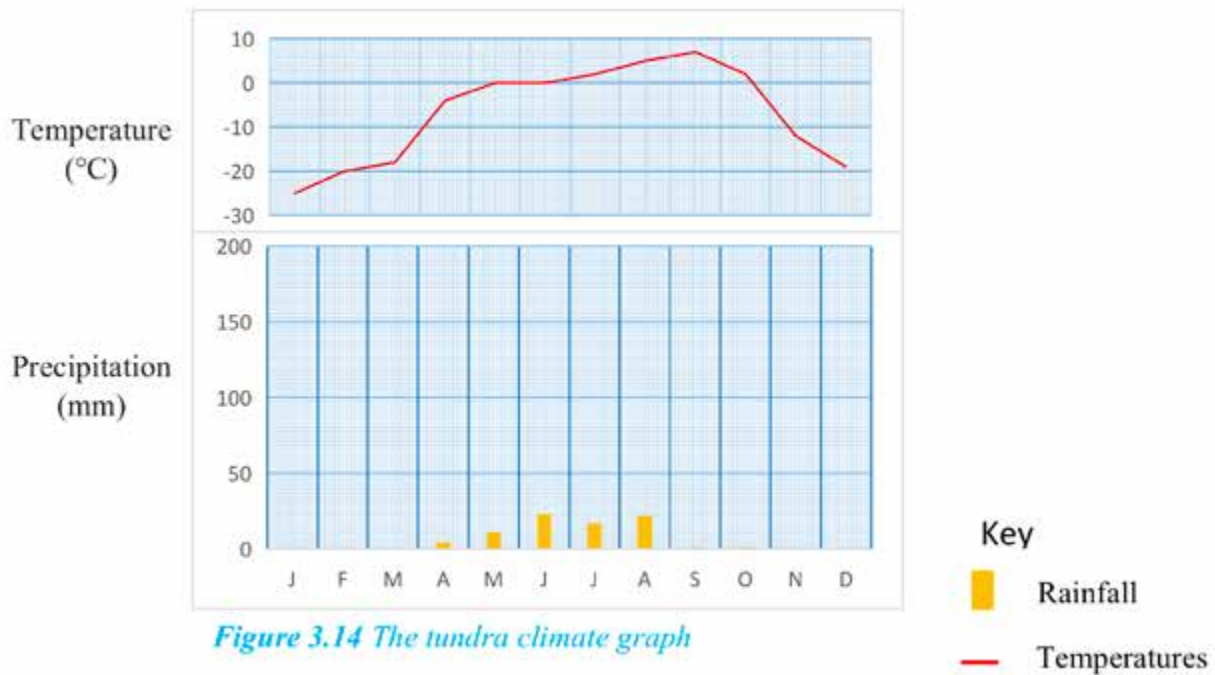


Figure 3.14 The tundra climate graph

Activity 3.4 The Desert and Tundra climates

- 1 Name two countries where the tundra climate is found.
- 2 To what extent does tundra climates support human activities?

3.4 Climatic data

Now that we have covered the main climatic types of the world. Let us look at the how climatic data is analysed. How can you define climatic data? It is the facts and figures about climate. If you were a climatologist – that is a person who studies climate – you would mainly calculate rainfall totals, temperature means (that is averages), and ranges.

3.4.1 The mean temperature

Let us now look at how the means are calculated. The mean temperature is the average of a set of temperature values. It helps in showing you whether a type of climate has generally high temperatures or not. It is calculated by the formula:

The simplest example of the temperature mean for you is the daily mean temperature. The daily temperature is calculated by adding the maximum and the minimum temperature of the day and divide it by two. The formula you would use to calculate this is:

$$\text{Daily mean temperature} = \frac{\text{Minimum} + \text{maximum of the day}}{2}$$

Examples

Let us calculate daily mean temperature from the figures shown in table 3.1.

Table 3.1 Temperature and rainfall figures for Makonde

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Minimum Temperature (°C)	19	16	11	14	13	11	14
Maximum Temperature (°C)	28	27	25	27	25	28	28

Let us calculate the mean daily temperature for Sunday.

$$\text{Daily mean temperature} = \frac{\text{Minimum} + \text{maximum of the day}}{2}$$

(Remember the formula)

$$\text{Daily mean temperature for Sunday} = \frac{14^{\circ}\text{C} + 28^{\circ}\text{C}}{2}$$

(Substitute the minimum and maximum with figures from the given table)

$$\text{Daily mean temperature for Sunday} = \frac{42}{2}^{\circ}\text{C} \quad (\text{Simplify the figures})$$

$$\text{Daily mean temperature for Sunday} = 21^{\circ}\text{C} \quad (\text{Express your answer in }^{\circ}\text{C})$$

You may need to find the mean for a year's temperatures. This is done as follows. Table 3.2 provides you with annual temperatures for a given place.

Table 3.2

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	28	27	25	27	13	8	6	12	21	27	30	28
Rainfall (mm)	191	164	101	54	13	2	0	0	2	13	78	96

Let us calculate the mean monthly temperature

$$\text{Mean monthly temperature} = \frac{\text{Sum of all 12 months temperatures}}{12} \quad (\text{That is the formula})$$

$$\text{Mean monthly temperature} = \frac{28+27+25+27+13+8+6+12+21+27+30+28}{12}$$

(You then add the monthly temperatures and divide by 12)

$$\text{Mean monthly temperature} = \frac{252}{12}$$

$$\text{Mean monthly temperature} = 21^\circ\text{C}$$

3.4.2 The Temperature range

You would also calculate the temperature range. The range is the difference between the highest and the lowest readings. Again, you find the simplest example of the range is the daily temperature range. It is calculated by the formula:

$$\text{Daily temperature range} = \text{Maximum temperature} - \text{minimum temperature}$$

Let us also calculate the daily range (also known as the diurnal temperature range). We will use the figures in Table 3.1 above.

$$\text{Daily temperature range} = \text{Maximum temperature} - \text{minimum temperature}$$

$$\text{Temperature range for Wednesday} = 25^\circ\text{C} - 11^\circ\text{C}$$

$$\text{Temperature range for Wednesday} = 14^\circ\text{C}$$

Let us also calculate the annual temperature range using figures in Table 3.2.

$$\begin{aligned} \text{Annual temperature range} \\ &= \text{Annual maximum temperature} \\ &\quad - \text{Annual minimum temperature} \end{aligned}$$

$$\text{Annual temperature range} = 30^\circ\text{C} - 6^\circ\text{C}$$

$$\text{Annual temperature range} = 24^\circ$$

3.5 The importance of the Mean and the Range in Climatic studies

You could be wondering why we need to calculate the mean and the range in climatic studies. The answer is that these statistics help as follows:

- The mean helps you to get the general average conditions of a climate. It will exclude the extreme temperatures for you so that it becomes easy to describe a particular climate.
- The mean simplifies the data and makes descriptions possible. It also summarises the figures.
- The range helps you notice the differences in the temperatures and even rainfall. It shows you how much a type of climate changes within a given space of time.

The range highlights the highest temperature as well as the lowest and therefore gives a picture of how bad or good the climate and weather can be in a particular place.

1 Study the table below and answer the questions that follow.

Table 3.3 Climatic data for Station X

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	24	25	29	27	11	2	5	10	19	25	28	28
Rainfall (mm)	186	167	95	54	1	0	0	0	2	13	78	96

- (a) Calculate the annual temperature
- (b) What is the annual range of the data show in the table above?
- (c) What is the importance of the temperature mean in weather studies?



Activity 3.5 Climatic data

Well done you have completed another unit. Please go over the points below and check whether you have understood everything in this unit.

- In this unit we covered the Climate types on a global scale and interpretation of climatic data.
- We started by looking at the definition of the term climate. We defined it as the average weather conditions of a place observed over 30 to 40 years.
- We then covered factors influencing climate. These are altitude, latitude, ocean currents and location in relation to land masses and oceans.
- You must have also covered five types of climate. The types of climate we covered in the unit are the tropical continental, the equatorial, the Mediterranean, the desert and the tundra climates.
- For each of these climates we covered their location, the climatic characteristics, the climatic graphs. You must have also noticed that the characteristics were summarised with by two statements for each climate type.
- After the climatic types we covered climatic data. The temperature mean and the temperature range were also covered.
- We also showed you examples on how to calculate each of the two statistics for climatic data.

End of Unit Assessment

1 Study the table below that shows types of climate, their location and rainfall and temperature characteristics. Some facts are missing. Fill-in the missing facts.

Climate type	Rainfall characteristics and temperature characteristics	Latitudinal location
(a)	Very cold winter with temperatures ranging between -30 and 0	(b)
Desert	(c)	Around the tropics and sub-tropics
(d)	(e)	Between 5° south and 5° north

2 (a) What is an ocean current?

3 Explain the effects of desert climate to people and their economic activities.

Research Work

1 Visit the nearest weather stations to you and ask for rainfall and temperature records for the past 30 years.

3 Based on the information you collect from your visit to the weather station, describe the nature of rainfall and temperature 30 years ago.



Progress Check

Now let us go through the objectives we listed at the beginning of the unit and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet to achieved. Then for any that you put an X against, find the section dealing with it in the unit and go over it again.

Objectives Are you now able to	Check Box
• explain the basis for climatic classification on a global scale	
• describe characteristics of world's climatic regions	
• describe the climate of Zimbabwe	
• interpret climatic graphs and tables	

Chabikwa, B., Mapungwana, M., & Phiri, F. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 4 Human influence on climate

- 4.1 Human Influence on Climate
- 4.2 Climate Change
- 4.3 Nature, Causes and effects of Climate Change
- 4.4 Adaptation to climate change
- 4.5 Mitigation against Climate Change

Introduction

It is our hope that you still remember weather elements and cyclones in the previous units. If not, you should revise units on weather and climate so that you can easily understand this unit. Those concepts are important in this unit. Now, get ready for this unit where we will look at human influence on climate. In the course of the unit we will look at causes, effects of human activities on climate. We will also look at causes, adaptation and mitigation against climate change.



Objectives

After going through this unit, you should be able to:

- identify human activities influencing climate
- define the terms urban heat island, climate change and mitigation
- describe nature, causes and effects of climate change in Zimbabwe and the World
- identify ways of adaptation and mitigation against climate change



Key Words

Climate change	Is the shift in average weather conditions of an area? The changes can take place over a shorter or longer period of time.
Urban Heat Island	Is the situation that occurs when a town or city is generally warmer than the surrounding rural areas. It occurs as a result of human activities that trap and absorb heat in the urban areas.
Mitigation	The activities done by human beings to reduce the bad effects of natural hazards. Mitigation looks at reduction of the causes of climate change.
Adaptation	Measures that can be taken to reduce the bad effects of climate change. The changes can be implemented step by step. Adaptation looks at how to reduce effects of climate change.

Greenhouse gas Is a layer of gas found at the lower levels of the atmosphere and traps heat as it is reflected back into the atmosphere. Examples of greenhouse gases include carbon dioxide, methane, chlorofluorocarbons and hydrofluorocarbons.



Time

You are expected to take an average of **10 hours** to go through this unit.



Study skills

Now that you have an understanding of key words like climate change, mitigation and adaptation, you are supposed to identify the different human activities and their influence on climate. It is important for you to think of what you as an individual have done to influence climate. You may brainstorm your own activities and write them down and then look closely at how each of your activities could have influenced climate.

4.1. Human Influence on Climate

You could have noticed from what you have listed that some of your activities affect climate. There are many such human activities that influence elements of climate such as rainfall, temperature and wind. Let us discuss some of these activities and see how they influence climate. You are supposed to attempt the activity below to make it easy for you. Study Figure 4.1 answer question on Activity 4.1.

From the human activities listed above you can see that one of them is deforestation.

4.1.1 Deforestation



You have seen people cutting down trees for a variety of reasons. As you can see from the pictures above people cut down trees in urban areas to increase the land for expansion. This has a negative impact on the environment. You can see that many areas have been left bare and the various tree species have been affected. Wind speed has increased as windbreaks are destroyed. There is also reduction in water holding capacity of an area as trees are removed leading to lower rainfall totals. The climate changes from being moist to dry. So, this is one way in which human activity can have a negative influence on the environment. Let us move on and look at another human activity that has a great impact on weather which is afforestation. Can you think of any effects of planting trees? Go through the activity below.

4.1.2 Afforestation

From what you have learnt in level one, you have realized that when people plant trees water moves down slowly and this reduces rates of runoff. The process of planting trees in areas that are bare is called afforestation.



Activity 4.2 Afforestation

What do you think are the benefits of planting trees?

As you have correctly noted above afforestation increases the amount of moisture in the atmosphere. It is the planting of trees in areas that were bare. As vegetation holds more water which results in more evapo-transpiration, this results in more rainfall in an area. The area changes from being dry to moist. The planting of trees therefore leads to the creation of a green world where there are lower temperatures and less pollution. This is a positive contribution to climate. Related to afforestation is reforestation.

4.1.3 Reforestation

The term reforestation refers to a process of planting trees in areas that were once covered by vegetation. Trees can be planted on the bare ground or in areas with stumps. When trees are planted in an area rate of transpiration increase leading to higher chances of rainfall in a given area.



Activity 4.3 Reforestation

1. What do you think is meant by reforestation?
2. How does it affect climate change?

As you have noted above, it is the planting of trees in areas once covered by forests. Reforestation has an effect of reducing temperatures as trees absorb carbon dioxide. Reforestation also reduces wind speed and increase the amount of moisture in the atmosphere. This human activity has a positive influence on the climate.

4.1.4 Stream bank Cultivation

In the rural areas, people grow crops in different places. When crops are grown along or close to river valleys, we call it stream bank cultivation. Crops like maize beans and rice can be grown along these areas.



Activity 4.4 Streambank cultivation

Study figure 4.2 and attempt questions that follow.



Figure 4.2 Stream bank Cultivation

1. Describe the scene in the photograph?
2. What are the effects of such an activity on the environment?
3. What do we mean by stream bank cultivation?

It is the cultivation of areas along river valleys and floodplains which are less than 30 metres away from river channels. Streambank cultivation causes water bodies to get filled up with soil. It also reduces the amount of water that can evaporate from dams and rivers thereby affecting total rainfall in an area. So this human activity contributes negatively to climate change. The next human activity is urbanisation.

4.1.6 Urbanisation



Figure 4.3 Effect of Urbanisation to climate change

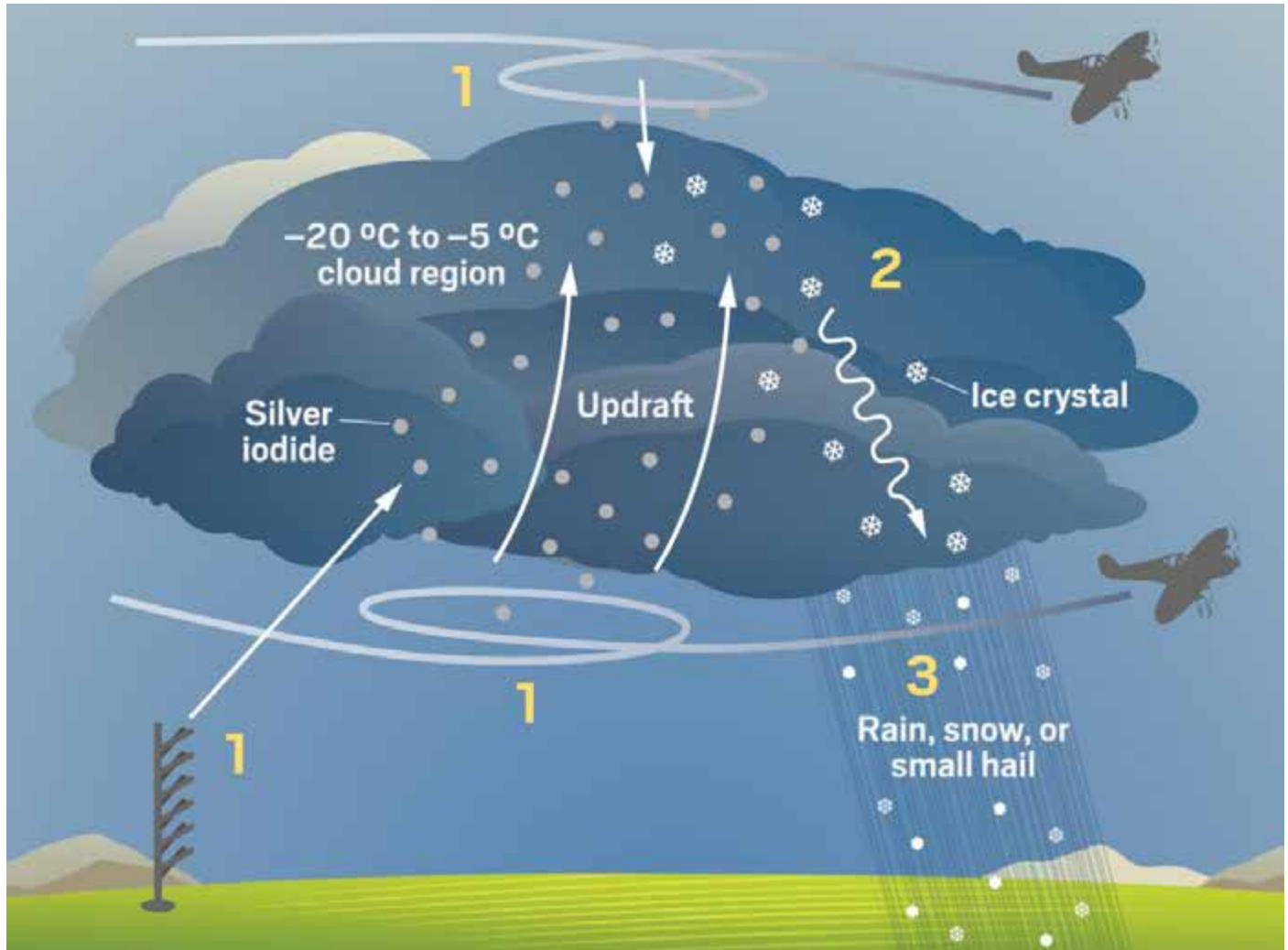
As you can see on the above diagram human beings have contributed to climate change, as there has been an increase in the number of people living in cities and towns. Can you list down some of the effects of urbanisation? Yes, the activities have the following results. The tarred surfaces and buildings that you can visualize in a city store a lot of heat and this often leads to higher temperatures than in the surrounding areas. This is called urban heat island. These cities and towns also make the environment and air around them dirty. Urbanisation has negative impacts on climate change. Let us move on to look at cloud seeding and its effects on climate change.

4.1.7 Cloud seeding

Cloud seeding is the artificial application of condensation nuclei into the atmosphere to help during rainfall formation.



Activity 4.5 Cloud Seeding



Study Figure 4.4 and attempt the tasks that follow.

1. List features you can see on the diagram.
2. From the illustrations define cloud seeding.
3. Name the materials we need for cloud seeding.
4. Describe the conditions suitable for cloud seeding.

You can see that cloud seeding is the artificial application of condensation nuclei into the atmosphere to help in the formation of rainfall. The condensation nuclei include chemicals like silver iodide and frozen carbon dioxide (dry ice). Cloud seeding increases the amount of rainfall in an area as the condensation nuclei necessitates rainfall formation. The increase in the amount of rainfall results in more rainfall in an area. This activity results in positive impact on climate change. So, you now have knowledge on cloud seeding.

4.1.6. Dam construction

You have seen or heard of a number of dams that have been constructed recently for example the Tokwe-Mukosi dam. Can you name any dams in your local area? Increase in the number of dams in an area have a lot of impacts. The area where dams have been built results in more rates of evaporation as dams store water. This is likely to lead to more rainfall in an area thereby changing the climate of a given area. This human activity influences positively to climate change. Another human activity which you should have identified is veld fires.

4.1.7 Veld fires

In our everyday life, people can start fires for variety of reasons. People can use fire when hunting or when clearing a new piece of land. These fires can get out of hand and lead to veld fires.



Figure 4.5 Veld fires

Attempt Activity 4.6 on veld fires.



Activity 4.6 Veld fires

1. Describe the scene in Figure 4.5.
2. What do you think are the effects of such an activity on the environment?

The picture above shows a veld fire. Let us look at how it affects climate change. These veld fires increase temperatures in an area thereby reducing the amount of water vapor. Veld fires lead to an increase in dryness in an area. So, this human activity influences the environment negatively. Can you add any other effects? Related to the issue of veld fires is desertification.

4.1.8. Desertification

Desertification can be referred to as the spread of dry conditions into once viable agricultural areas. This can be a result of a number of activities, which include overgrazing, veld fire, overpopulation and stream bank cultivation.



Activity 4.7 Desertification

Study Figure 4.6 which shows an area undergoing desertification



Figure 4.6 Desertification

1. List the changes that have happened to Figure 4.6
2. What could have caused the changes shown in Figure 4.6?

The picture in figure 4.6 illustrates the changes that can take place due to **desertification**. On the above activity you were supposed to identify issues like wilting of plants, destruction of vegetation. Any other issues that you can think of? **Desertification** is the process of turning a once viable agricultural land into a desert it is a result of a number of activities. Overgrazing in rural areas leads to the loosening of the soil, thus the area becomes liable to soil erosion. In areas surrounding the urban areas people depend on wood fuel for energy this has accelerated rates of **desertification**. The above activities have an important bearing on climate. So, **desertification** has a negative impact on climate change

So, the activities above show human beings influence climate as a way of checking your understanding attempt the activity below in table 4.1



Activity 4.8 Effects of human activities on climate change

Table 4. 1 Human activities

Positive influence	Negative influence
E.g. afforestation	Stream bank cultivation

4.2. Climate Change

From the activities that you have done above you should have realized that under positive influence we have afforestation, reforestation cloud seeding. Negative influences include stream bank cultivation, deforestation and veld fires. The activities above cause long and short term changes in climate. These short- and long-term changes in average weather conditions can also be referred to as Climate Change. Areas that used to receive high rainfall may start to experience low rainfall whilst areas that used to experience mild winters can begin to experience long severe winters.



Activity 4.9 Climate change

From what you have learnt above now list down the causes of climate change.

4.3. Nature: Causes and Effects of Climate Change

Climate change is a result of different inter-related natural and human activities. You should know that climate change is a natural process, especially issues related to global warming. However, human activities have accelerated climate change. Let us look at what are the actual causes of climate change.

4.3.1. What causes climate change?

From the activity that you have done above you were expected to realize that climate change is mainly a result of human activities. Climate change is caused by the emission of gases like carbon dioxide which comes from the burning of fossils, methane from cows and sheep when they digest, nitrous oxide from fertilisers and fluorinated gases like chlorofluorocarbons. These gases trap heat and lead to global warming.

Continuous destruction of trees can also lead to global warming. Deforestation through burning has also meant an increase in the amount of carbon dioxide in the lower levels of the atmosphere. The increase of gases leads to global warming.

High levels of industrialization can also play a part in causing global warming. Increase in number of activities in towns and cities has led to a rise in temperatures. Urban areas produce smoke from moving vehicles and burning of wastes.

Increase in agricultural activities, especially the use of fertilisers is another cause. The growing of wheat and rice results in the production of methane gas. Production of these gases harm the atmosphere as they remain at the lower levels trapping heat. You can now add more causes of climate change.

4.3.2. Effects of Climate Change on Agriculture

In the previous work, we have identified the causes of climate change, we now want to discuss about the effects of climate change.



Activity 4.10 Effects of climate change on agriculture

Study the figure 4.7 and try to identify the effects of climate change.



Figure 4.7 Crops wilting due to high temperatures and shortage of rainfall

From study of the picture above you should have identified some of the following effects;

- Lowered agricultural production as there is likely to be a marked decrease in rainfall totals. The high temperatures are also likely to destroy a lot of pastures leading to the death of livestock.
- Climate change can also result in the increased frequency of floods
- Droughts and heat waves also increase as summer temperatures are expected to rise

- Global sea levels will also rise
- Drying up of rivers
- Stress on agricultural production
- Melting of glaciers
- Shifting seasons

4.4 Adaptation to Climate Change

Imagine you wake up early in the morning and you find out that it is very cold, what will you do?

We expected you to come out with responses like wearing of warm cloth. The changes in weather patterns can call for you to adapt. If you have forgotten the meaning of the word adapt go back to the key words Yes, you can see that to adapt means to change in order to reduce the bad effects of climate change. Human beings have adapted to climate change through the following ways:

- Wise/efficient use of scarce water sources
- Building flood barriers
- Water recycling
- Education campaigns
- Evacuation from disaster prone areas
- Improvement in irrigation methods

4.5 Mitigation against Climate Change

You now have an idea on climate change in this section. We now want to look at mitigatory measures against climate change Can you list some of the measures. Mitigation looks at reducing the causes of climate change. These measures include the following:

- Construction of dams
- Practicing irrigation
- Growing drought resistant crops
- Water harvesting
- Reforestation
- Environmental education



Activity 4.11 Mitigation on climate change

1. Define the terms climate change and heat island effect. (4)
2. Suggest measures that can be taken in your local area to reduce the negative effects of climate change. (5)

Summary

- Remember that this unit is on human influence on climate change and we described the causes of climate change. We covered human causes such as afforestation, deforestation streambank cultivation, cloud seeding and desertification.
- We also looked at effects of climate change on agriculture that include lowered agricultural production, increased frequency of floods, drought heat waves, drying up of rivers and melting of glaciers.
- We also discussed about adaptation measures to climate change. The measures include water harvesting, building flooding barriers, education campaigns and improvements in irrigation methods
- We ended the unit by looking at mitigation measures that include the construction of dams, practicing irrigation farming and growing of drought resistant crops.
- You need to do extra reading from your internet or library in order to keep pace with what is happening to the climate

End of Unit Assessment

1. Tropical continental air mass is
 - A. Cold and dry.
 - B. Cold and wet
 - C. Hot and dry
 - D. Hot and wet
2. The Congo air comes from
 - A. South-westerly
 - B. North-westerly
 - C. South-easterly
 - D. North-easterly.
3. Frontolysis occurs when
 - A. Two different air masses meet
 - B. Front breaks down
 - C. Front is formed
 - D. When rain stops falling.
4. What immediate action can a government take to help flood victims for example those affected by Cyclone Idai?
 - A. Early warning system
 - B. Education
 - C. Evacuation
 - D. Rebuilding
5. Which of the following is not a sign of climate change?
 - A. Desertification
 - B. Rise in sea level
 - C. Droughts
 - D. Increased plant life

Structured Questions

1. Suggest measures which can be taken to reduce the effects of climate change in Africa (5)
2. What problems would you face in implementing these measures? (4)



Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding. I have listed them here below. Go through them and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it in the unit and go over it again. Right mark yourself!

Objectives: Can you now:	Check box
• identify human activities influencing climate	
• define the terms urban heat island, climate change and mitigation	
• describe nature, causes and effects of climate change in Zimbabwe and the World	
• identify ways of adaptation and mitigation against climate change	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 5 Plate Tectonics

- 4.1 The continental drift theory
- 4.2 Plate tectonics
- 4.3 Folding and resultant landforms
- 4.4 Faulting and resultant landforms
- 4.5 Volcanoes and Earthquakes

Introduction

In Level 2 you learnt about the different layers that make the internal structure of the earth. You might also have noted that the outer layer; the crust, is the one that carries continents and oceans. The crust is lighter and it floats on top of the mantle layer beneath and therefore, unstable. In this unit, you are going to learn about the movements and processes that occur within the crust and the landforms that result from these movements and processes. These movements are referred to as plate tectonics.



Objectives

After going through this unit, you should be able to:

- outline the continental drift theory
- describe tectonic movements
- explain implications of plate tectonics on climate
- describe processes of folding and faulting
- describe resultant landforms
- outline the distribution of volcanoes and earthquakes
- explain the causes of volcanoes and earthquakes



Key Words

Plate tectonics	the movement of plates and processes that take place within the crust of the earth and the landforms that result from these processes.
Folding	the bending of rock layers due to forces of compression. Remember compression forces are those forces acting horizontally towards each other.
Faulting	the fracturing or breaking of rock layers in the crust due to internal forces of tension and compression which cause displacement of rocks.
Volcano	the process by which magma moves into the crust or erupts onto the surface as lava to form landforms. The term can also refer to the landforms that result from volcanic activity.
Earthquakes	the sudden shaking or vibrating of the earth's crust resulting from crustal instability



Time

You are expected to take an average of **10 hours** to go through this unit.

- The study of plate tectonics needs a high level of imagination as most tectonic processes cannot be observed with a naked eye.
- Revisit your previous Level 1 unit on the Earth's Structure, to have a better understanding of the new concepts to be learnt in this unit
- You can take down your own notes on important points
- For you to understand the concepts in this unit better, I advise you to use diagrams effectively to illustrate processes.

5.1 The Continental drift theory

In this topic, we will introduce you to the theory of continental drift. Can you try to identify some continents that you are familiar with? Have you ever imagined how the massive continents came to existence? There are many explanations to how continents came to existence; some are religious and others are scientific. While we do not argue with the religious explanations, in this unit we will focus on the scientific theory of the continental drift theory.

The theory of continental drift was put forward by an Austrian climatologist, Alfred Wegener. Remember that this theory, only tries to explain the formation of continents and how they moved apart from their original positions to where they are today.

The theory proposed that the continents were once joined together as a single supercontinent. This supercontinent was named **Pangea**. Pangea later on broke up into two large continents. The one to the north was named **Laurasia** and the other one to the south was named **Gondwanaland**.

It is important for you to note that the two larger continents further broke up into fragments which became the continents as they are today. Six major continents were formed (North America, South America, Africa, Australia, Asia and Europe) whereas the smaller fragments became the islands. These continents started to move away from each other to the positions where they are today. Do you now realise that the drifting of continents away from each other bears the name, "continental drift"?

Now attempt to name the continents shown on Figure 5.1.



Figure 5.1 World map showing the different continents as proposed by Wegener

We understand that you might have some questions and doubts about Wegener's explanation. However, the following pieces of evidence which were collected by Wegener and other scientists help to support the theory. We hope that after going through the explanations you will have a different view of the theory and begin to appreciate the value of his theory.

5.1.1 What evidence is available to support the continental drift theory?

1. Some continents' coastlines can fit together like a jigsaw suggesting that they were once a single continent. For example, if you take the Western coast of Africa and the Eastern coast of South America, they fit well.
2. Similarities in flora (plants) and fauna (animals) show that the continents were once joined together.
3. Matching mountain belts and rock types. The study of mountain belts and rock types on the coastline of West Africa and South America as well as North America and Greenland shows that the rocks were formed during the same period when the continents were still joined together.



Activity 5.1 Continental drift theory

Now you can attempt the following questions to check your understanding.

1. The theory of continental drift suggests that the _____ were once joined together. Some millions of years ago, they broke up to form six major continents namely _____, _____, _____, _____, _____ and _____.
2. Outline any two pieces of evidence that support the idea that continents were once assembled together

5.2 Plate tectonics

You now have an idea of the origin of continents. We are sure you can appreciate that continents are unstable. With this knowledge about continents, you may be wondering what are plates! Tectonic plates are plastic like massive rafts which are suspended on the mantle. These plates carry continents and oceans. We will now introduce you to plate tectonics and the various movements that occur within the crust due to some internal forces caused by convectional currents in the interior of the earth.

5.2.1 What is plate tectonics?

Plate tectonics refers to the movements of plates and processes that take place within the crust of the earth and the landforms that result from these processes. The crust consists of eight major plates that are floating on the semi-liquid mantle beneath. You now know that some of the plates carry oceans and others carry continents. The ones that carry oceans are called oceanic plates and those that carry continents are called continental plates. Study Table 5.1 which shows types of plates.

Table 5.1 Types of plates

Continental plates	Oceanic plates
African	Nazca
South American	Pacific
North American	Philippines
Eurasian	
Indo-Australian plate	

Now study the map on Figure 5.2 which shows the different plates and plate boundaries. Try to identify some of these plates and plate boundaries from the map.

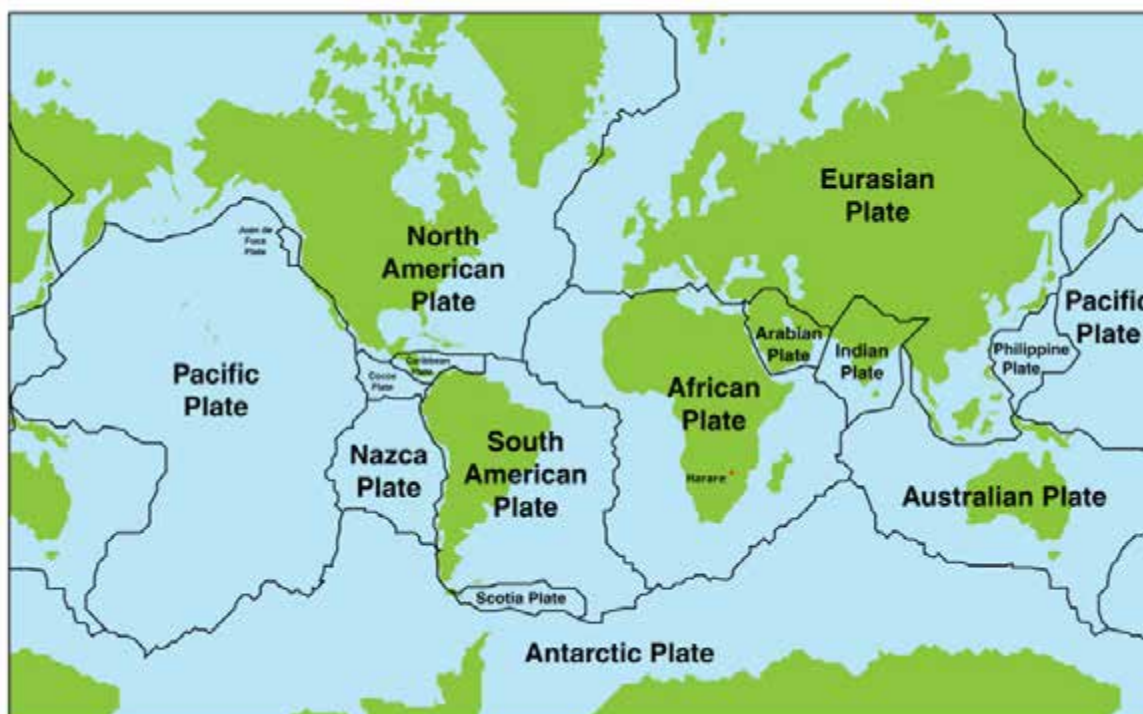


Figure 5.2 World map showing plate boundaries. Arrows show direction of plate movement.

Oceanic plates are denser because they are made up of basaltic rocks of magnesium silicate minerals. We hope you have realised that the word **sima** is an amalgam (combination) of the first two letters of magnesium and silica. You can therefore use the acronym sima; "si" for silica and "ma" for magnesium. Oceanic plates are lighter because they are made up of granitic rocks which are made up of silica and aluminium based minerals. Again, you have realised that the word *sial* itself is an amalgam of the first two letters of silica (si) and aluminium (al). The sial and the sima layers form the crust. The sima lies below the sial and forms the ocean floor while the sial forms the continents. This crust ranges from 6 to 50 km in thickness.

Do you remember these layers from your Level 1? Try to complete the diagram on Figure 5.2 for a recap of your previous tutorials in Level 1.

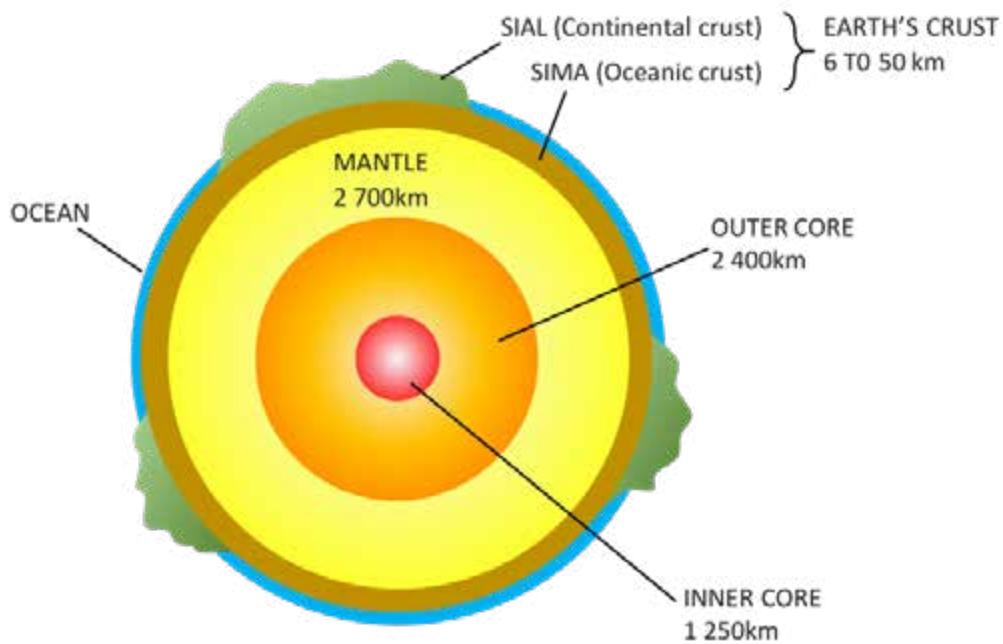


Figure 5.3 Internal structure of the earth

We are sure you managed to label the **sial**, **sim**a, the **mantle**, the **outer core** as well as the **inner core** of the earth's internal structure.

Remember in Level 1 we learnt that the mantle is denser than the crust. As a result, both oceanic and continental plates float on top of the mantle. In the mantle, temperatures are very high and this causes the material in the mantle to be semi-liquid and generate convectional currents. These convectional currents make the oceanic and continental plates on top unstable. They are in constant motion drifting away and against each other. They are either colliding with or diverging from each other. Try and place two floating objects in a bowl of boiling water, you will see that the objects will be diverging and colliding. What could be the reason for such unstable movements? If you said convectional currents generated by boiling water, you are correct. This is similar to what happens with plate movement.



Activity 5.2 Plate Tectonics

Now we are going to do an experiment which will help you to understand the fact that both continental and oceanic plates float on top of the mantle. It will also demonstrate that the semi-liquid mantle generates convectional currents which makes the plates above unstable.

Take a large bowl and fill it up with water. This water represents the mantle layer. Then take two plastic plates one with water to represent oceans and the other one with sand to represent continents. Now, place them on the surface of water in the bowl. What did you observe?

We are sure you noted that the two plastic plates floated on water but they are not stable. They are sometimes moving towards each other and other times away from each other. This brings up the concept of **plate tectonics**. Remember we defined plate tectonics as **the movements and processes that take place within the crust of the earth and the landforms that result from these processes**. The movements of the plastic plates from your experiment is similar to what happens with the oceanic and continental plates as they float on top of the semi-liquid mantle material. You should also note that if plates collide or move towards each other, this is called plate **convergence** and that when they move apart, this is called plate **divergence**. This happens along **plate margins**.

Plate margins are boundaries between plates. It is important for you to note that there are three types of plate boundaries as explained below.

5.2.2 Types of plate boundaries

Now let us look at the types of plate boundaries before we look at examples of plate movements that occur along these boundaries.

(a) Divergent /constructive plate boundary

This is where two plates move away from each other. Divergent plate boundaries are constructive because they lead to new material being born. For example, North American and Eurasian plates. Look at the Fig. 5.4 (a) which illustrates how plates move at the constructive boundary.

(b) Convergent or destructive plate boundary

Here plates move towards each other and collide at the zone of subduction. Convergent plate boundary is destructive because it destroys features along the edges. Fig. 5.4 (b) shows the convergent plate margin.

(c) Transform or conservative plate boundary

This is when two plates move horizontally in opposite direction past each other. Not many changes, in terms of landforms, occur along this boundary. This is why it is called conservative. The transform plate boundary is shown on Fig. 5.4 (c).

5.2.3 Examples of plate movements

You now know that plates can move towards each other (converge) or they can move apart (diverge). We now want to look at which plates converge and which ones diverge. We will then describe the features that are formed during plate movement. It is, therefore, important for you to study and understand the following examples before you proceed to the next section.

Oceanic vs continental plates converging

It is important for you to know that when an oceanic plate and a continental plate collide, the oceanic plate which is denser is pushed underneath the lighter continental plate. This happens at the zone of subduction. The rocks at the edges of the oceanic plate are subducted into the mantle where temperatures are very high. We hope you still remember the characteristics of the mantle? Yes, it is very hot. Because of the high temperatures, the rocks on the edges of the oceanic plate melt and they are destroyed. A good example is when the Nazca plate which collided with the South American plate at **the zone of subduction** and led to the formation of the Andes fold mountains. An oceanic trench also forms along the zone of subduction e.g. the Java Trench. Sediments of eroded materials will accumulate in the trench and folded up by compression forces to form fold mountains as illustrated on Figure 5.5. As this happens, the processes will be accompanied by volcanoes and earthquakes. You shall notice that the strongest volcanoes and earthquakes of the world occur along this zone.

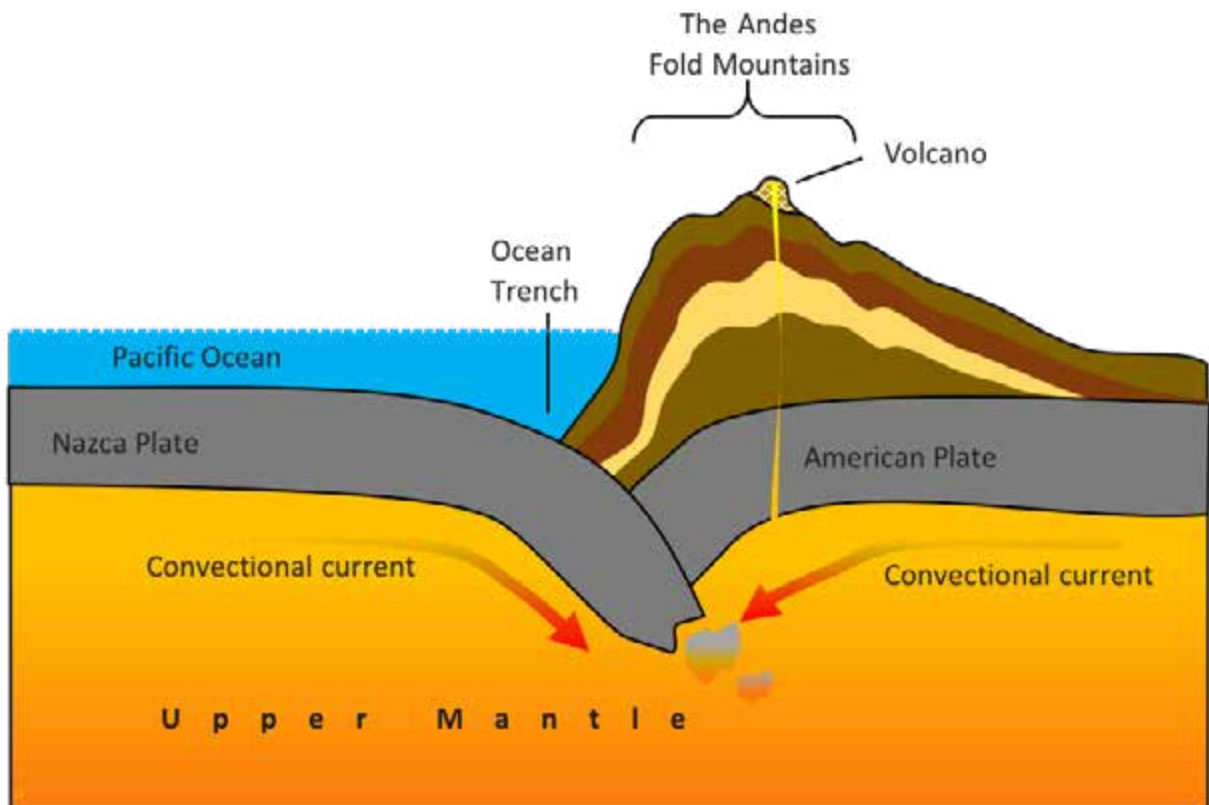


Figure 5.5 Convergence of an oceanic and a continental plate

b) Continental vs continental plates converging

When two continental plates collide, their edges crumble and bend upwards to form fold mountains. A good example that you can refer to are the Himalaya Mountains that were formed due to the collision of Indo-Australian and the Eurasian plates.

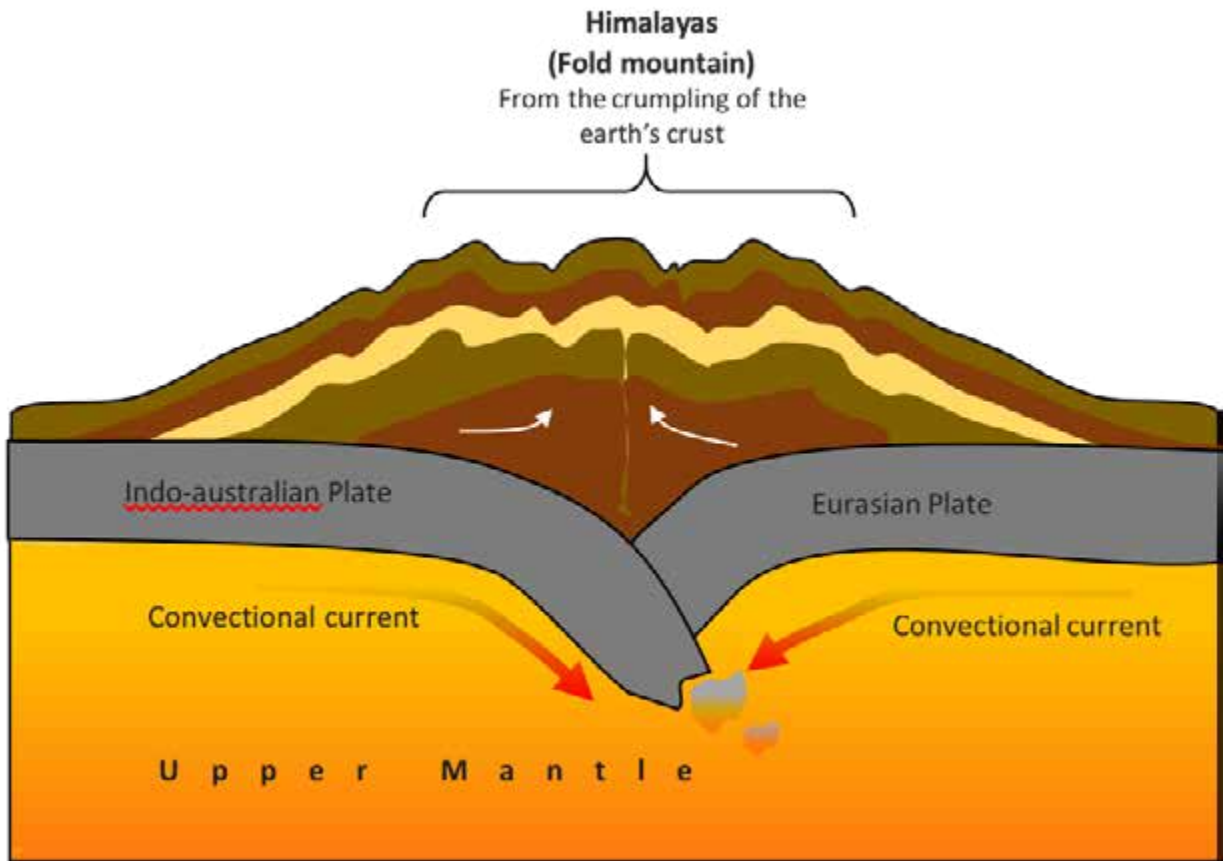


Figure 5.6 Convergence of two continental plates

c) Oceanic vs oceanic plates diverging

Have you ever tried to close a pot full of boiling water? If you open the pot, the water will bubble out escaping from the container due to pressure inside. This is similar to what happens when the crust opens up to form deep cracks or fissures when oceanic plates diverge. The divergence of two oceanic plates causes a gap to be created in the crust which opens a way for the magma in the mantle to flow onto the surface. The magma cools and solidifies to form a ridge in the middle of an ocean called the mid-oceanic ridge. An example is the Mid-Atlantic Ridge which formed in the middle of the Atlantic Ocean.

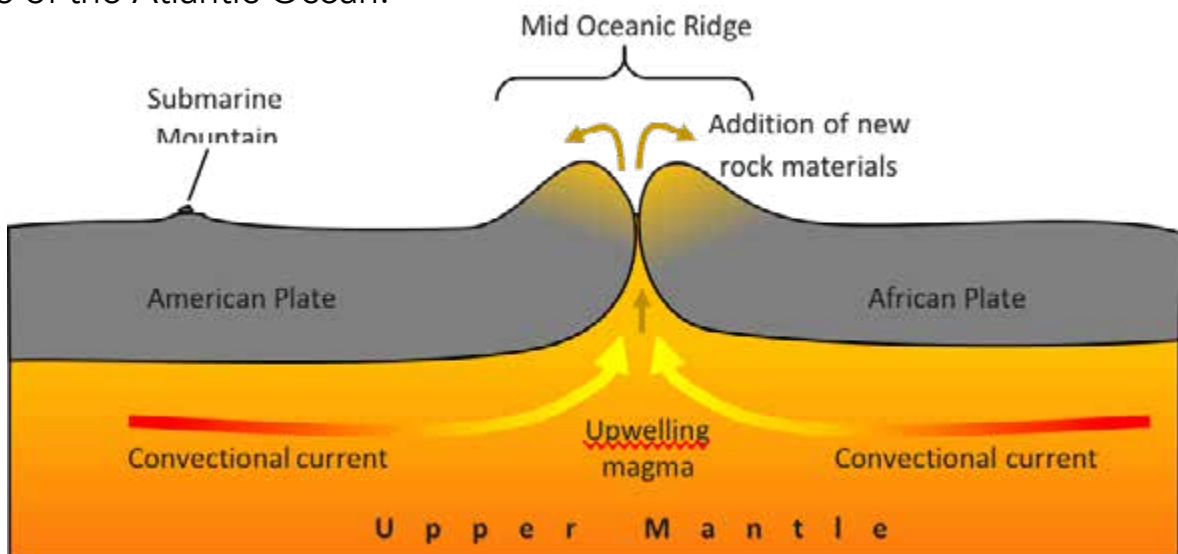


Figure 5.7 Oceanic plates diverging forming a mid-oceanic ridge

d) Continental vs continental plates diverging

You should also note that if a continental plate splits into two or if two continental plates diverge due to forces of tension, a deep crack called a fault is produced. This leads to the formation of an elongated depression called a rift valley. A good example is the Great East African Rift Valley. The rift valley can be a site for lakes. Lake Malawi and Lake Tanganyika lie within the Great East African Rift Valley.

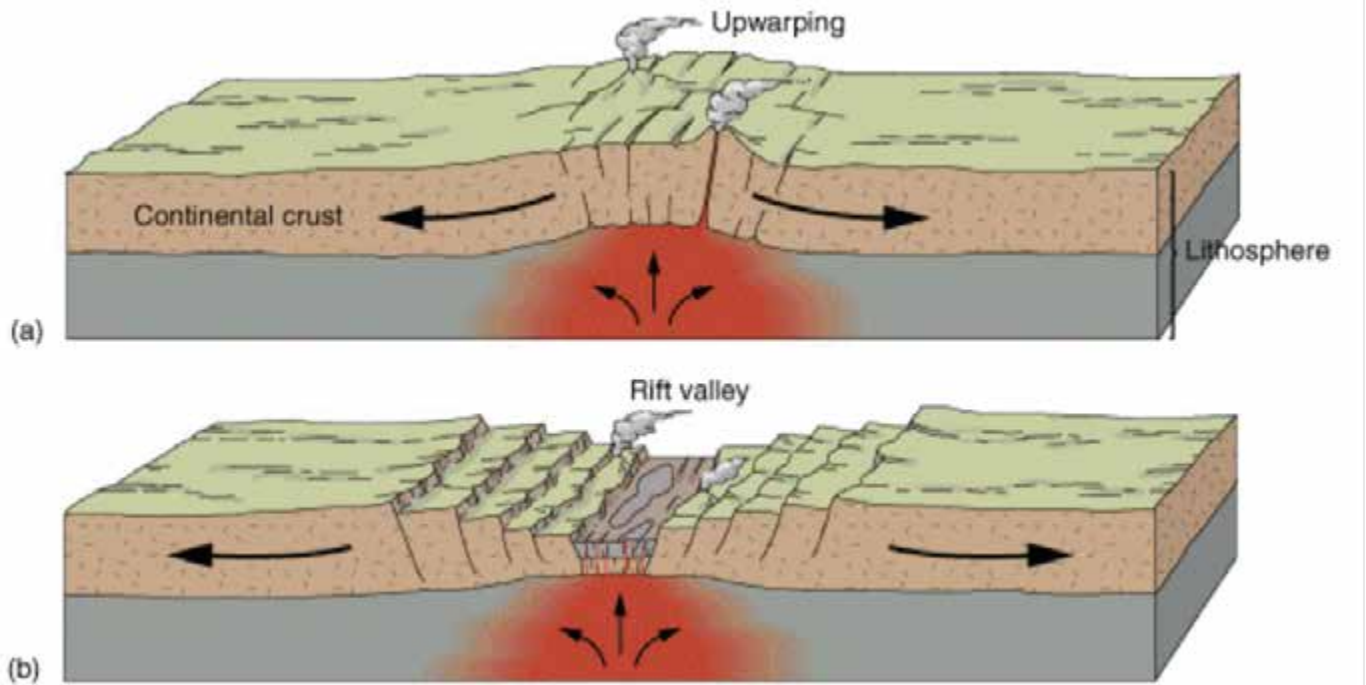


Figure 5.8 Continental plates diverging forming a rift valley

(a) Faulting and upwarping

(b) Rifting of the crust and formation of the rift valley

e) Oceanic vs oceanic plates converging.

Another scenario is the convergence of two oceanic plates. When two oceanic plates converge, it results in opening up of fissures which run from the mantle to the surface which cause the occurrence of a series of volcanoes. For example, the convergence of the Pacific plate and the Philippines plate led to the formation of a group of volcanic islands called an island arc.

f) Island arc

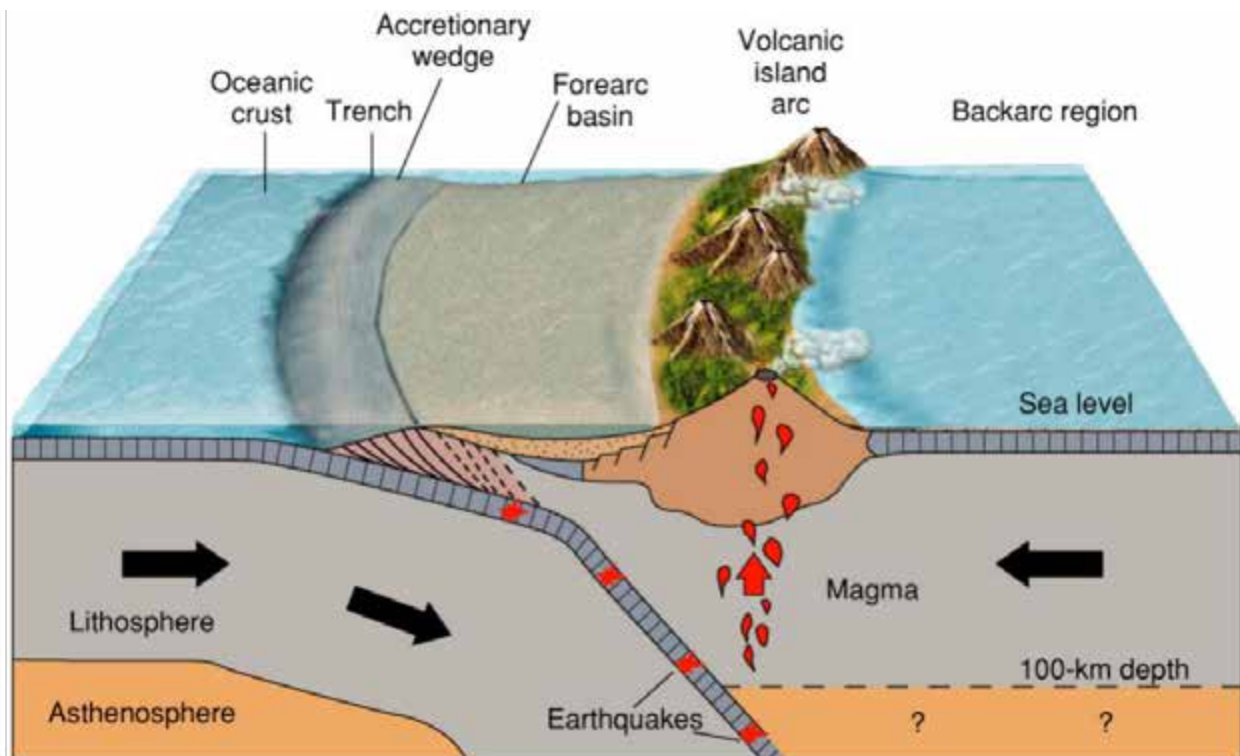


Figure 5.9 Island arcs form from the upwelling magma at the convergence zone

Study the following map which shows the distribution of fold mountains along plate boundaries. You will note that most fold mountains are located along convergent plate boundaries. Thus, when two continental plates converge, they cause their edges to fold up into fold mountains along the convergent boundary.



Figure 5.10 The global distribution of fold mountains

Now we want you to attempt questions in Activity 5.3 to check if you have understood what you have learnt on plate tectonics so far. If you cannot answer the questions correctly, you are encouraged to revisit the topic before you proceed to the next topic.



Activity 5.3 Plate boundaries

- 1.State two minerals that make up the core of the earth.
- 2.Explain any three types of plate boundaries (6
- 3.Using information from Figure 5.7, describe and explain the distribution of fold mountains.

5.3 Folding and resultant landforms

In the previous section you learnt about the movements that occur within the crust as a result of the convectional currents caused by the hot magma in the mantle. These convectional currents cause forces of tension and compression on the rocks in the crust. You should have a fair understanding of this first for you to be able to link them to the processes of folding and faulting. Thus, this unit will explain further, the processes that occur in the crustal rocks and the resultant landforms. Be reminded that folding and faulting are still part of the tectonic process.

5.3.1 What is Folding

Folding refers to the bending of rock layers due to forces of compression. Remember compression forces are those forces acting horizontally towards each other. You can try to apply compression force on a flexible plastic ruler. What do you observe? You should have seen that the middle part bends upwards and the two outside ends bend downwards.

Thus, the rock layers that bend upwards form an **upfold** or **anticline**. Those layers that bend downwards form a **downfold** or **syncline**. The sides of a fold are called **limbs**. Initially we have horizontal layers of sedimentary rock which are then folded up to form the different parts as you can see on the diagram below.

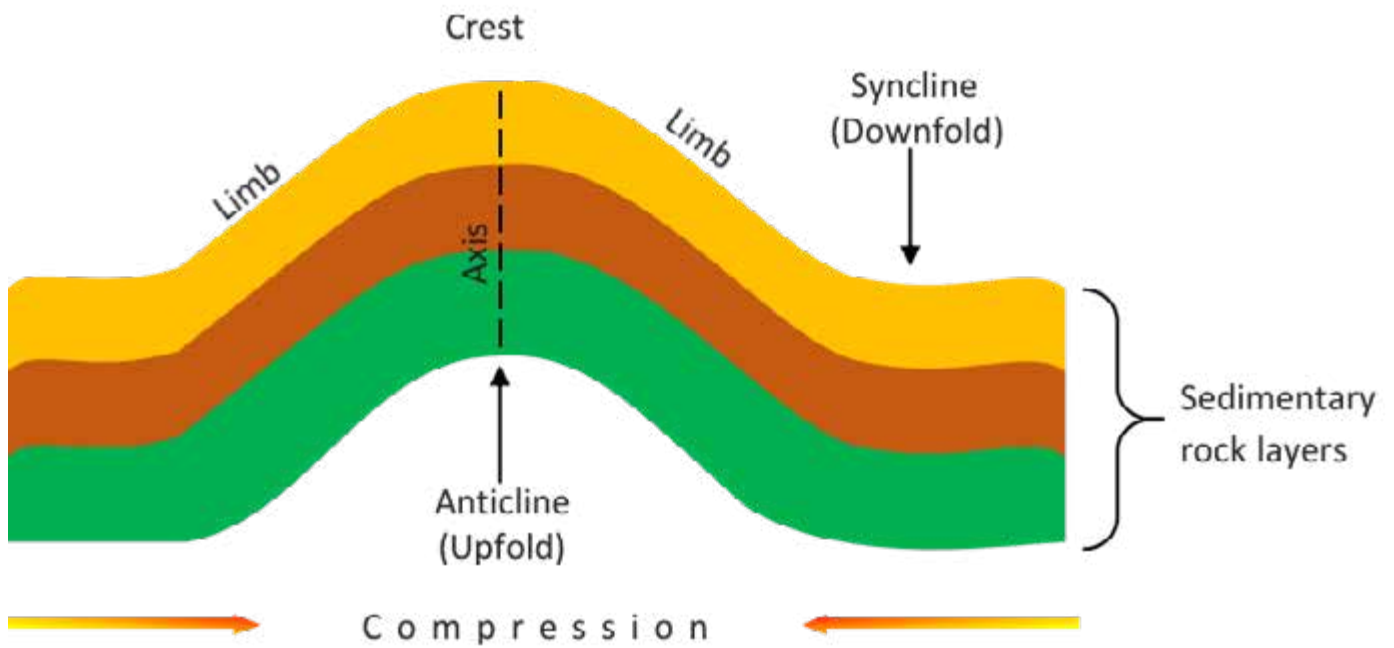


Figure 5.11 Parts of a fold

5.3.1.1 Types of folds

We are now going to take you through the different types of folds. It is important to note that the nature of folds depend on the amount of force applied and the amount of bending.

a) Simple fold

In a simple fold both limbs have the same steepness. This is because compression force being applied on both sides is relatively the same.

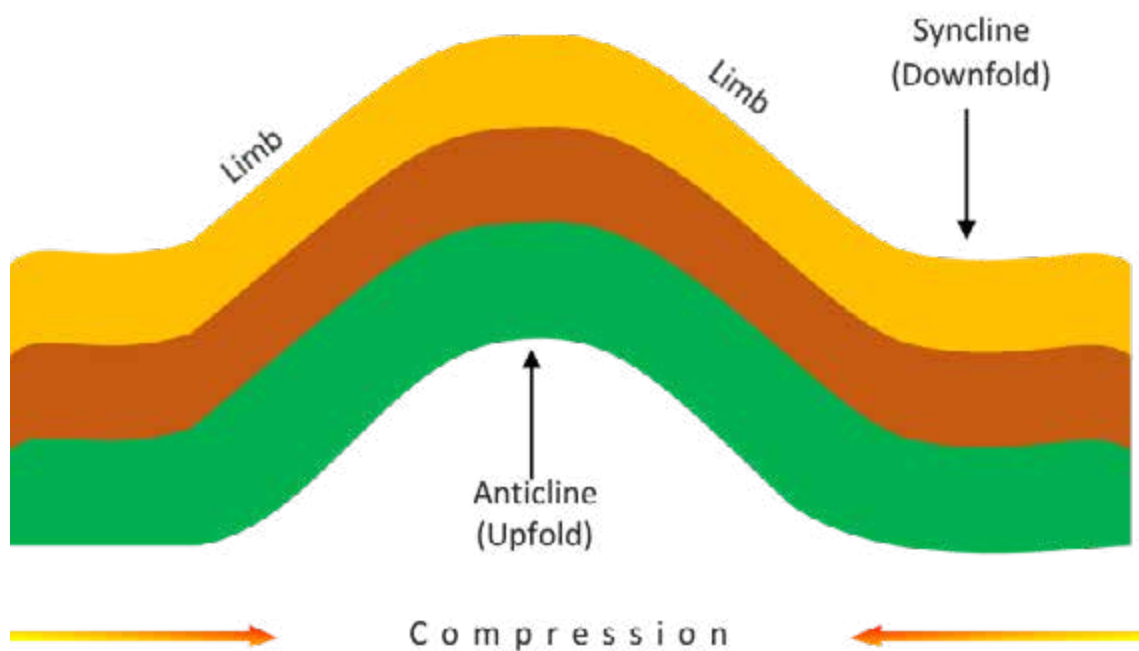


Figure 5.12 A simple fold

b) An asymmetrical fold

One limb is steeper than the other. Can you suggest the reason why this is so? I am sure you noted that it is because the forces of compression applied from the two sides are different.

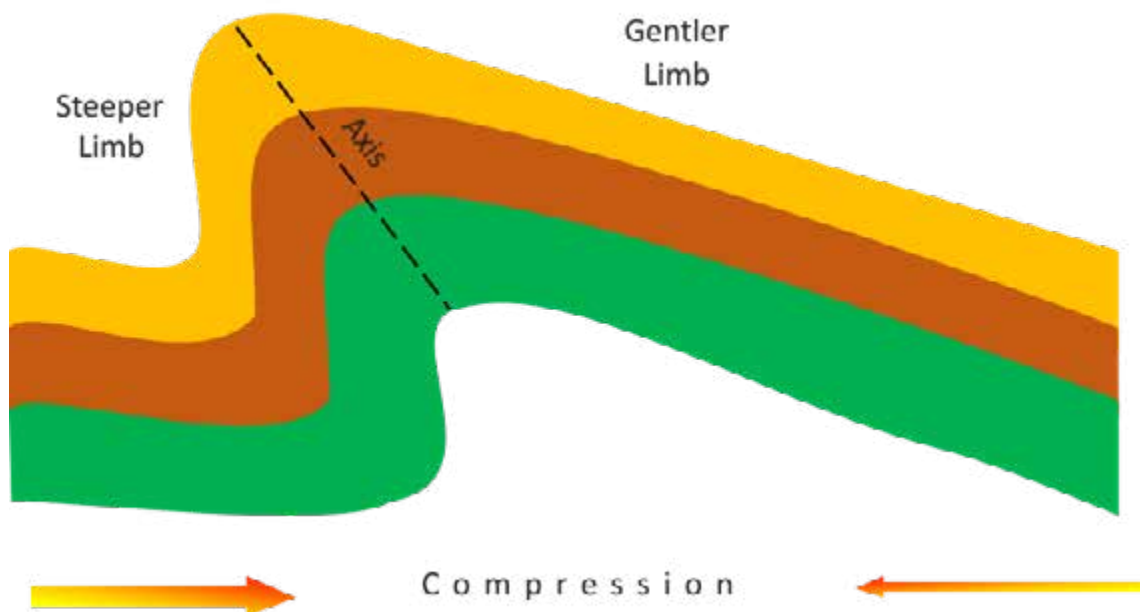


Figure 5.13 An asymmetrical fold

c) Overfold

An overfold forms if pressure continues and one limb is forced over the other. If compression forces continue to be applied on the overfold, one limb will thrust over the other resulting in a recumbent or overthrust feature.

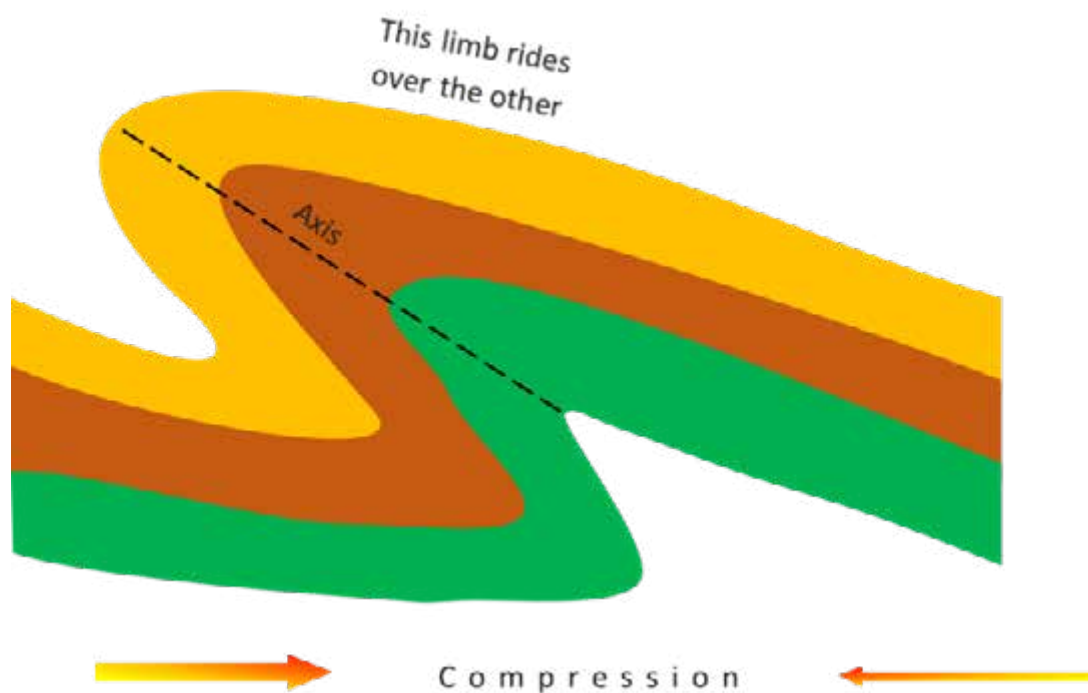


Figure 5.14 An Overfold

d) **Recumbent fold or overthrust fold**

This results from continued pressure which causes the rock layers to fracture and leave both limbs nearly horizontal.

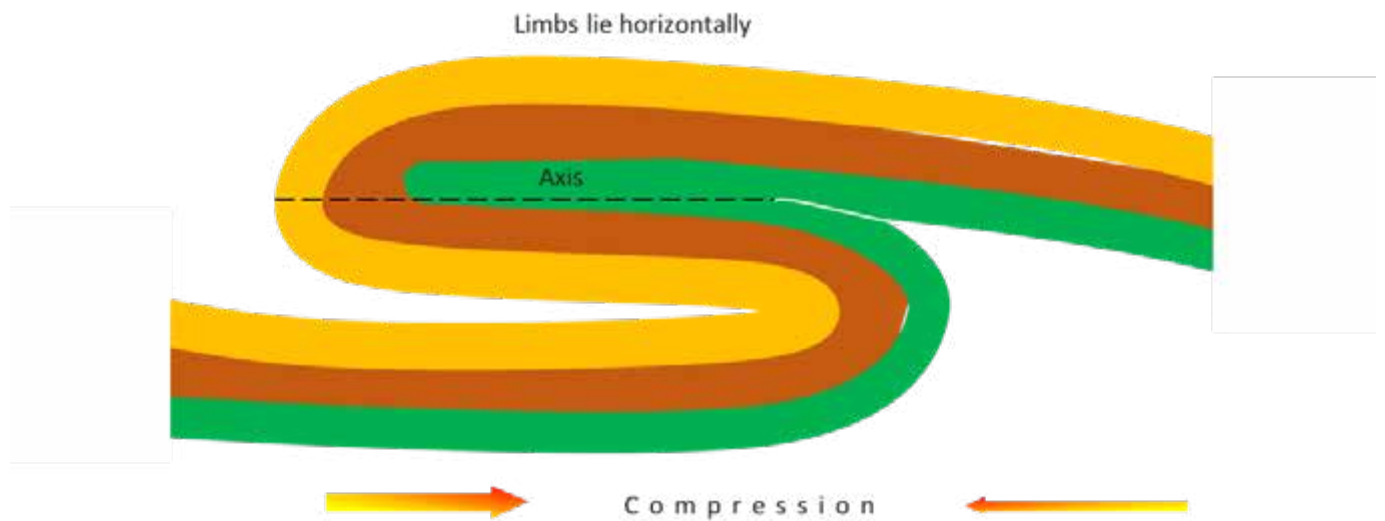


Figure 5.15 A Recumbent fold

e) **Nappe**

If the recumbent fold is displaced further, along a fault, a **nappe** is formed as you can see from the diagram above.

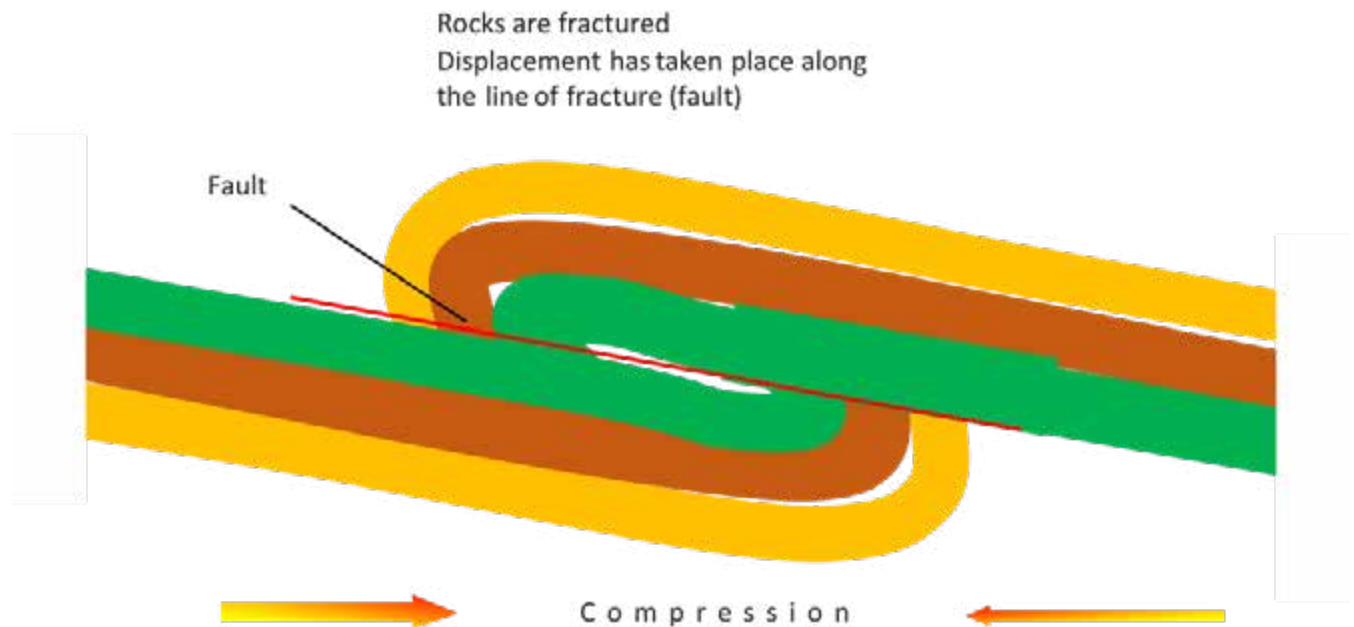


Figure 5.16 A Nappe

5.3.2 Landforms resulting from folding

The major landforms that result from folding are the fold mountains. You would realise that the process of formation of fold mountains occur in stages. The initial stage involves collision of plates which results in the formation of a trench. The trench becomes the site of a sea. Deposition of sediments will take place in the trench layer upon layer. Compression forces continue to force the tectonic plates closer together squeezing the sediments in between. As the continental plates continue to approach each other, the sedimentary rocks are folded up forming fold mountains.

It is important here to note that, as fold mountains develop, the weight of sediments cause faulting and volcanic eruptions occur forming volcanic features in association with fold mountains as illustrated in Figure 5.17.

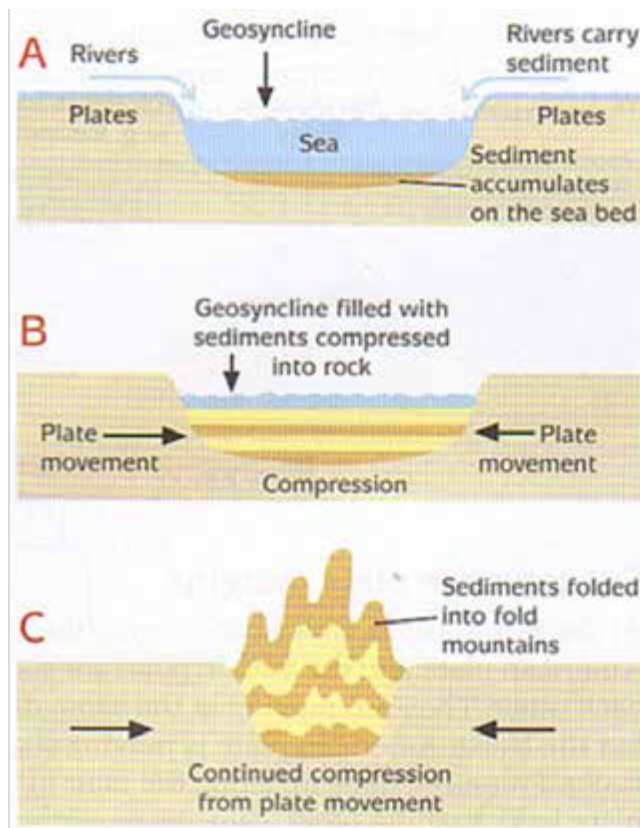


Figure 5.17 Development of fold mountains Stages A, B and C

5.3.3 Importance of fold mountains

You now have an idea of the processes that lead to the formation of fold mountains and their distribution. Let us now look at the importance of fold mountains and also problems associated with their existence.

- Some fold mountains may expose minerals such as oil, iron and limestone which benefit people.
- Snow covered slopes of fold mountains encourage sporting activities
- Relief rainfall is formed on windward slope of mountains and benefit people.

- Some fold mountains are so beautiful that they attract tourists and bring in foreign currency.
- Some fold mountains attract settlement as they are good for defence.

5.3.4 Problems of fold mountains

- Steep slopes hinder settlements
- Steep slopes lead to high rate of erosion
- High erosion causes shallow soils which makes it difficult to practise arable farming.
- Sometimes mountains block lines of communication such as roads and railway lines making construction of these very expensive.
- Rain shadow zones which are prone to drought may be created on the leeward side

5.4 Faulting and resultant landforms

In this section we want to look at another process related to folding. Faulting is the fracturing or breaking of rock layers in the crust due to internal forces of tension and compression which cause displacement of rocks.

Remember from your study of folding you learnt that compression forces push towards each other. On the other hand, tension forces pull apart. When either of these forces are applied, a **crack** develops. Such a crack is called a **joint** if there is no displacement of rocks. If there is displacement of rocks along the crack or fault line it is called a **fault**. Vertical displacement in a rock is called a **throw**. Refer to Figure 5:14.

5.4.1 Types of faults

You will note that there are three types of faults depending on the type of force applied.

Normal fault – results when forces of tension act upon a block of horizontally layered sedimentary rocks. The fault plane or scarp will become an escarpment. The escarpment is formed by vertical displacement as shown on Figure 5.18.

Reverse fault – forms when compression forces push inward the horizontal layers of sedimentary rocks. Compression force may cause the rock to fault (break) if the rock is brittle when put under stress

Tear fault – occurs when there are horizontal movements along a fault line which results in lateral displacement of rocks. Refer to Figure 5.18.

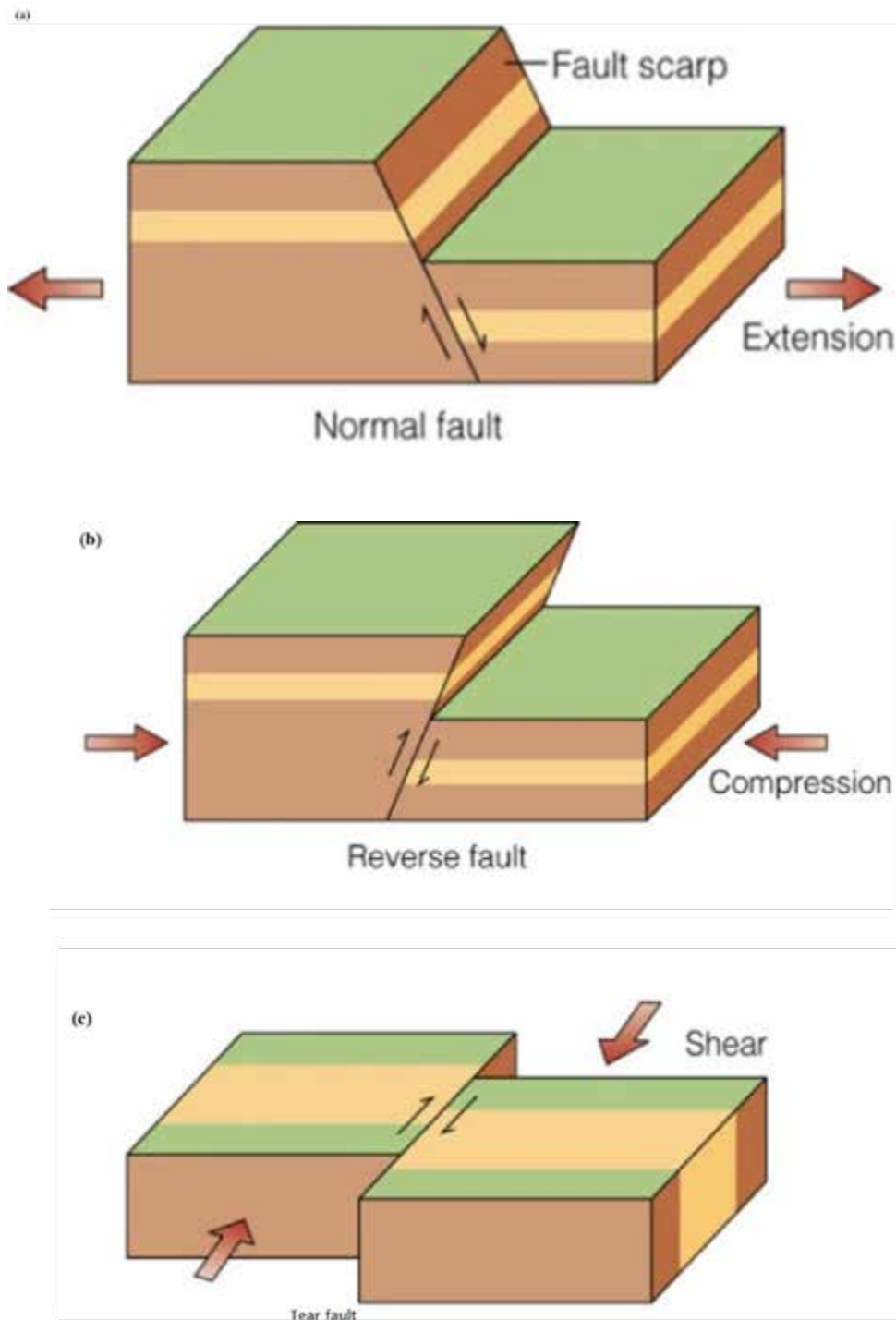


Figure 5.18 (a) normal fault (b) reverse fault (c) tear fault

5.4.2 Landforms resulting from faulting

You have so far learnt about the process of faulting. Let us now look at the major landforms that result from faulting.

Rift valley.

If tension force act upon a block and two fault lines develop, the middle block drops forming a rift valley. A good example which you might be familiar with now is the Great

East African Rift Valley which extends from Beira, Mozambique through Ethiopia into the Red Sea. Lake Tanganyika and Lake Malawi occur in this rift valley. The diagrams in Figure 5.15 illustrate the formation of a rift valley.

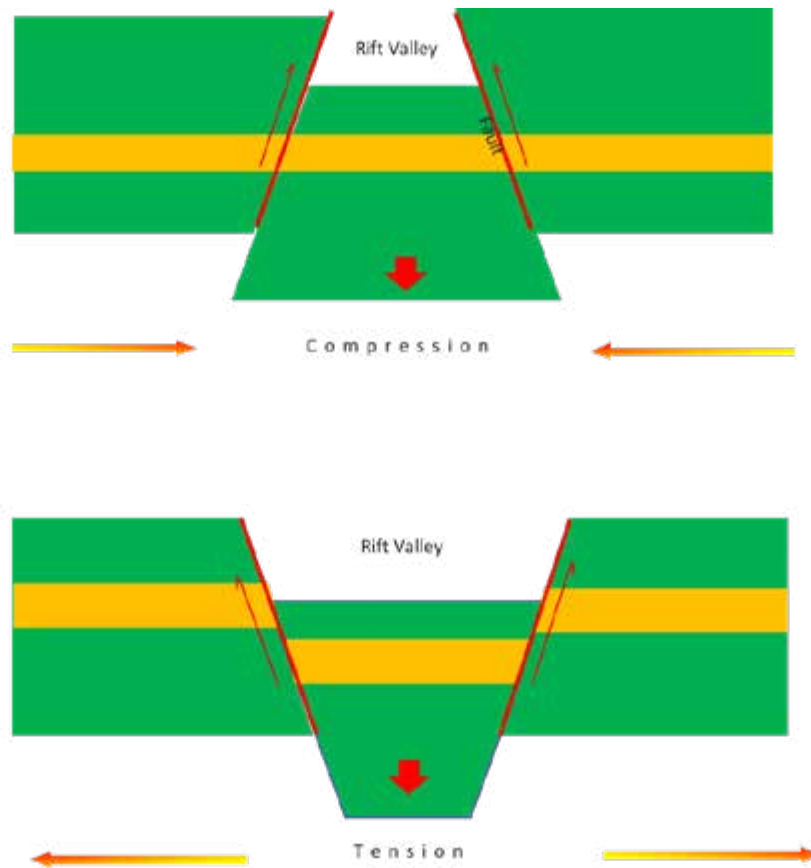


Figure 5.15 Formation of a rift valley (a) by compressional forces (b) by tensional forces

Block mountain

If compression force act upon a block and two fault lines develop, the fault-bordered block in the middle may be pushed up forming a horst or block mountain. An example of a block mountain is Ruwenzori Range. The diagrams in Figure 5.16 illustrate the formation of block mountains due to tensional forces.

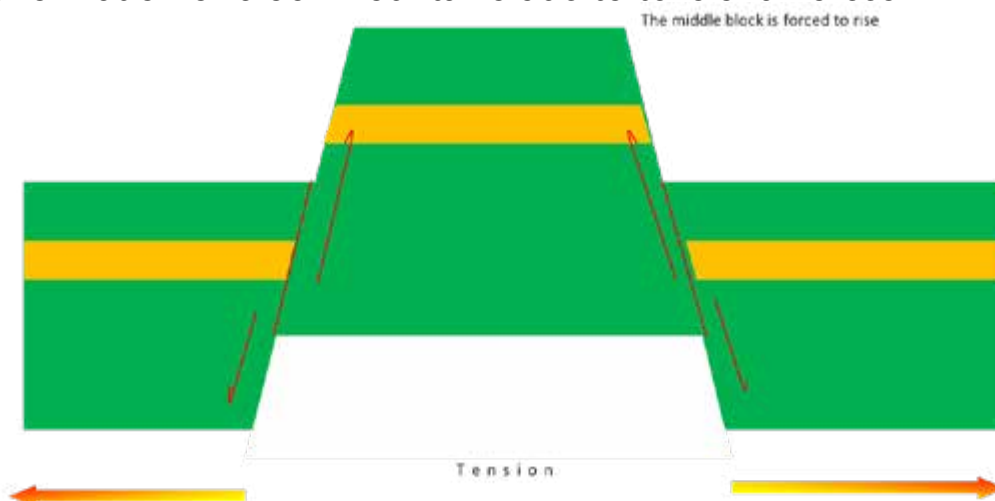


Figure 5.16. Formation of a block mountain

You must also note that sometimes faults occur in series and cause displacement of rocks upward or downward. The raised blocks become block mountains and the elongated fault-bordered depressions become the rift valleys. Thus, rift valleys occur in association with block mountains as shown on the Figure 5.17 below.

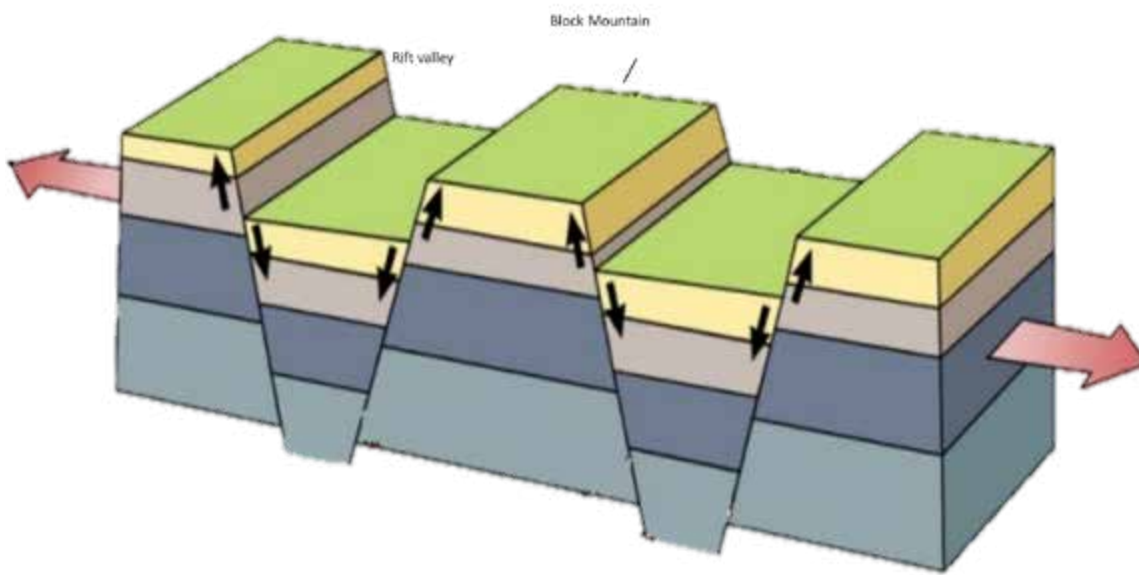


Figure 5.17 Faults and their associated landforms

Fault scarps

Fault scarp is another feature that results from faulting. A fault scarp is a steep slope created on the face of a block when displacement occurs along a fault line. A fault scarp is also called an escarpment. Figure 5.14b) above shows you this feature.

Plateaus

Plateaus are formed as a result of the earth's bending upward or downward. The uplifted parts become the plateaus and the depressed areas become the basins as shown on Figure 5.18 below.



Figure 5.18 Tectonic plateau and its accompanying basin

5.4.3 Importance of faulting

Like any other tectonic processes, faulting pose both benefits and problems to people. Let us now look at the benefits.

- Block mountains leads to formation of relief rainfall on the windward side which benefit farmers
- Springs that occur at the foot of the fault scarps attract settlements.
- Faulting leads to development of beautiful landforms such as rift valleys, escarpments and block mountains which attract tourists.
- Faulting leads to formation of rift valleys which become sites for lakes such as Lake Tanganyika and Lake Malawi. Do you still remember in which rift valley these two are located?
- Lakes can become important fishing grounds
- Faulting may cause displacement of rocks which may expose minerals.
- Faulting creates deep cracks which may create passages for steam jets from underground which can be exploited for geothermal power.

5.4.4 Negative effects of faulting

- When faulting occurs, deep cracks formed may hinder development of transport routes.
- Displacement of rocks by faulting creates steep scarp slopes and deep valleys which makes it difficult to build settlements and grow crops
- Steep slopes make it difficult to construct roads, railways and pipe and power lines.

- Deep narrow valleys created by faults are often dry and create natural droughts.
- Faulting cause crustal instability which leads to occurrence of earthquakes and volcanoes which are more hazardous to human life.



Activity 5.4 Folding and faulting

1. Define the following terms

- folding

- faulting

2. State any **two** types of folds and draw diagrams to illustrate each of these types.

3. Draw a well-labelled diagram to show all the parts of a fault.

4. Outline the benefits and problems associated with faulting.

5.5 Volcanoes and earthquakes

You might agree with me that the two processes of volcanic activity and earthquakes have been a nightmare in the history of mankind. So many cities have been destroyed and people lost their lives due to volcanoes and earthquakes. You might have heard of or experienced any of these phenomena in your life. How do you feel about volcanoes or earthquakes? Some people have attributed this to misfortunes as a result of anger of their gods. Scientist, on the other hand, explain volcanoes and earthquakes as resulting from processes that occur in the earth's interior. In this unit, we are going to discuss the causes of volcanoes and earthquakes and their effects on both the physical and human environment. We are also going to outline the distribution of these on a global scale.

5.5.1 Volcanoes

Volcanoes are landforms that result from volcanic activity. Volcanic activity involves all the processes by which magma is forced into the crust and on to the surface.

Magma is the molten rock and other materials formed underground in the mantle. When magma is ejected from the mantle and it solidifies in the underlying rock, it forms a variety of features known as **intrusive** volcanoes. Some magma erupts onto the surface as **lava** and results in the formation of **extrusive** volcanic features. Lava is the name given to magma when it reaches the ground surface.

Let us now look at the intrusive volcanic features. We are going to summarise these features on the Figure 5.19 below.

5.5.1.1 Intrusive volcanic features

As we have explained to you earlier on, intrusive features are formed when hot molten magma penetrates into the bedding planes between the horizontal layers of sedimentary rocks, cools and solidifies before reaching the surface. The main features are the batholiths, sill, dyke, laccolith and lopolith.

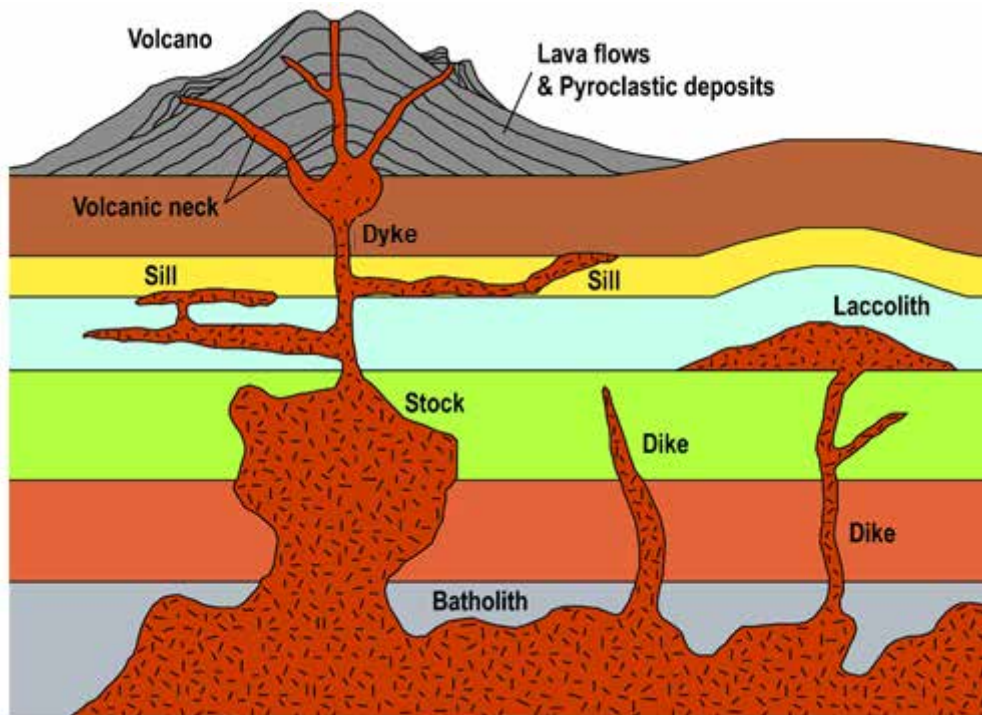


Figure 5.19 Intrusive volcanic features

In this section we shall describe the characteristics of each feature.

Batholith

As you can see from the diagram, a batholith is a deep-seated, dome-shaped large mass of granite rock which solidified underground. This feature can only be exposed onto the surface by the process of erosion. When exposed on to the surface it forms a feature known as **ruware/ idwala or bonhardt**.

Sill

This feature forms when magma squeezes itself horizontally into the bedding planes of sedimentary rocks in the crust. When the surface is eroded, they are exposed as escarpments and sometimes they become sites of a waterfall. Sills are resistant to erosion and can form caps on top of hills or mountain ranges protecting them from erosion. For example, the Three Sisters in South Africa's Cape Province and the Nyanga Dolerite Sill in Zimbabwe.

Lopolith

This is a saucer-shaped feature formed when magma penetrated horizontally into the bedding planes of sedimentary rock. Initially the feature is like a sill and as it cools and solidifies, some magma subsides back into the magma chamber leaving a depression in the middle and saucer-like feature. Upon exposure onto the surface, lopoliths form mountain ranges.

Laccolith

A laccolith is an arch-like igneous intrusion formed when magma cools and solidifies along the bedding planes of sedimentary strata (layers). Magma is released from a pipe-like feeder coming from the magma chamber deep down. As it pours out it forces igneous rock layers to curve up forming an arch-like shape.

Dyke

Dykes are igneous intrusions that form when magma cuts across the horizontal layers of sedimentary rocks and solidified. They can be vertical or inclined. A good example is the one that you might be familiar with, the Great Dyke of Zimbabwe which stretches from Mvurwi in the North East to Zvishavane in the South East.

5.5.1.2 Extrusive volcanic features

You have learnt about the different volcanic landforms that are formed within the crust. Now we will take you through the extrusive features. As we mentioned earlier on, extrusive features are those that were formed when magma and other materials (gases and solids) erupted as lava onto the surface. You will notice that the extrusive volcanic activity has a direct effect on the physical and human environment. Apart from the different types of volcanoes, other major features that we are going to discuss here include the lava plateau, craters, calderas, geysers, and hot springs.

5.5.1.3 Types of volcanoes

In this section we will look at the different types of volcanoes paying more attention to how each of the features were formed. You should try to draw each of the given diagrams on your own in order to increase your understanding of the concepts.

Ash and cinder cone.

An ash and cinder cone is formed when lava is violently ejected through a crater to great heights and it breaks up into smaller fragments. The violent eruption is as a result of high temperatures and pressure deep down. These small rock fragments (cinder) will fall back to the ground and build up a cone. The cone is tall, steep-sided and has a narrow base and is made up of alternating layers of ash and cinder. An example is the Jos Plateau and Likaiyu in Kenya. To understand this better, study Figure 5.20.

Lava cone

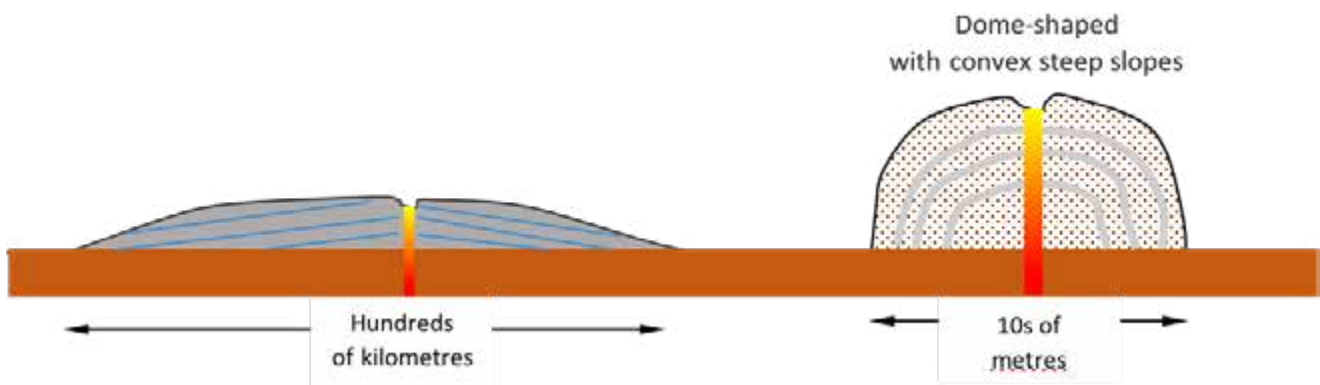
Lava cones can be classified into two depending on the nature of material, that is, whether the material is fluid or viscous. Now let's look at these two types of lava cone namely basic and acid lava cones.

a) Basic lava cone or shield volcano

Basic lava cone is formed by highly fluid lava which is highly mobile. This means that it flows over long distances. The eruption of fluid lava is normally quiet or less violent but with very hot lava flows. As a result of the nature of material, they produce gently sloping cones as shown on Fig 5.17a) below. An example is Nyamulagira near Lake Kivu in Democratic Republic of Congo (DRC).

b) Acid lava cone

When lava is said to be viscous, it is thick and less mobile. As a result, viscous lava when forced out through a vent, it flows slowly over short distances and quickly solidifies producing a steep-sided dome-shaped cone. Sometimes they form a plug dome that may completely block the vent. Good examples are the Hoggar Mountains in Algeria. Figure 5.17b) below will help you to understand this type of cone.



5.21 a) Basic lava cone b) Acid lava cone

Composite cone

This is the most magnificent and beautiful of them all. It is formed from alternating layers of ash and lava. A violent eruption begins at a central vent forming a layer of ash. As the eruption ceases, lava pours out forming a layer on top of ash. The cycle continues and the cone continues to build into a very big feature. Some lava escapes from the sides of the cone where it builds up small conelets as you can see from Figure 5.18 below.

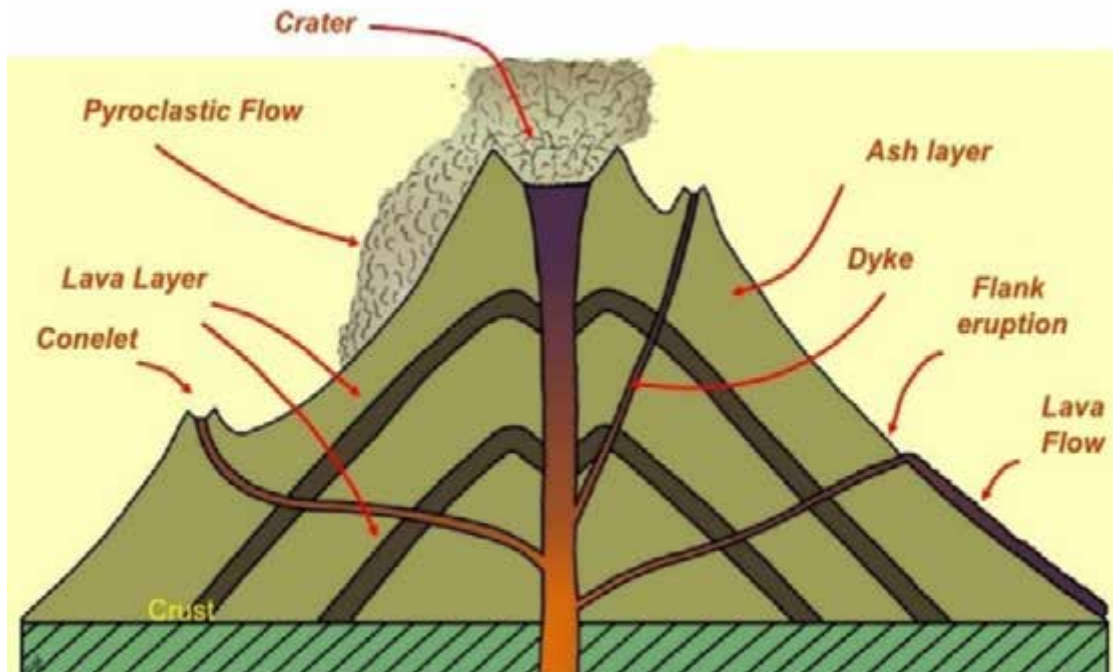


Figure 5.22 A composite volcano

Caldera

A caldera is a very large crater about 2 kilometres in diameter and 100 metres deep and sometimes contain lakes. Let us look at the two ways by which this landform can be formed:

a) By eruption

When a composite volcano explodes violently, it blows off and disintegrates its top into ashes leaving the crater greatly enlarged. This enlarged crater or depression is the one called a caldera.

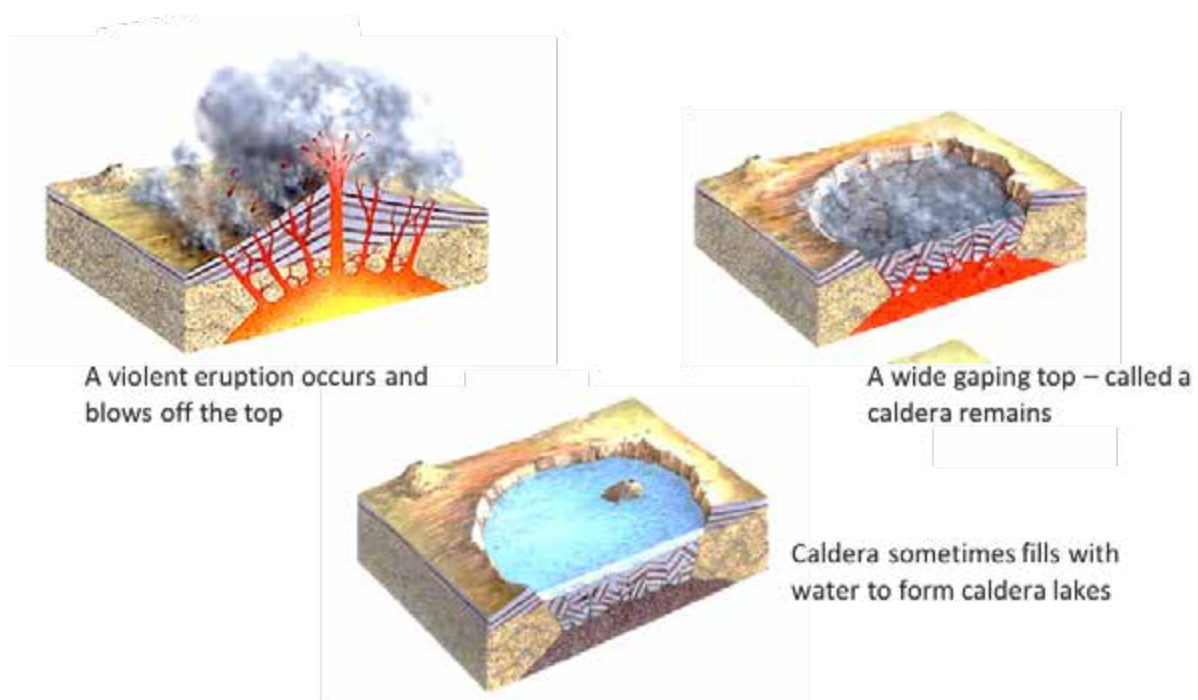


Figure 5.23 Formation of a caldera by eruption of the crater

b) By subsidence

A caldera may also form through subsidence. Thus, after a major eruption, there is depletion of magma in the magma chamber below. As a result, a huge chasm is formed beneath the volcano. The weight of the cone above will cause some faults to develop. Do you still remember what faults are? If you have forgotten, please go back to your topic on faulting. With time the weight of the cone will cause the whole cone to collapse into the chasm beneath leaving a large depression called a caldera.

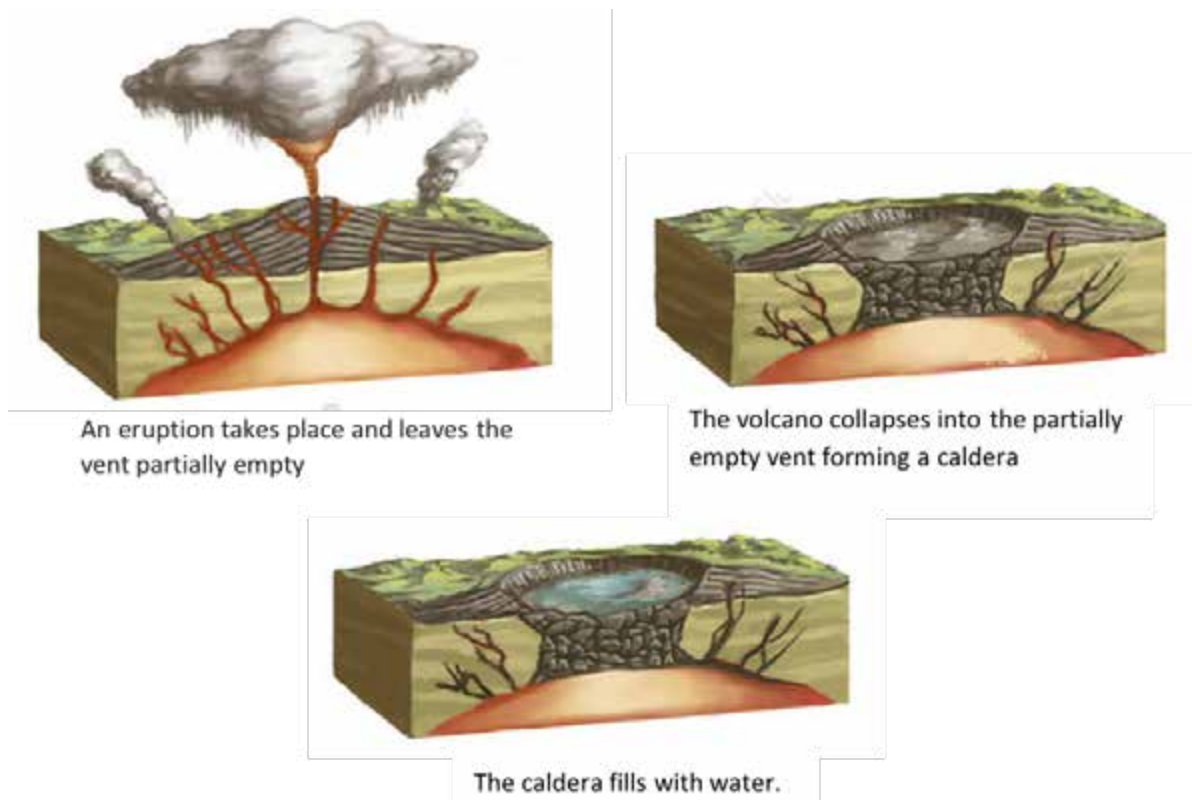


Figure 5.24 Formation of a caldera by subsidence

Lava plateaus

Lava plateaus form when lava reaches the surface through an elongated fault line called a fissure. The lava spreads over the surface and builds up a platform called a lava plateau. An example is Haruj el Aswad of Central Libya.

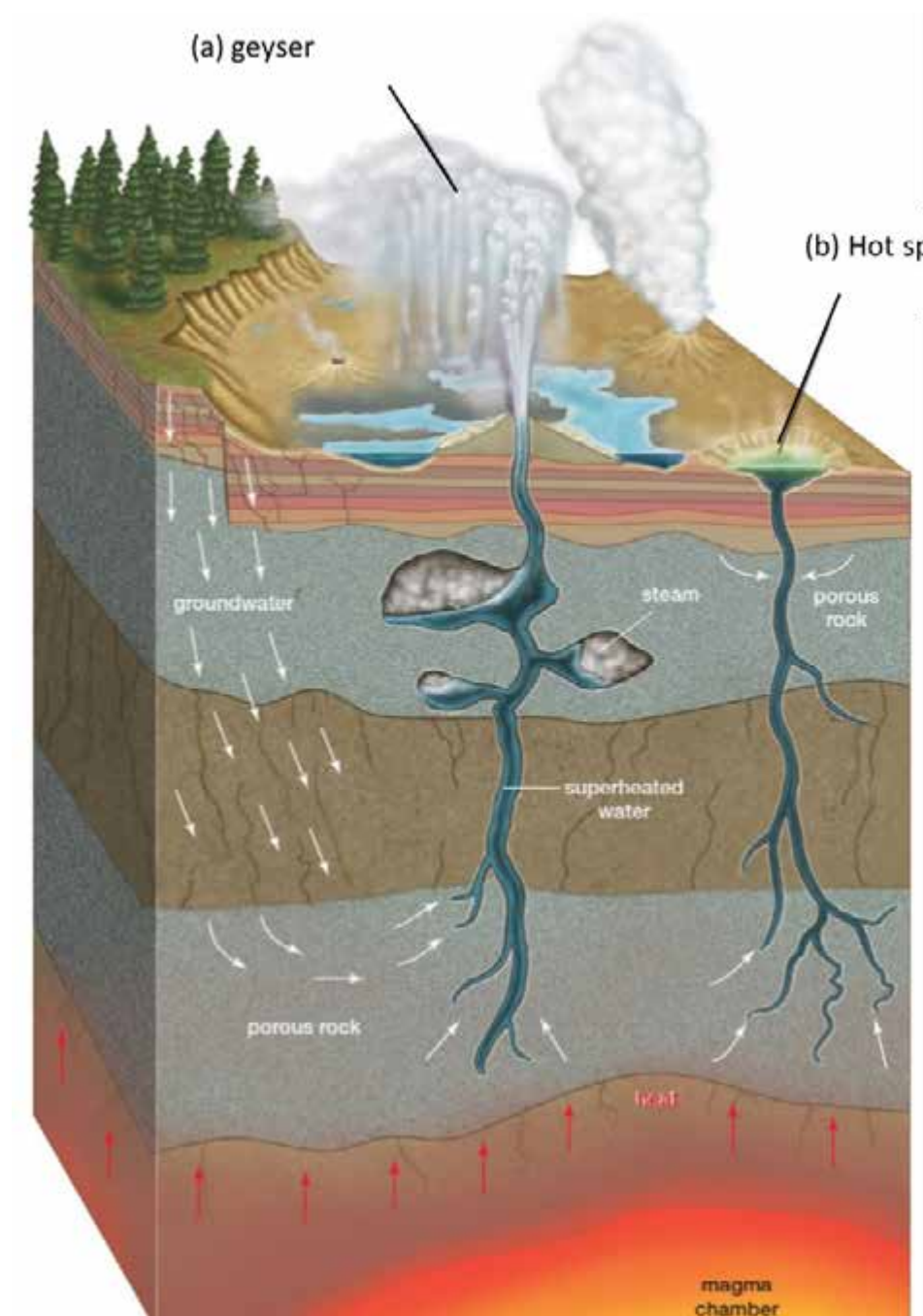
Hot springs

Hot springs are also volcanic features. We are sure you are familiar with these features since we have some in Zimbabwe. Have you ever heard about the Nyanyadzi Hot Springs? Hot springs are streams of water flowing from underground. Remember you learnt that deep down in the crust the rocks are very hot because they are closer to the hot molten magma. If underground water gets in contact with these rocks, it is heated and it bubbles out to the surface quietly through rock cracks as a hot spring.

Geysers

It is important for you to note that geysers are formed in almost the same way as hot springs. However, with geysers, the temperatures of underground rocks are too high that water in contact with the rocks boils and converts into steam. The steam escapes onto the surface with great pressure at regular intervals acquiring the colour of materials dissolved in the boiling water.

Figure 5.25 (a) geysers (b) hot spring





Activity 5.5 Volcanic activities

1. Define the following terms as they are used in the study of volcanoes and earthquakes

a) magma

b) lava

2. Describe any two intrusive volcanic features.

3. With the aid of well- labelled diagrams, explain the formation of a caldera.

5.5.3 Earthquakes

Another tectonic process that we will introduce to you is the earthquake. An earthquake is the sudden shaking or vibrating of the earth's crust resulting from crustal instability. Here are some of the causes of earthquakes.

5.5.3.1 Causes of earthquakes

- Tectonic movements - This is when plates move or slide past each other causing shock waves which cause earth tremors.
- Volcanic eruptions - the movement of molten rock beneath or onto the surface also cause shaking of the surrounding rocks resulting in earth tremors.
- Folding and faulting- the displacement of rocks due to faulting also cause earth tremors.
- Enormous or large water bodies such as lakes and dams exert pressure on the crustal rocks causing them to shake. Can you quickly think of examples of such lakes or dams that you know? Examples include Lake Kariba, Lake Tanganyika and Cabora Bassa.

5.5.3.2 Origin and nature of earthquakes

The point at which an earthquake originates underground is called the **focus**. This may be several kilometres below the ground surface. The point on the earth's surface directly above the focus is called an **epicentre**. This is where the **shock waves** first hit the surface. The shock waves are the ones that give rise to an earthquake.

5.5.3.3 Types of shock waves.

Let us now look at the types of shock waves that cause the tremors. These can either be body waves or surface waves:

a) **Body waves**

Body waves travel through the crust. They can either be **primary** or **secondary** waves. Primary waves cause the crustal rocks to move back and forth in the direction of wave movement whereas secondary waves cause crustal rocks to move sideways at right angles to the direction of wave movement.

b) **Surface waves**

They travel through the surface rocks. They are of two types, **love (L)** waves and **Rayleigh (R)** waves. Love waves cause surface rocks to move sideways at right angles to the direction of wave movement. Rayleigh waves cause surface rocks to move in a circular manner like sea waves. Figure 5.12 shows the focus, the epicentre and the paths followed by the different types of waves.

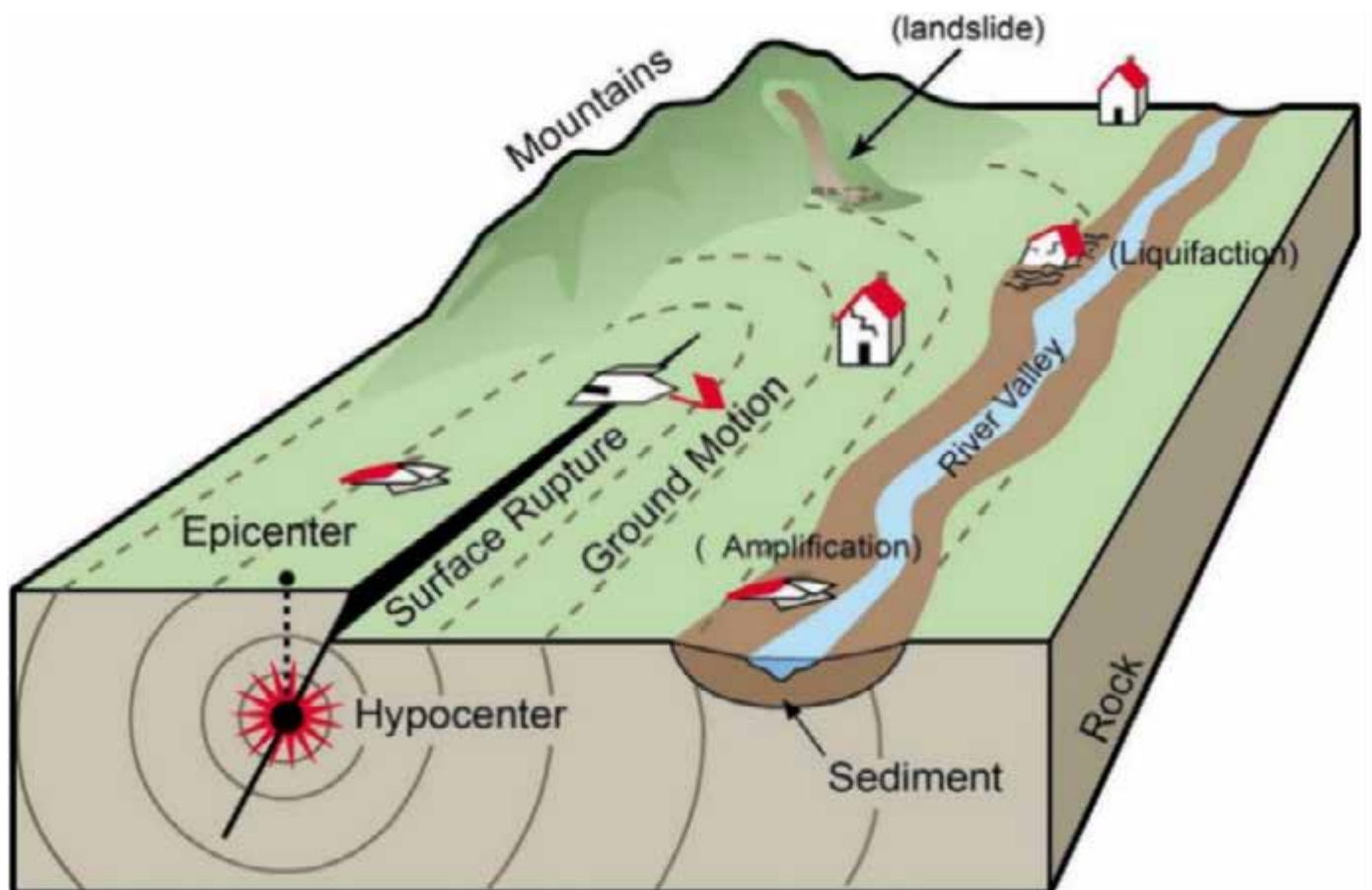


Figure 5.26 The nature of an earthquake

You should note that it is these waves that cause vibrations. The surface waves produce the most damage to buildings and human life that occurs in an earthquake. Earthquakes differ in terms of their **magnitude** and **intensity**. Magnitude of an earthquake is the total amount of energy released. Magnitude is measured by an instrument called the **Richter Scale**. Intensity of an earthquake refers to the effect produced by an earthquake and it is measured by an instrument called a **seismograph**. You must however not confuse magnitude with intensity.



Activity 5.6 Earthquakes

1. Define the following terms
 - a) focus of the earthquake
 - b) epicentre of the earthquake
2. Draw a well labelled diagram to illustrate the characteristics of an earthquake.
3. Describe surface waves and body waves of an earthquake.

5.5.4 Distribution of volcanoes and earthquakes

Having discussed the various causes of volcanoes and their types, as well as the origin and nature of earthquakes, let's now illustrate and explain the distribution of volcanoes and earthquakes. First and foremost, let us look at the distribution of volcanoes.

In Zimbabwe, there are volcanic features which resulted from intrusive volcanic activities. The features were formed underground and were exposed to the surface after a long period of denudation. Most of these features are made of granite rocks that make the Great Dyke in Central Zimbabwe, the Flood Basalts and granite sills in the Eastern Highlands and other several lava plateaus around the country.

Around the world, volcanoes occur along the mid – oceanic ridges such as the Mid – Atlantic Ridge and Mid – Indian Ocean Ridge. They also occur along rift valleys such as the Great East African Rift Valley in Africa which resulted in such features as Mt Kilimanjaro, Mt Kenya, Mt Nyamulagira and Mt Meru.

As you can see on the map on Figure 5. 27, volcanoes also occur along convergent zones along plate boundaries. Can you explain why this is so?

Where do earthquakes occur?

Earthquakes occur so often but most of them go without being noticed either because they are too small or too far. From the causes of earthquakes that we discussed in the previous session, where do you think most earthquakes occur?

You will realise that most earthquakes are as a result of tectonic processes and as such most of them occur:

- Along plate boundaries where plates converge or diverge due to forces of compression or tension which results in crustal instability such as the West Indies and the Great East African Rift Valley
- Along mid-oceanic ridges where oceanic plates diverge creating a fissure through which new material finds its way to the surface. The movement of the material

may be so violent that it causes the earth to shake. Most recently recorded earthquakes are concentrated along the margins of the Pacific Ocean.

- Along volcanic islands.
- At a local level, earthquakes have been experienced around large water bodies such as Lake Kariba because of the weight of water exerted on the crust.
- Where large –scale mining operations take place and around construction sites minor earth tremors can occur due to rock blasting.

From your map on Figure 5.27, you will also realise that world's major active volcanoes and earthquakes occur along regions of crustal instability such as plate boundaries, fold mountains, oceanic trenches and mid- oceanic ridges.



Figure 5.27 Distribution of volcanoes and earthquakes in the world

Summary

In this unit, you learnt about the origin of continents through the continental drift theory. This topic introduced you into plate tectonics which cause tectonic processes such as folding and faulting. You also went on to describe the various landforms that result from folding and faulting. The unit also touched on the causes and formation of different types of volcanoes and the nature of earthquakes. We hope you benefited a lot from this unit and you are ready to learn about the effects of such processes on human activities and on the physical environment.

End of Unit Assessment

1. Which of the following landforms is a result of collision of two oceanic plates?
 - A. an island arc
 - B. a rift valley
 - C. fold mountains
 - D. an oceanic ridge
2. Which of the following is not a result of faulting?
 - A. a block mountain
 - B. an oceanic trench
 - C. an escarpment
 - D. a rift valley
3. The following are direct causes of earthquakes except
 - A. volcanic eruption
 - B. tectonic movements
 - C. large water bodies
 - D. extreme temperatures
4. What feature is formed at a divergent plate boundary?
 - A. oceanic ridge
 - B. block mountain
 - C. deep sea trench
 - D. island arc
5. The following are features of an earthquake except
 - A. epicentre
 - B. focus
 - C. surface waves
 - D. tension forces

6. a) Using information on the map in Figure 5.27, describe and explain the distribution of volcanoes and earthquakes. (7)
- b) Explain how a composite volcano was formed. (5)
7. Outline the benefits and problems posed by folding. (7)

Research Work

Visit the local council and find out how your local community is benefiting from the landforms in your area. Compile a list of such landforms in terms of:

- a) a) name of landform
 b) b) benefits of each landform
 c) c) problems posed by each landform.



Progress Check list

Now that you have come to the end of the unit, you should now go through the objectives we listed at the beginning of the unit and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet been achieved. Then for any that you put an X against, find the section dealing with it in the unit and go over it again.

Objective Are you now able to...	Check Box
• outline the continental drift theory	
• describe tectonic movements	
• explain implications of plate tectonics on climate	
• describe processes of folding and faulting	
• describe resultant landforms	
• outline the distribution of volcanoes and earthquakes	
• explain the causes of volcanoes and earthquakes	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 6: Landforms resulting from water action and river processes

- 6.1 Seasonal nature of rivers in Zimbabwe
- 6.2 Processes operating along a river channel
- 6.3 Landforms resulting from river processes

Introduction

Have you ever seen a river flowing? Well as it flows there are so many processes that will be going on. Some which can not be seen by our own eyes. In the previous unit you learnt about Tectonic plates and their effects, plate boundaries and how these landforms formed. In this Unit, however you are going to learn about landforms that result from water action and river processes. This Unit will help you understand how various landforms form through water action and the processes that take place in a river channel



Objectives

After going through this unit, you should be able to:

- describe the nature of seasonal water flow in rivers
- explain the river processes in shaping the landscape
- describe landforms resulting from river processes



Key Words

- | | |
|------------------------------|--|
| • Landforms | these are land features that are formed on the earth's surface due to different processes. |
| • River Processes | these are occurrences that take place in a river. |
| • Seasonal water flow | means the flow of water in rivers basing on seasons e.g. winter and summer. |



Time

You are expected to take an average of **10** hours to go through this unit. Make sure that you read each topic at times suitable to you.



Study skills

In this unit you will be learning about landforms. You will have to use your imagination and or previous experience in relation to landforms that you have seen or that you know.

6.1 Seasonal nature of rivers in Zimbabwe

Do you know that Zimbabwe has a lot of water attractions? It has many rivers and some flow all year round while others flow seasonally. Some rivers flow in summer as soon as the rains begin to fall, while others flow all year round. Rivers which flow all year round are called perennial rivers. Those that flow seasonally or for a short period of time are referred to as seasonal or intermittent rivers. Examples of major rivers found in Zimbabwe are Save, Mutirikwi, Runde, Munyati, Gwaai and Sanyati to mention just a few. The Highveld of the Zimbabwe is known as the watershed of the country. Water flows in three different directions in this region to the north west, south east and north east. The Save, Mutirikwi and Runde flow to the south east. The likes of Sanyati, Munyati flow north–west. North- east rivers flow into the Zambezi rivers while south east and south rivers flow into the Limpopo. In Zimbabwe the water volumes increase in summer and decreases during winter. Why do you think this happens? There are some factors that affect the seasonal variation of rivers. These include droughts, vegetation cover, the terrain of an area and rock permeability.

Droughts

Have you ever seen a drought-stricken area? This is when an area receives lower rainfall than anticipated. When this happens, it results in shortage of surface and underground water. When drought occurs, it affects the growth and yields of crops due to shortage of water. In turn, this causes starvation and loss of livestock.

Vegetation cover

Did you know that loss of vegetation cover results in shortage of water? Deforestation causes the ground to be bare and unable to hold rain water. The bare soil alone cannot hold water for without the aid of vegetation cover which binds and holds soils together. Eroded material and soil will be washed away into rivers resulting in siltation of rivers. You should note that this means that heaps of soil will be piled up in the rivers causing the base of the river to rise and therefore affects the seasonal flow of rivers.

The terrain of an area

This means the steepness or gentleness of a slope. Rivers flow in terrains that are mainly gentle and easy to erode. Steep slopes are not mainly favourable for the smooth flow of rivers.

Rock permeability

This is the hardness or softness of rocks. Rock permeability has to do with the rock composition and formation. This causes the rock to be hard or soft. There is less run-off when rocks are permeable. There would be more of infiltration as the water will seep into the ground.



Activity 6.1 Seasonal nature of rivers in Zimbabwe

Describe the season nature of rivers in Zimbabwe?

1. Find out the meaning of the following terms:

- (a) Perennial river
- (b) Intermittent river
- (c) Seasonal river

6.2 Processes operating along a river channel

You should know that there are various processes that operate along a river channel. Processes operating along a river channel are also the same with those that operate along the stream. In this case we are going to focus on the river processes shaping the river channel.

6.2.1 River Transportation

Note that river transportation is the process where the river moves its materials from one place to another. Did you know that rivers transport their load in four main ways? We are going to describe the four main types of river load

These four ways are:

1. Solution (solution/dissolved load)
2. Suspension (suspended load)
3. Saltation (saltation load)
4. Traction (bed load)

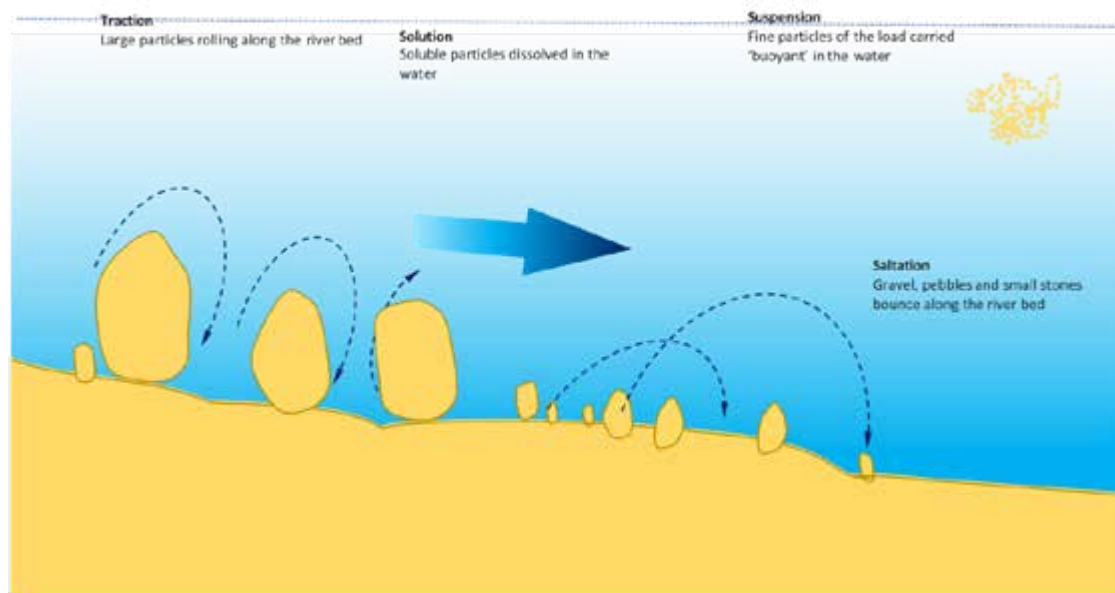


Figure 6.1 River transportation processes

From figure 6.1 you should be able to tell the amount and type of load carried by the river along the river channel. The amount and type of load carried by the river varies due to:

1. Season (flood time, dry season, mass movement)
2. Type of rocks (which give result to the dissolved loose materials of various sizes)
3. Bare or vegetated surface
4. Human activities such as farming, gold panning, mining, pollution and dumping waste material along the river channel

6.2.2 River erosion

Do you know what erosion is? This is the process by which a river removes materials on the river bed or river bank when it is flowing. The energy of the flowing river washes away some soil and rock particles. This removal of materials usually takes place when streams are flowing fast and the sediments on the river channel are eroded due the frictional force of running water. Take a container of water and pour it on a steep surface. What do you see? Certainly, you will see flowing water turned to the colour of soil. This shows that the water has carried some soil particles. If you continue doing that, you will observe that, tiny channels will form as evidence of soil being washed away and that is erosion.

Let us continue our discussion on erosion by looking at the types of erosion occurring in a river:

- **Head ward erosion which occurs in the upper course**

The upper course of the river is the area near its source. Mainly the type of erosion which occurs is called head ward erosion. Head ward in the sense that the river velocity would be high enough to erode and at the source and lengthens the river.

- **Vertical erosion which occurs in the upper course**

This involves the fast flowing of water as it deepens the channel of the river. The permeability of the rocks in the upper course are not uniform thus resulting in formation of river features like waterfalls.

- **Lateral erosion which occurs in the middle and lower course.**

This happens in the middle and lower course of the river as the river would have lost its velocity. Erosion is quite less but there is more of deposition in the lower course of the river than erosion. Lateral erosion is the wearing away of material on the river banks. Lateral erosion widens the channel.

These directions are done through the following processes

- **hydraulic action**- this is the sheer force of the moving water which separates loose and solid rocks particles from the channel bed and banks
- **abrasion or corrosion**- this process occurs when the rivers load rubs against the river bank as it is being transported along the river bed
- **potholing**-this is a result from the abrasion process we discussed above. Potholes are round holes drilled into riverbed by pebbles and stones due to the swirling of water associated with the turbulent flow (to be discussed later)
- **corrosion or solution** – this is when river water dissolves the rock particles in the river channel through chemical weathering processes such as solution and hydrolysis
- **attrition**-this is when the solid materials carried by the river hit against each other or rub against each other and break into smaller particles.

The breaking material causes erosion when it hits against the banks and river bed, thereby tearing off other material while breaking into pieces.

6.2.3 River deposition

Deposition occurs when there is a reduction in river velocity or when river does not have enough strength to transport its material. As a result, the river drops whatever sediments or eroded materials it would be carrying. Deposition occurs in any of the following places along the course of the river:

Channel bed: The other name for channel bed is the river bed. Did you know that as the river loses its velocity it deposits its material on the river bed? Heavy materials like boulders are deposited first and lastly fine silt as it reaches the mouth of the river.

The river valley flow during floods: A river valley flow during floods has high velocity as the water will be rushing downstream. Materials are eroded and are carried downstream until the river loses its velocity. There is more of erosion and transportation than deposition.

The banks of a river: The river banks are the areas which the water is in contact with when it is in flood. After a flood there is deposited material which is called alluvium which is left on the bank of the river. It is a composition of silt, clay and sandy soils.

The soils are quite favourable for agricultural activities as they are fertile. Figure 6.2 below shows deposition on the banks of a river.



Figure 6.2 The banks of a river

The river mouth: What came into your mind when you read the term “the river mouth”? Well this is where the river meets the sea or ocean. The area is called the river mouth. Deposition takes place as the river loses its velocity and this results in the formation of deltas. The material that the river deposits blocks the channel smooth flow and this results in the channel breaking into several channels which are known as distributaries. The more the river deposits material, the more the distributaries are formed. There are various types of deltas which include arcuate, cuspate delta, estuarine and birds foot. Figure 6.3 shows types of deltas.

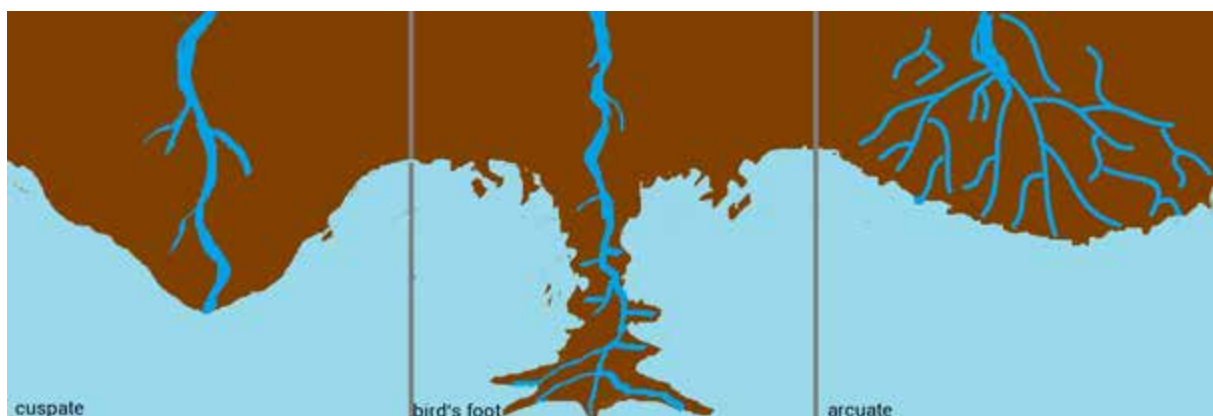


Figure 6.3 Types of delta

I hope from the above discussion you are now able to draw well labelled diagrams showing the processes that take place along the river channel, as well as explaining how the processes occur and where and when they take place. Refer to figure 6.1.

6.3 Factors influencing the rivers energy

You should note that river energy is simply its ability or work to erode, transport and deposit eroded material and or load. I guess you still remember that energy is the ability to do work. Rivers have also work to do and their work is to erode, transport and deposit load. We have now introduced you to yet another term, **river load**. What do you think river load is? You are correct if you say, it is the soluble or solid matter a river carries along the channel. Give three examples of river load. Some examples you can add to your list are leaves, sand tree branches and rocks. Let us now discuss these factors that influence river energy together.

Gradient of channel

Note that gradient is the steepness or gentleness of a slope. Here we are referring to the kind of space or area covered by the river channel. The gradient through which the river flows determines the amount of energy a river has in its ability to erode and transport the sediments or the load. On a steep gradient, the river energy is more and its power to erode is great. The upper course of the river has steep gradient; therefore, this means that the fast-flowing water possess more energy and erosion is higher at the upper course of a river. It is a different case at the lower and middle course of the river channel. whereat these sections of the river there is a gentle gradient. The gentle gradient then causes less energy to erode and transport its load. Note that with little energy in the river a lot of deposition takes place.

NB. As far as gradient is concerned the upper course of the river has more energy to erode and transport river load as compared to the middle and lower course.

1. Volume/ discharge

Water flowing in a river is due to the pull of gravity and the pull of gravity is determined by these mass (load) and hence volume of the water being moved. Upper course river has smaller discharge because their only source of water is from overland flow (surface runoff) which is generated in the immediate surrounding and channel precipitation. Middle and lower course river sections, however, have high volumes due to the fact they obtain water from upstream or upper course tributaries surface runoff generated in the immediate surrounding and channel precipitation. As far as volume is concerned, middle and lower course stream have more energy to erode, transport and deposit as compared to the upstream course.



Activity 6.2 Processes operating along a river channel

1. Name and describe any two river transportation processes (4)
2. Describe the processes of river erosion or deposition (4)
3. State any two landforms that can be found in the deposition stage of a river (2)

6.4 Landforms resulting from river processes

Do you happen to live close to a river or have you ever been to a river before? Well, the water might be clear or dirty at times but you should know that there are various processes which will be taking place.

6.4.1 River valley

A river valley is the area which is found along the river channel which is either V-shaped, U-shaped or asymmetrical. River valleys vary from place to place.

Characteristics of river valley

- Characteristics of a river from its source to the mouth are different or they vary due to the river's ability to erode, transport and deposit material which is affected by the gradient of the river.
- Long profile-this is the cross section along the length of the river from the source to the mouth as shown in figure 6.3
- Short profile –this refers to the cross section of the river valley from the crest line through the channel to crest line.

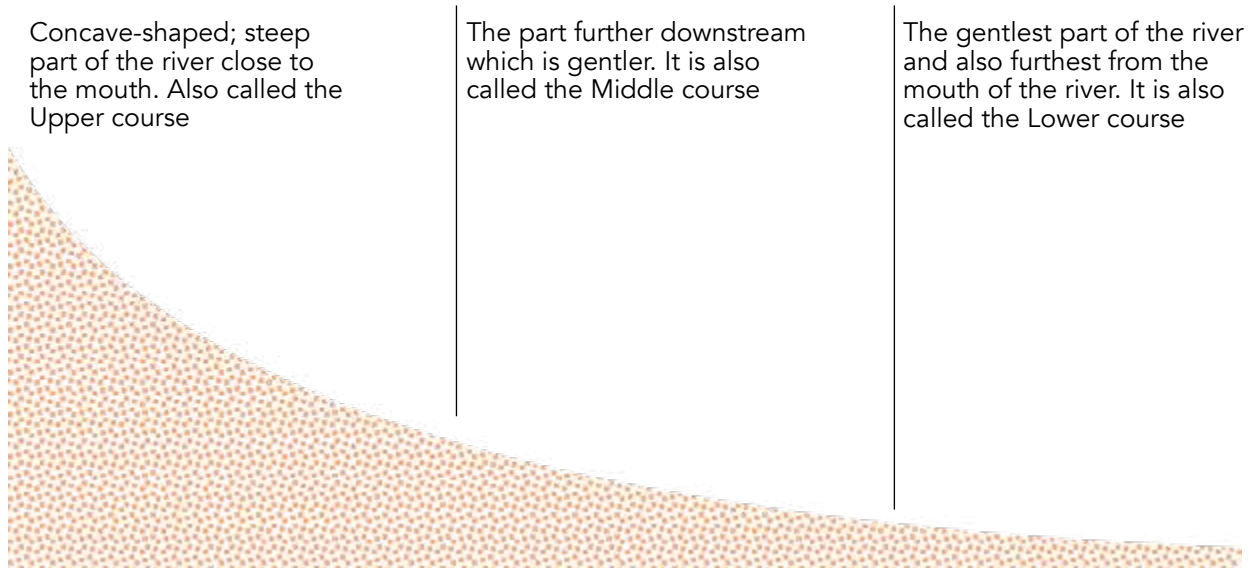


Figure 6.7 A long profile of a river

6.4.2 Types of valleys common or the common features in major sections of the river profile

1. Upper course

In the upper course of the river profile there is the existence of v-shaped valleys. They are a result of fast flowing rivers that have a downward erosion, the fast-flowing river deepens the river channel. Where the resistance of the rocks in these areas is not the same, some of the river features are formed. These features we will discuss them later under figure 6.8.

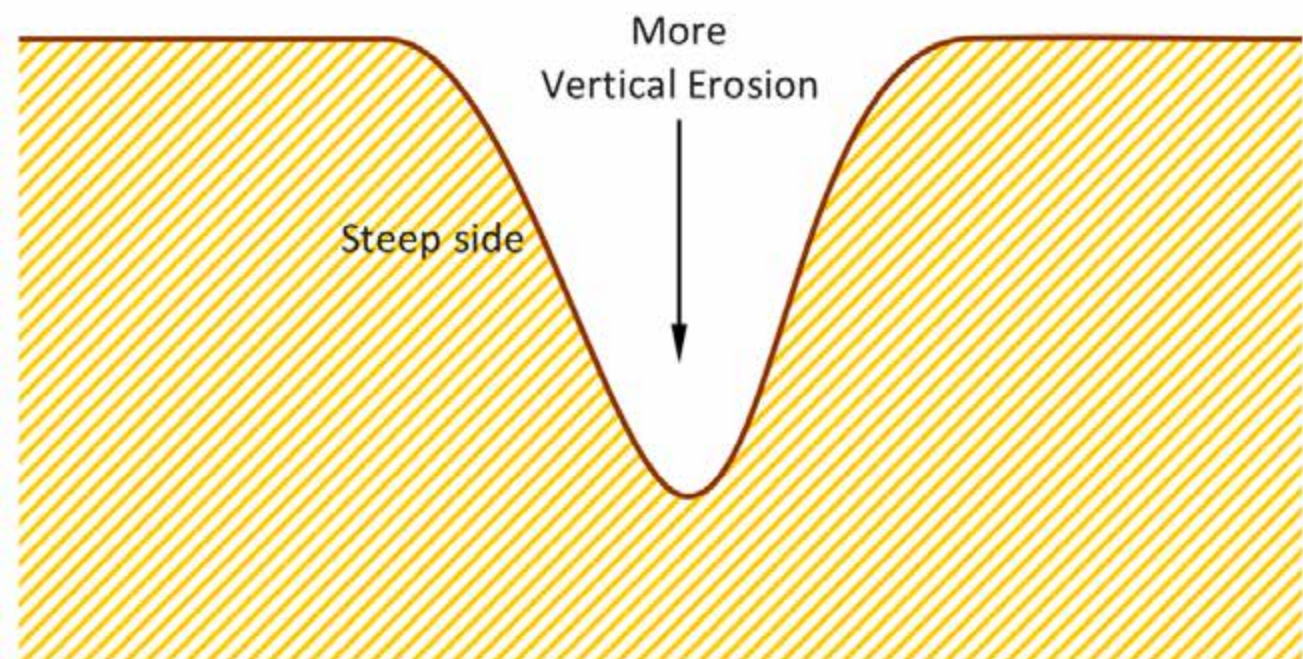


Figure 6.9 Widened river channel on the middle course

2. Middle course

In the middle course the river channel widens since the river would be flowing in a less steep gradient of the middle course as there is a gentle gradient. At this course there is more of lateral erosion which is the wearing away of material on the banks of the river and the transportation of materials become dominant. Since there will be less steep gradient it will result in reduced velocity. This then cause material to be deposited on the river bed.

NB. Note that because of the gentle gradient, the river velocity is reduced and deposition of sediments begins to occur on the river beds.

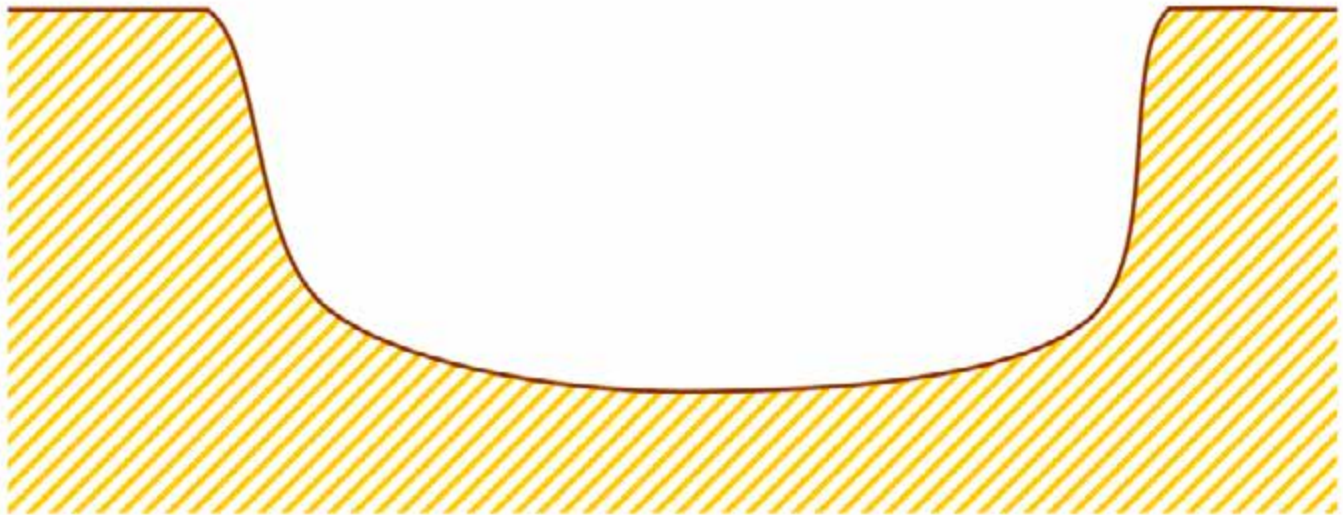


Figure 6.8 Diagram of the v-shaped river valley at the upper course

3. Lower course

In the lower course there is the existence of U-shaped valleys. When the river flows in plains in the lower course, there is much of deposition due to the reduced velocity or there is reduction in the speed of the river during transportation leading to deposition. Lateral erosion increases and the result is the widening of the river channel giving a U-shaped river valley.

NB. You should know that not only u-shaped river valleys are the resultant landforms of the deposition on the river channel, but there are also many features which are formed as a result of the deposition as we are about to discuss.



Figure 6.10 U-shaped river valley at the lower course

Meanders

Meanders are a result of erosion and deposition landforms. Meanders usually lead to the existence of ox-bow lakes. Meanders usually become more pronounced on the middle course of the river channel. The meanders are also a result of the river flowing along its lines of weaknesses and avoiding obstacles along the course. It is also attributed to the alternating occurrence of erosion and deposition along the river channel resulting in the river swaying sideways (meandering). On the outer bank of the meander, erosion is active creating a **river cliff** (as shown in the diagram below), on the inner bank there is active deposition resulting or creating a **slip-off slope** (as illustrated in the diagram below)

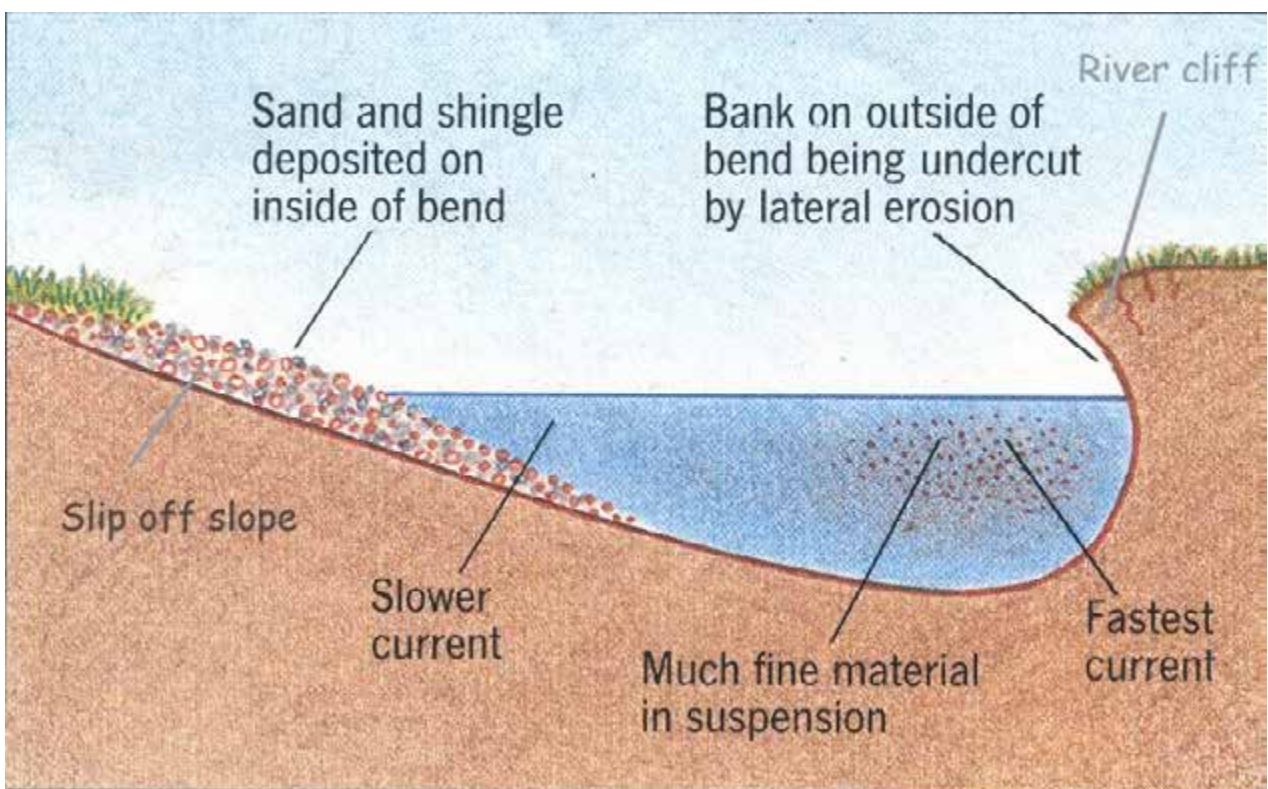


Figure 6.11 A cross section of a river meander

Ox-bow lakes

What is an ox-bow lake? Have you ever come across this word before? The ox-bow lakes are a result of both erosion and deposition because of the meandering action taking place in the river channel. As in figure 6.7 below you should be able to know that the area marked 'erosion' leads to the meander becoming more pronounced. The meander neck becomes smaller as erosion continuous. The river finds a new channel that is straight and the isolated body of water is known as the ox-bow lake. Eventually the ox-bow lakes dry up and become fertile areas for the growth of crops.

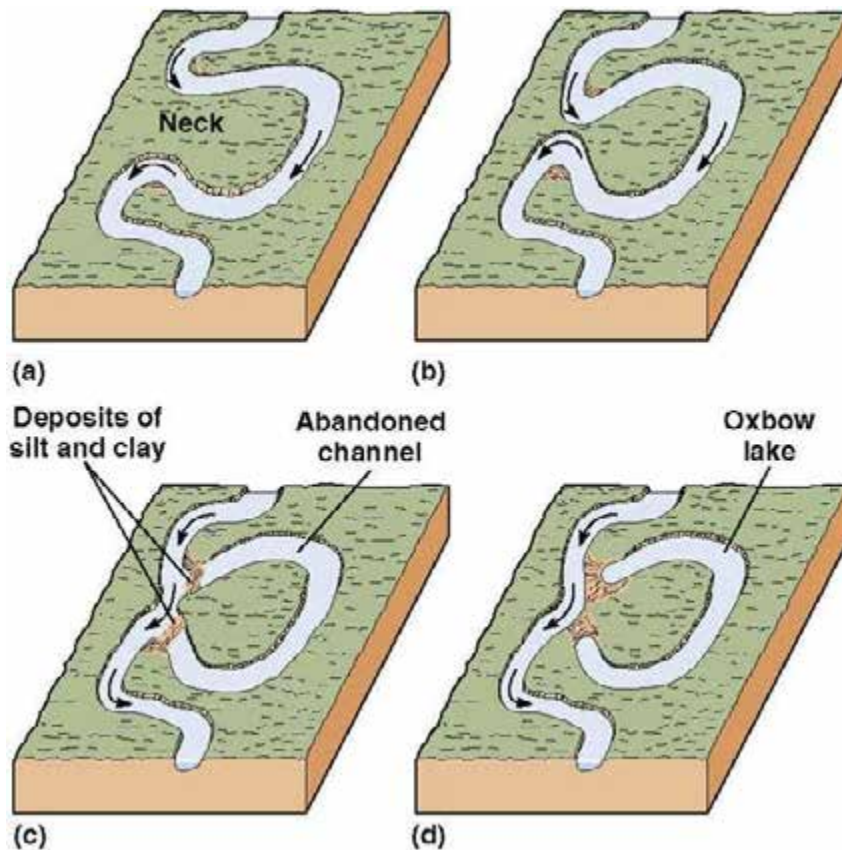


Figure 6.12 The formation of Ox-bow lakes

Waterfalls

Have you ever seen a waterfall before? Or maybe the mighty Victoria falls? Did you know that waterfalls and rapids are a result of a river bed that has rocks of different resistance to erosion (heterogeneous rocks)? Where resistant rocks that lie on the river bed abruptly end, the water would fall resulting in a waterfall. Actually, you should know that in order for a waterfall to be created there is the presence of homogenous rocks with the hard and resistant rock at the upper profile and a soft rock which is easily eroded at the middle course resulting in the creation of a gorge on the waterfall. Waterfalls also occur where there is a drop in the river course or channel. Waterfalls represent a higher fall than rapids (which are to be discussed later in the lesson). As a river descends the scarp in areas of faulting, it also forms a waterfall for example, the Victoria falls is an example of a waterfall resulting from faulting. The type of waterfall is a Knick point which is a break in the long profile due to uplifting of the land.

WATERFALL FORMATION

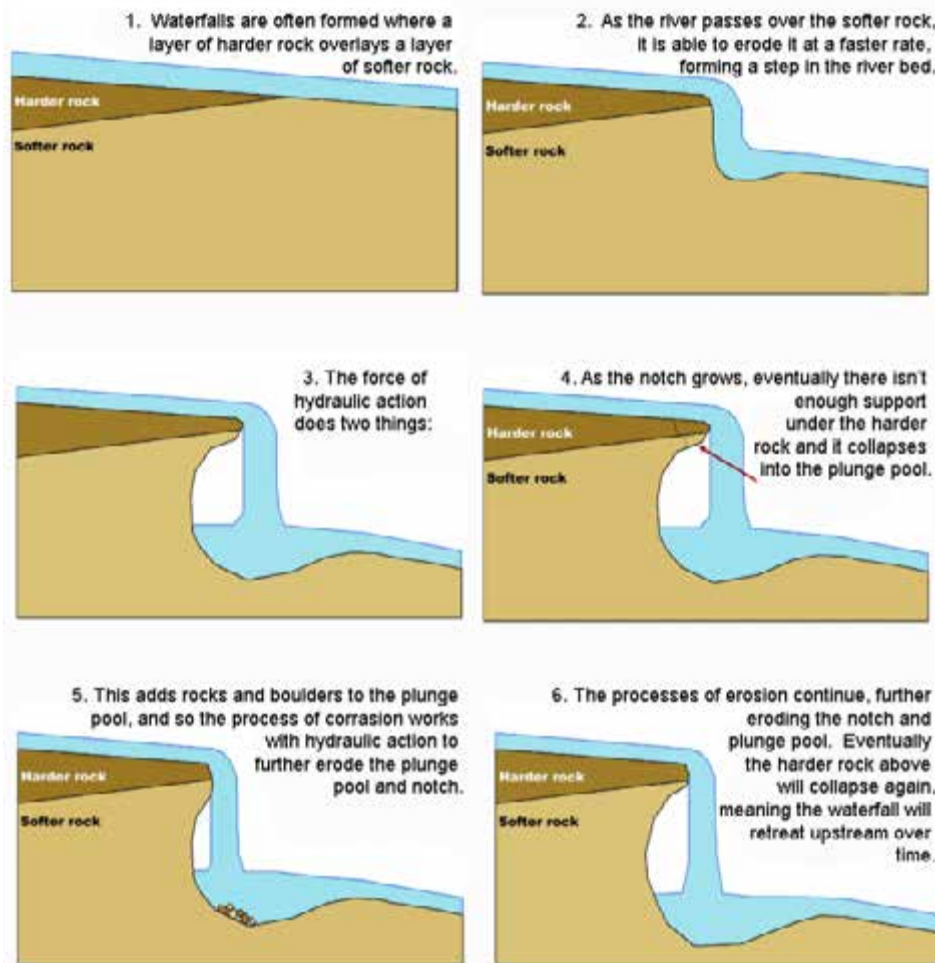


Figure 6.13 Formation of a water fall

Tip

From what we have explained about the formation of the waterfall, I hope you are now able to draw and explain the conditions necessary for the formation of a waterfall.

Rapids

Rapids are also landforms that form due to the occurrence of resistant bands or rocks across the channel. This means that the area downstream of the band can be deepened, therefore forming a rapid. They also form due to a series of resistant bands over wide rock bands. They also occur when the river flows down the edge of a plateau or where there is faulting. To add on, rapids are also formed where there are many alternate layers of hard and soft rocks on the river bed. Such rapids often result in river navigation and in some instances such as along the Zambezi river, they create the ideal environment for water sports like rafting which is also a major tourist attraction.

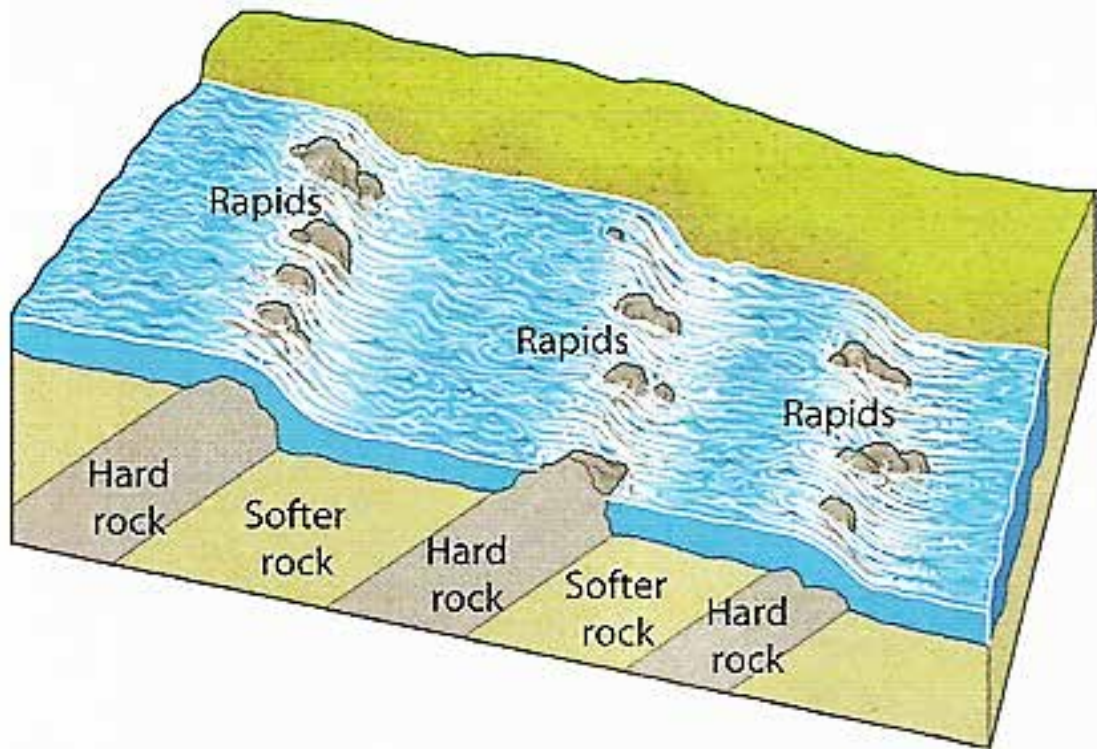


Figure 6.14 *The rock structure that causes rapids*

Therefore, from what we have discussed you are now able to describe the formation and explain the resultant landforms from a river profile or a cross section.

Reflection

We have come to the end of our unit. Hopefully you mastered all the concepts of this unit. For further reading and clarification use relevant websites as well as the books given on further reading.

Summary

Well done you have completed another unit. Please go over the points below and check whether you have understood everything in this unit. If you did not understand some of the concepts in this unit, please go back and read again before attempting the end of unit assessment test below. As part of your revision please fill in some summary points below.

- River Processes these are operations that take place in a river.
- Seasonal water flow means the flow of water in rivers basing on seasons e.g. winter and summer.
- Drought is a dry spell caused by receiving inadequate rainfall.
- Hydraulic action is the process by which a water removes materials on the river bed or river bank when it is flowing.
- Gradient is the steepness or gentleness of a slope.
- Rivers help in shaping the earth's surface through erosion, transportation and deposition.
- The characteristics of a river from its source to mouth vary due to the ability of the river to erode, transport and deposit material.
- V-shaped valleys are a result of fast flowing rivers
- The speed of a river is low at its mouth therefore resulting in deposition to take place.

End of unit assessment

Section A Multiple choice

Answer the following questions by choosing the correct answer from the options given.

1. Gradient is
 - A. A slope
 - B. The gentleness of a slope
 - C. The steepness or gentleness of a slope
 - D. The long profile of a river
2. Eroded material is first deposited when
 - A. A river gains velocity
 - B. A river loses velocity
 - C. Velocity is high
 - D. The river is in flood
3. Which of the following is a type of a delta?
 - A. Zeugen
 - B. Delta
 - C. Piedmont
 - D. Birds foot
4. Lateral erosion is
 - A. The wearing of material on the river banks
 - B. The wearing of material on the river bed
 - C. The wearing of material in the lower course of the river
 - D. Erosion of material.
5. A waterfall is found in
 - A. The middle course of the river
 - B. Lower course of the river
 - C. Upper course of the river
 - D. All the courses of a river

Section B Answer all questions

6. Identify four processes by which a river erodes its channel (4)
7. Identify features commonly found in the lower course of a river valley (4)
8. Define the term hydraulic action with reference to the processes that occur in a river channel (2)
9. What measures would you take to reduce the problem of siltation in the rivers of Zimbabwe? (4)
10. If you were the Zimbabwean minister of environment, what problems would you face in trying to implement the measures stated above? (3)

Research Work

Visit a river site in your local area to do this research. We would like you to measure the velocity of a river. Record your measurements and present them to your facilitator. Good luck. Use the following materials and guidelines to help you in your research. Note that you will need someone to help you carry out the research and make sure the part of the river you will choose is safe enough to carry out this work.

Materials needed for the research

1. Tape measure
2. Floats (these may be orange peels or anything that can float on water)
3. At least two poles to mark your starting point and finishing point (make sure the area you select should be about 20 metres in length from starting point to finishing point.)
4. A timer or stop watch
5. A rope

How to carry out the research

- First and foremost you should find a suitable place to do this exercise and this should be a straight path along the river channel. Make sure it is safe.
- Now measure the distance using your tape measure. Mark your starting and finishing points with the poles to approximately 20 metres or so.
- With your timer in hand, at the starting point drop a float just near the river bank and start to record the time taken by the float up to the finishing point
- Use another float, this time throw it in the middle part of the river to measure the velocity.

Make sure you will be recording this. Below is a formula used to measure velocity. The distance will be according to your measurements on the actual ground that is approximately 20 metres. The time is the average seconds taken by the float and the velocity would be in metres per second.

Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding, I have listed them here below. Go through them and check how many of them you achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it in the unit and go over it again. Right, mark yourself.

Objectives	Check box
Can you now:	
• Describe the nature of seasonal water flow in Zimbabwe	
• Explain the river processes in shaping the landscape	
• Describe landforms resulting from river processes	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 7 Landforms resulting from wind action in Zimbabwe and Africa

- 7.1 Characteristics of arid and semi-arid regions
- 7.2 Distribution of arid and semi-arid regions
- 7.3 Wind action processes such as erosion, transportation and deposition
- 7.4 Landforms resulting from wind action in Africa

Introduction

Have you ever seen a whirlwind in action? We are sure one way or the other you have seen or experienced the wind blowing. Can you touch wind? Of course, no, but its effects are seen on landforms that result from its actions? In the previous unit you learnt about the river process and the landform resulting from wind action. Have you heard of the term arid or aridity? In this unit you are going to learn about the characteristics and distribution of arid and semi-arid regions. Furthermore, you are going to learn about wind processes such as erosion, transportation and deposition.



Objectives

- describe the characteristics of arid and semi-arid regions
- explain the distribution of arid and semi-arid regions
- explain the processes of wind action
- describe the landforms resulting from wind action



Key Words

Arid regions	these are areas which are hot and very dry or known as deserts these are dry areas that receive less than 250 mm of rainfall annually. They also known as hot deserts
Semi-arid regions	these are areas which are not completely dry but resemble characteristics of arid areas. They receive little or no rainfall at most. These are areas with a long dry season such that the evapotranspiration exceeds the precipitation. The rain in these regions higher than that of the arid areas.



Time guide

You are expected to take not more than 10 hours to go through this unit.



Study skills

This unit requires you to use your imagination, critical thinking and research skills. You should also visit relevant websites on desert landforms so that you view images of some of these landforms. There are websites that can show you animations or even videos on landforms.

7.1 Characteristics of arid and semi-arid regions

7.1.1 Arid regions

Do you remember what we said arid areas are? We gave the definition of arid regions as dry areas that receive less than 250 mm of rainfall annually. They are also known as hot deserts.

Note that arid areas are characterised by the following:

- The areas are dry meaning that they receive less than 250mm throughout the year.
- The day temperatures can reach 40°C while the night temperatures they can reach -4°C.
- The evapotranspiration in these areas always exceeds the precipitation.
- Droughts occur frequently.
- There is little or no vegetation cover.
- Gusts of wind blow strongly due to absence of vegetation which could have acted as wind breaks.

You have gone through the characteristics of arid areas. Now let us move on and look at the characteristics of semi-arid areas:

7.1.2 Semi-arid regions

Note that semi-arid regions have high temperatures and do experience rainfall.

These are quite hot but fairly humid areas

Characteristics

- The region experiences rainy summers and cool dry winters.
- Rainfall is usually between 250-500mm
- Temperature usually between 21°C and 32°C.
- There is sparse vegetation such as short grasses and scattered trees

Henceforth, from the characteristics above it is prudent to mention that the semi-arid region is quite different from the arid region.



Activity 7.1 Characteristics of arid and semi-arid regions

1. Explain any three characteristics of arid regions (6)
2. What do you think are the causes of aridity? Give two points (2)

7.2 Distribution of arid regions

7.2.1 Distribution of arid regions

Do you know any desert in the world? Arid regions are those regions which are mainly called the hot deserts. The hot deserts are found in three different places in Africa. These are the Kalahari Desert in Botswana, Namib desert in Namibia and the Sahara Desert 30° north of the equator covering one quarter of the Saharan area. Worldwide most hot deserts are located between 15° and 30° north and south of the equator and mostly on western coast. These areas are characterised by high pressure. Figure 7.1 shows the location of deserts in Africa.



Figure 7.1 *The location of the Desert type of climate in Africa*

7.2.2 Climatic characteristics of arid areas

Note that these areas are very dry. They receive rainfall which is less than 250mm. When the areas experience rainfall it is usually of high intensity and short lived (meaning for a short period of time) in other words a short storm. There is no or little cloud cover and the temperature ranges from 38-40 degrees Celsius. The high temperatures result in high evapotranspiration rates and this causes a deficit in moisture levels. At night temperatures drop down to at least 0 degrees Celsius and this causes the formation of dew. High wind speeds are common in the arid regions. You have probably heard of the Sahara or Namib deserts. There are various types of deserts. Hot deserts are located north and south of the equator in the interior of continents and the west coast. Hot deserts are arid regions in the world include the Kalahari and Namib deserts in southern Africa, The Sahara Desert in north Africa, the Indian Thar desert, Arabian desert, West Australian, the Mohave in Western America and the Atacama in South America. Figure 7.2 show the locations of the deserts mentioned above.



Figure 7.2 The global distribution of hot deserts

7.2.3 Vegetation cover in arid areas

Deserts support the growth of a few and small plants. However, the vegetation is scarce due to extreme harsh weather conditions like high temperatures and less rainfall. The saline soils which are infertile and sandy support the growth of very little specialised vegetation like xerophytic plants. **Xerophytic** plants grow in semi-arid regions where ground water is available. These are plants that grow in arid and semi-arid conditions. They can survive with little water.

7.3 Distribution of Semi-arid regions

Have you ever heard of semi-arid regions? The semi-arid region is quite different from the arid region. This region is also known as the savannah climatic region. It covers the largest part of Africa and is mainly found within the tropics. This type of climate also constitutes much of the low veld areas of Zimbabwe.

NB. You should also note that in most cases it is affirmed that due to climate change the semi-arid regions are slowly turning to arid regions.



Activity 7.2 Distribution of arid and semi-arid regions

1. Describe how arid and semi-arid regions are distributed. Give three points for each area. (6)
2. Describe the climatic characteristics of arid and semi-arid regions.

7.4 Wind action processes and resultant landforms

Have you ever noticed that air is not stationary? It moves from place to place. As it moves it erodes, transports and deposits material. These are therefore called wind action processes. Wind also has the ability to curve landforms as it erodes and deposits material. Wind plays a very important role in landform development in desert areas.

7.4.1 Wind erosion

We hope you are familiar with the word erosion and you have heard it before. You are probably wondering if it is possible for wind to erode. Yes, wind has the capability to erode. In this section you are going to see examples of landforms that were formed due to wind erosion. Wind erosion is the process whereby wind participates in the removal or eroding of loose materials. Wind erosion is a very effective process in this case because of the existence of large areas with dry and loose unconsolidated sand soils and silt. The absence of vegetation cover also facilitates or promotes the wind action to erode as there is nothing that binds the soil particles together. Nevertheless, we have three main processes of wind erosion namely deflation, abrasion and attrition. These processes are to be discussed as follows:

Deflation: What comes into your mind if you hear the word deflation? Deflation is a process by which wind blows away dry and unconsolidated sand, silt and dust from surfaces. Wind removes loose materials and if it has a high velocity (speed) even heavier particles can be moved. For deflation to occur it also takes into play the surface roughness, clay content of the soil and moisture. When clay is wet it becomes sticky and the particles are not eroded quite easily. Wind deflation results in what are called deflation hollows. Below is a diagram showing a depression hollow.

In A the wind blows away light material from the surface of the earth.

In B, a depression results from the continued removal of light materials from the surface.

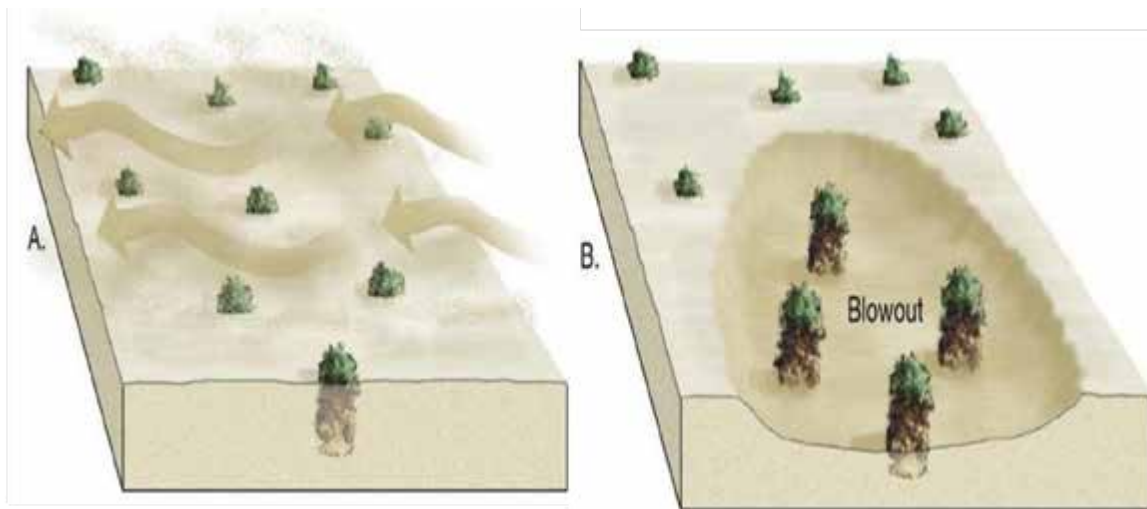


Figure 7. 4 The formation of a deflation hollow

In B, a depression results from the continued removal of light materials from the surface.

Abrasion: It is the blasting effect of sand and rock materials as they are being transported through the process known as saltation. This sand blasting is usually effective in areas with less resistant rocks as well as near the ground level. Abrasion results in landforms which are called rock pedestals, yardangs and zeugens and these are mainly found in hot deserts.

Attrition: As wind transports its material, the material is constantly rubbing against each other as it moves. The rock particles wear off as this happens. This is therefore called attrition.

7.4.2 Wind transportation

Did you know that wind can transport loose material from the ground for a long distance? The distance depends on the speed of the wind. For the transportation to occur it depends with the wind velocity, turbulence and direction of the wind as well as the nature of materials being transported. The transported materials vary in size. Wind transportation is favourable when winds are strong usually 20km per hour. You should know that wind transports its material in suspension, saltation and creep form.

Suspension

Have you ever seen a whirlwind? Usually it picks up every loose material that is in its way. The loose material could be papers, sand and silt. These are then carried in suspension form or in air? Well wind has the capacity to move things in suspension form. Material that can be carried or transported in suspension form include sand, silt and clay.

Saltation

Do you know that wind has the ability to carry rock particles and sand from the ground? The material is lifted up and down from the ground in what can be referred to as a hopping manner.

Surface creep

There are some material which are quite big to be lifted and transported by wind. These materials include pebbles and large rock fragments. They are rolled along the surface depending on the direction of the wind. The diagram below shows the three transportation processes.

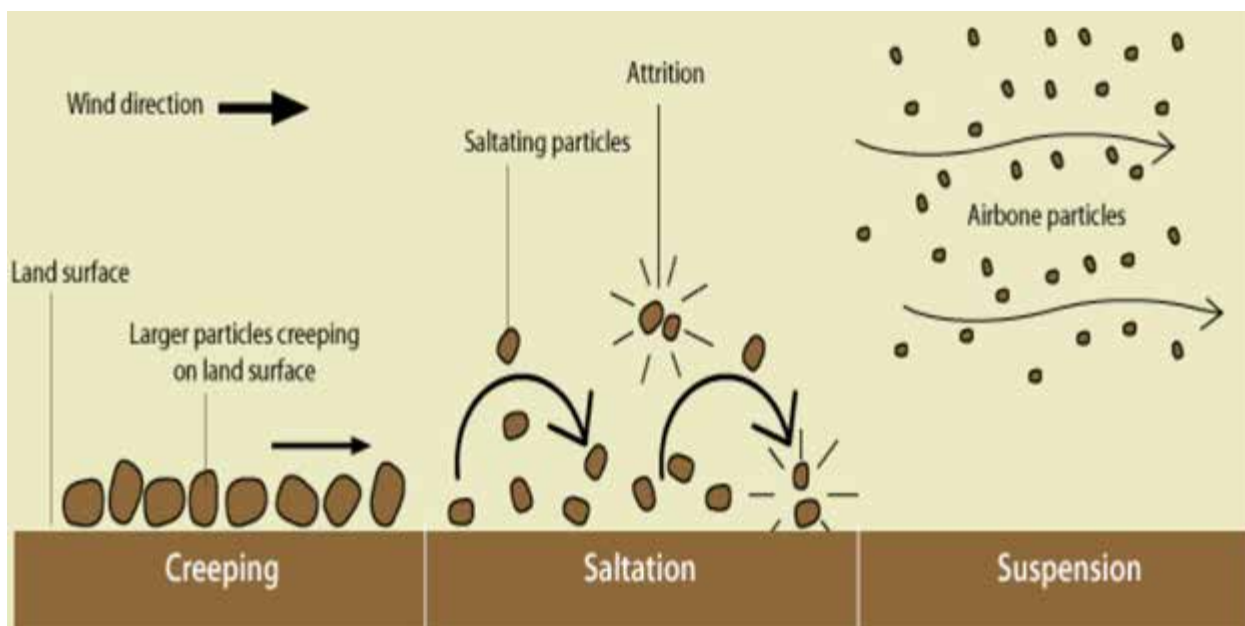


Figure 7.5 Wind transportation processes

7.4.3 Wind deposition and resultant features.

Well we have been talking about how wind erodes and transports material. Wind reaches a point where it finally deposits the material. You should know that wind deposit its material when wind velocity drops. Firstly, course material such as sand are deposited first then finer materials like dust comes last. There are various types of sand dunes which are formed due to wind deposition. Namely there are barchan dunes, seif dunes transverse dunes and loess deposits.

Barchan dunes

These are crescent shaped dune with a convex windward side. It also has two horns which curve downwind on either side of the steeper concave slip to the leeward side. They are formed at right angles to the direction of the prevailing wind. You should know that barchan dunes are symmetrical. See how the barchan dune is formed in Figure 7.3.

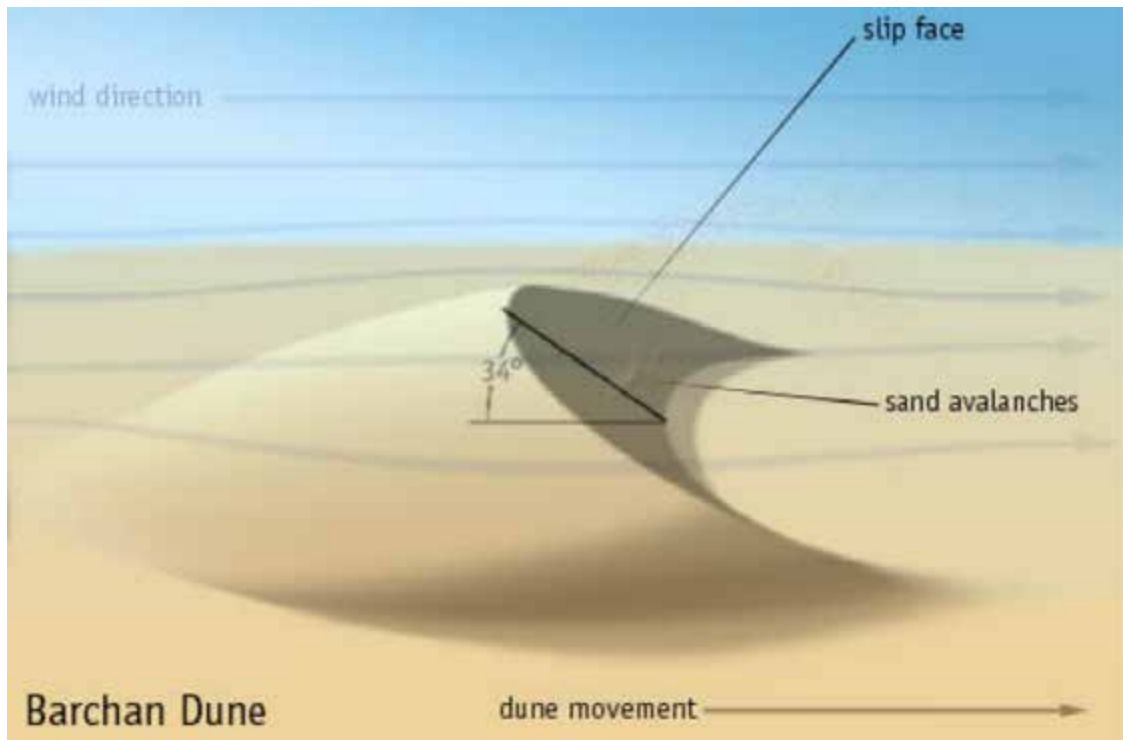


Figure 7.6 Characteristics of a barchan dune

Seif dunes

The other name for seif dunes is longitudinal dunes. These are long kind of ridge like dunes. They run parallel to the direction of the prevailing wind. Did you know that seif dunes can be up to 100 or 200 metres long? They are also asymmetrical in cross profile. It is also safe to say that seif dunes develop where barchan dune suffers a blow-out which then causes partial destruction. Below is a diagram showing seif dunes.



Figure 7.7 Seif dunes

Transverse dunes

These types of dune are a bit different from the others. They start off as irregular ridges formed due to coalescence of several barchans. Mainly these dunes form a series of long wavy ridges. These ridges will be lying at right angles to the direction of the winds.

The dunes lie at right angles to the prevailing winds.

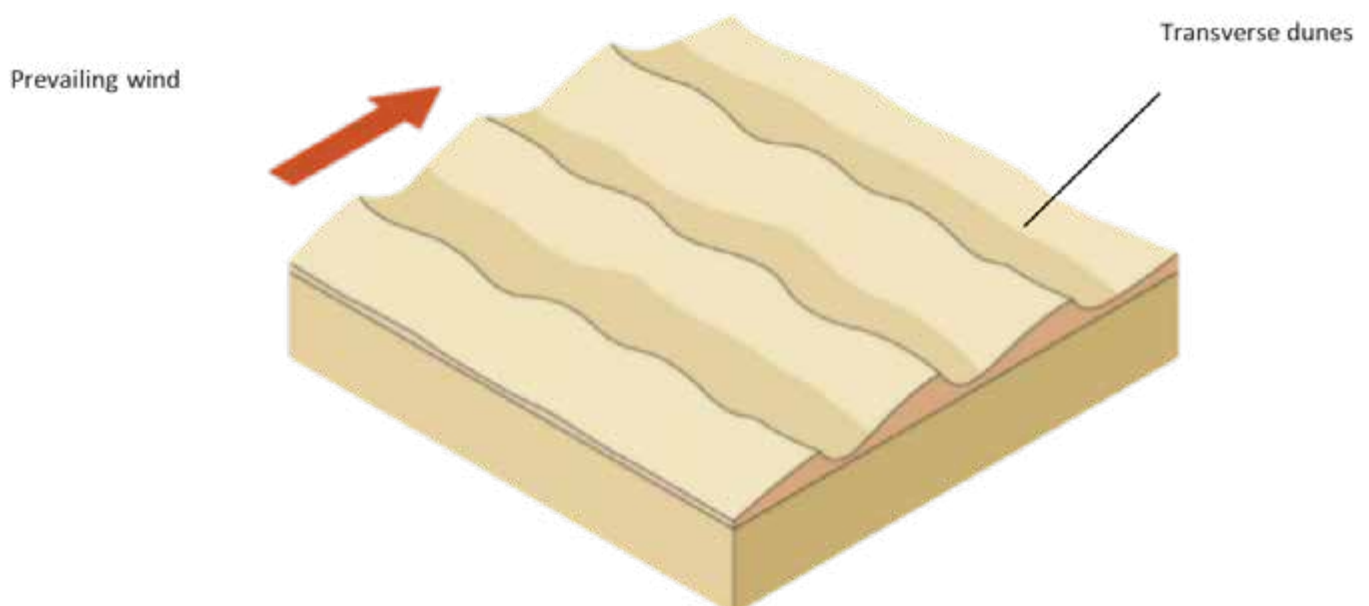


Figure 7.8 Transverse dunes

Loess deposits

These are thick brownish yellow like sandy loam rich in lime and are homogeneous in structure. They are sand deposits from deserts and are deposited in areas outside the desert margins. Loess are rich fertile soils and did you know that they cover at least 10% of the earth's land surface.



Activity 7.3 Wind action processes

1. Draw a well labelled diagram showing the formation of a barchan dune (6)
2. What problems do you think are caused by development of barchans?

7.4.4 Landforms resulting from wind erosion in Africa

Have you ever been to a desert? Or have you seen some landforms that are found in deserts? Some look pretty funny. Well you should know that those landforms are as a result of wind and water action in the deserts. The processes of deflation, abrasion and attrition have led to the development of landforms in hot deserts. There are different landforms that are found in deserts. We are going to look at rock pedestals, yardangs, deflation hollows and zeugens.

Rock pedestals

These are landforms which are found in deserts. The rocks which form this type of landforms are those with alternating bands of weak and hard rocks. As wind blows the softer rock is eroded at a faster rate than the hard rock. This however results in landforms which are mushroom shaped like as shown below in Figure 7.9.

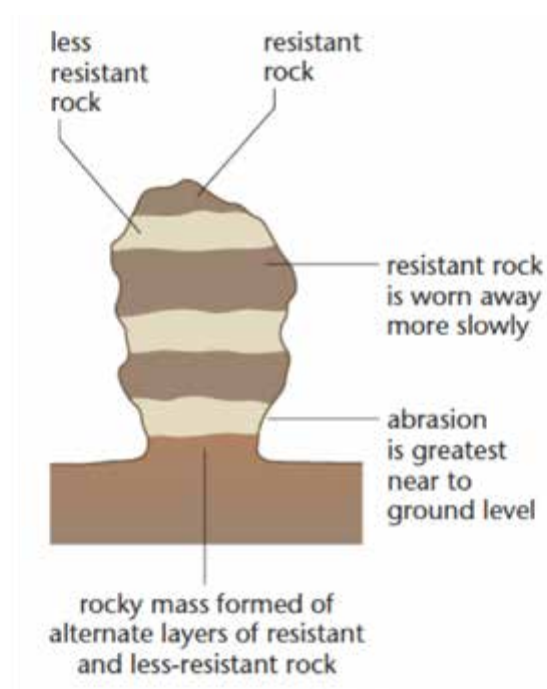


Figure 7.9 Formation of a rock pedestal

Yardangs

Yardangs are landforms which develop where rock masses have vertical bands of hard and soft rock. The rock masses lie parallel to the prevailing wind. There is more of wind abrasion which attacks the soft rock to form troughs whereas the more resistant rock form ridges. The ridges are therefore called yardangs.



Figure 7.10 Yardangs and how they form

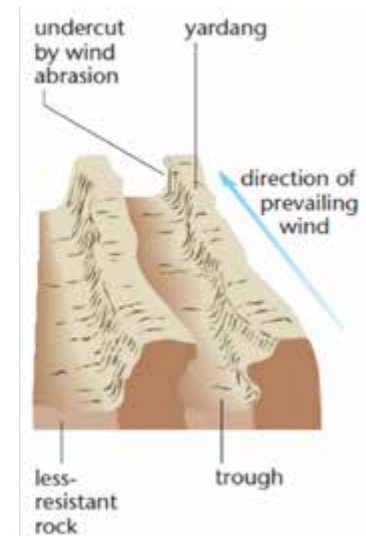


Figure 7.10 Yardangs and how they form

Zeugens

These are landforms which develop where rocks have horizontal layers of soft and hard rocks. Wind erosion attacks the soft weaker rock producing ridges and furrow landscapes. The ridges formed are called zeugens.

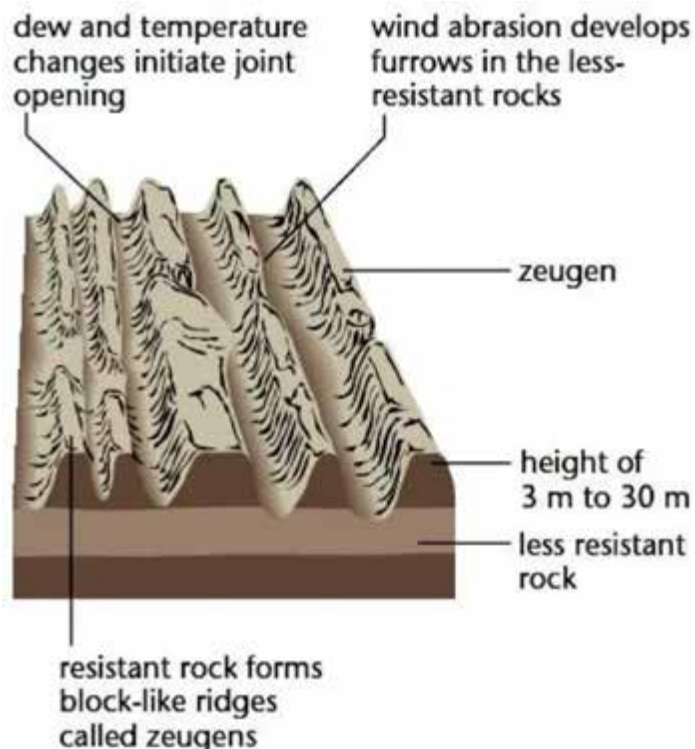


Figure 7.11 Zeugens



Activity 7.4 Wind action processes

1. Give similarities and differences between yardangs and zeugens (6)
2. List three reasons why wind erosion is an effective process in the development of landforms in desert areas. (3)
3. Draw a well labelled diagram of a piedmont zone (5)
4. Explain the diagram (5)

Reflection

We hope that you have mastered this unit. What is abrasion? Hope you got that right. If not go back and read again. Do not forget to meet up with your teacher and get further clarification.

Summary

Well done you have made it. Hope you were able to understand this unit. Below is a list of key points. They will help you to revise. Please add some of your points. Make sure you revise thoroughly before you attempt the end of unit test.

- Wind deposits found on the desert margins are referred to as loess
- Arid regions receive little or no rainfall at all.
- Wind transports its material through suspension, surface creep and saltation.
- There are arid and semi-arid regions but the semi-arid regions are slowly turning arid.
- There are various types of deserts which are hot, cold and temperate
- Deserts occur due to different effects. Most of them are found on the western coasts and interior continents.
- There are various types of sand dunes which include seif dunes, yardangs, zeugens and transverse dunes
- Rock pedestals have alternating bands of hard and soft rocks and are mushroom like in shape.
- Temperate are areas between 35 and 50 degrees north with moderate to low temperatures.

Tip

We hope you have understood the concepts of this unit. Before you attempt the end of unit assessment make sure you have read and visited relevant websites to help you understand quite clearly.

End of unit assessment

Section A Multiple choice

Answer the following questions by choosing the correct answer from the options given.

1. Deserts receive an annual rainfall of
 - A. 1000mm
 - B. 300mm
 - C. 700mm
 - D. 250mm

2. The vegetation cover consists of
 - A. Grass
 - B. Medium sized trees
 - C. Xerophytic plants
 - D. Oases

3. Weathering processes that occur in deserts are
 - A. Mechanical
 - B. Exfoliation
 - C. Pressure release
 - D. Physical

4. Which of the following is a type of a desert?
 - A. Erg
 - B. Yardang
 - C. Zeugen
 - D. Playa

5. Depositional features of wind found outside the desert are called
 - A. Barchan dunes
 - B. Seif dunes
 - C. Loess
 - D. Ripples

6. With the aid of diagrams explain the formation of a
 - a) Yardang (4)
 - b) Seif (4)

7. State any five characteristics of semi-arid regions (5)
8. Give any four characteristics of arid regions (4)
9. What causes deserts to occur? Give four points (4)
10. Rock pedestals result from (2)



Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding, I have listed them here below. Go through them and check how many of them you achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it again. Right, mark in the unit and go over it yourself.

Objectives	Check Box
Can you now:	
• Describe the characteristics of arid and semi-arid regions	
• Explain the distribution of arid and semi-arid regions	
• Explain the process of wind action	
• Describe the landforms resulting from wind action	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 8 Hazards associated with landforms development and disaster risk management

- 8.1 Volcanoes as hazards
- 8.2 Earthquakes as hazards
- 8.3 Mass wasting
- 8.4 Flooding
- 8.5 Disaster risk management of volcanoes, earthquakes, flooding and mass wasting.

Introduction

Have you ever seen a hazard or disaster be it on television or in online sources? Disasters do happen in many parts of the world. In the previous unit, you learnt how landforms develop through tectonic processes of folding, faulting, volcanoes and earthquakes. What do you think are hazards? Certainly, hazards are associated with danger and harm to the environment, people and their property. A hazard is any source of potential damage, harm or adverse health effects on something or someone. Because of the suffering they bring upon people, they are called hazards. Now we are going to describe the hazards associated with the processes that lead to formation of these landforms. However, these processes have their own benefits which we are also going to highlight in this unit. We will also discuss methods of disaster risk management of these hazards namely volcanoes, earthquakes, floods and mass wasting as well as mitigation measures.



After going through this unit, you should be able to

- describe the hazards associated with development of landforms
- identify ways of disaster risk management of volcanoes, earthquakes, floods and mass wasting
- describe mitigation measures for these hazards



Key words

Hazards	any natural phenomenon that may cause great harm or suffering of people.
Risk management	measures taken to reduce the impact of a hazard
Mitigation	reducing the impact of a problem



Time

You are expected to spend no more than **10** hours to go through this unit.



Study skills

You are encouraged to revisit your Unit 5 on plate tectonics and volcanoes and earthquakes to have a better understanding of the concepts that follow in this unit. You are also advised to take down some notes as you go through this unit noting down important points.

8.1 Volcanoes as hazards

In this section of the unit let us discuss the negative and positive effects of volcanoes. I am sure you have heard of volcanoes and their effects on human activities before. As you learnt in the previous unit, volcanoes are violent by nature and when they erupt, they affect human activities negatively. Lava flows sometimes burn up people and cause great loss of lives. Some eruptions cause great damage to property and infrastructure such as buildings, roads, railways and communication lines. Volcanoes can leave people homeless after their villages are destroyed or buried under ashes. They also cause disruption of service provision such as electricity, water and transport. Volcanoes often cause air pollution as they are associated with gases, dust and ash which may affect the respiratory system of humans and cause diseases.

Some volcanic eruptions may cause tsunamis if they occur in seas or oceans. Tsunami refers to the giant sea waves that result from both volcanic and earthquake activities which cause rising of the sea floor. Tsunami results in floods, loss of lives, destruction of property, food shortages, disruption of service provision and diseases. A good example is the tsunami that occurred in Krakatoa in South East Asia in 1883 which drowned thousands of people.

Small hot rock particles called cinder can be thrown into air and destroy people and vegetation; and bury farmlands, roads and settlements. Volcanoes can also trigger landslides which destroy settlements and cause loss of life. In Africa, areas that are

prone to volcanic activity include the Western part of the Democratic Republic of Congo (DRC) and Cameroon. In Zimbabwe there is no active volcanic activity.

Now that you have gone through this discussion on negative effects of volcanoes. We now want you to attempt the following case study and check how much you have understood so far.



Activity 8.1 Effects of volcanic activity

Case study

Imagine you live in a settlement close to a sea and the major economic activities in that settlement are farming and fishing. A major volcanic eruption occurs and affects the whole settlement.

Brainstorm some of the negative effects that are likely to be caused by the volcanic eruption.

When you are through, compare your responses with points that you can pick from our discussion above.

In spite of the dangers associated with volcanoes, did you know that they also come with some positive results? Like what? Can you just brainstorm some of their benefits? Compare your responses with what is in this discussion.

Volcanic eruptions result in the formation of minerals such as diamonds and copper. When volcanic rocks are weathered, they give rise to rich agricultural soils. In addition, the ashes formed from violent eruptions form rich soils for agriculture as well. Hot springs that result from volcanic activity may supply households with hot water. Tall volcanic cones may result in the formation of relief rainfall which benefits both people and animals who live in the windward side. Tall volcanic mountains may also attract settlements as they provide favourable climate as well as defence. We guess you have heard of or seen settlements on hill tops and wondered why people would build their houses up there! These are some of the reasons. Volcanic rocks such as igneous can be used for building purposes. Some volcanic features attract tourists, for example, volcanic mountains, hot springs and geysers.



Activity 8.2 Hazards caused by volcanoes

Despite the dangers posed by volcanic activities, people continue to live in areas that frequently experience volcanoes. Explain why this is so. (5)

8.2 What are tsunamis and their effects?

Did you know that most waves form due to winds or tides, but tsunamis have a different cause altogether? A tsunami is most often formed by an earthquake, but it can also be formed by an underwater landslide, volcano eruption or even meteorite.

The process is fairly complex, so let's start digging into it.

Tsunamis are indeed waves, but unlike wind waves, they have a much larger wavelength. Think a bit about waves; in the context of physics, not in the context of sea waves. A defining characteristic of every wave is its wavelength. Wind waves have short wavelengths which can be clearly seen on any shoreline. They come in every few seconds, with a few meters in between, sometimes, even less. But a tsunami has a huge wavelength, oftentimes longer than a hundred kilometres and this is why they are so dangerous. Tsunamis are almost always not singular waves, but come in as train waves.

The vast majority of tsunamis form due to earthquakes, specifically tectonic tsunamis. As an earthquake happens, the ground beneath the water is moved up and/or down abruptly and as this movement happens, a mass of water is displaced and starts moving in all directions. This marks the start of a tsunami. The displaced water starts to move as a wave.

8.2.1 Effects of tsunamis

We are sure you can imagine some of the effects of tsunamis. Can you list what you think are effects of tsunamis?



Figure 8.1 Infrastructure destroyed by Tsunami

Look at the figure 8.1, what do you think are some of the effects shown on figure 8.1? The following are some of the effects of tsunamis:

- destruction of onshore infrastructure
- destruction of boats and fishing facilities
- death of people, animals and vegetation
- soil erosion

8.3 Earthquakes as hazards

Just like volcanoes, you will realise that earthquakes are also a cause for concern to human activities. Let us look at some of the negative effects of earthquakes.

Earthquakes cause lowering or rising of the sea floor which can cause tsunamis to occur. This can cause floods along coastlines. What are tsunamis by the way? If you said tsunamis are huge sea waves advancing towards the land as a result of raised sea floor levels, you are correct. They can cause displacement of rocks laterally or vertically which can destroy property and communication lines. They also cause landslides and opening up of deep cracks on the earth's surface which may destroy infrastructure. A good example is the tsunami that occurred in South East Asia in 2004. Now study the photograph on Fig 8.2 below and take note of the various ways by which people living in the area might have been affected.



Figure 8.2 An earthquake devastated area

However, did you know that earthquakes can also benefit people.? When an earthquake occurs, geothermal energy can be exploited for power. Heat energy produced can be converted into electricity.

8.4 Mass wasting

Have you ever heard about or seen mass wasting? Mass wasting is another hazard associated with landform development. Mass wasting refers to the movement of loose rock boulders and particles down the slope under the force of gravity. This process is also called mass movement and the movement can be slow such as soil creep or rapid such as rock falls or avalanches and mudflows. Rapid mass movements destroy everything in their path, killing people, burying buildings, roads, and valleys. They can occur everywhere where there are steep slopes.

Now, for you to have a better understanding of this process, let us discuss in details the different types of mass wasting.

Soil creep

What do you understand by creeping? If you thought of a very slow movement you are correct. Soil creep is a steady downward movement of soil on a sloping land. Rain water lubricates soil particles and enables them to slide over each other down the slope. Soil creep is also caused by wetting and drying of soil which weaken soil particles. Wetting and drying of soil also contribute to soil creep as well as trampling of grazing animals. Soil creep as we noted earlier on, is a very slow process and cannot be noticed. However, the effects can be recognised such as bulging walls with mounds of sand behind walls and fence poles that lean in the direction of the slope. The diagram below may help you to understand the effects of soil creep.

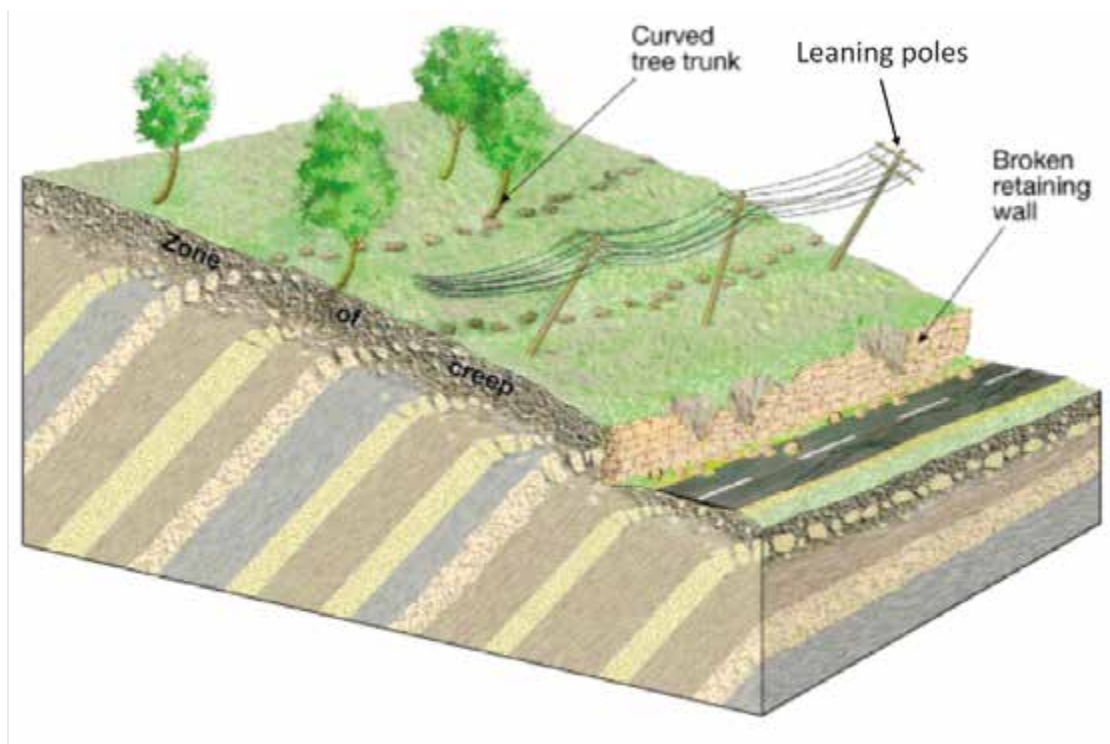


Figure 8.2 Effects of soil creep

Mudflow

Mudflows occur on soil-covered slopes. If heavy rains occur continuously, they turn soil into semi-liquid state. The soil which is now mud starts flowing like a liquid and this is known as mudflow.

Imagine the sandy desert slopes which are not protected by vegetation! If heavy torrential storms occur and more rain falls than the soil can absorb, mudflows occur on these surfaces.

Do you still remember that when a volcano erupts it may lead to the formation of mounds of ashes? When heavy rain falls on the volcanic ash covering the slopes, mudflows occur as well. These can destroy and bury settlements, roads and rivers at the bottom of the slopes. This happened in the Rif Atlas Mountains of Morocco in 1963.

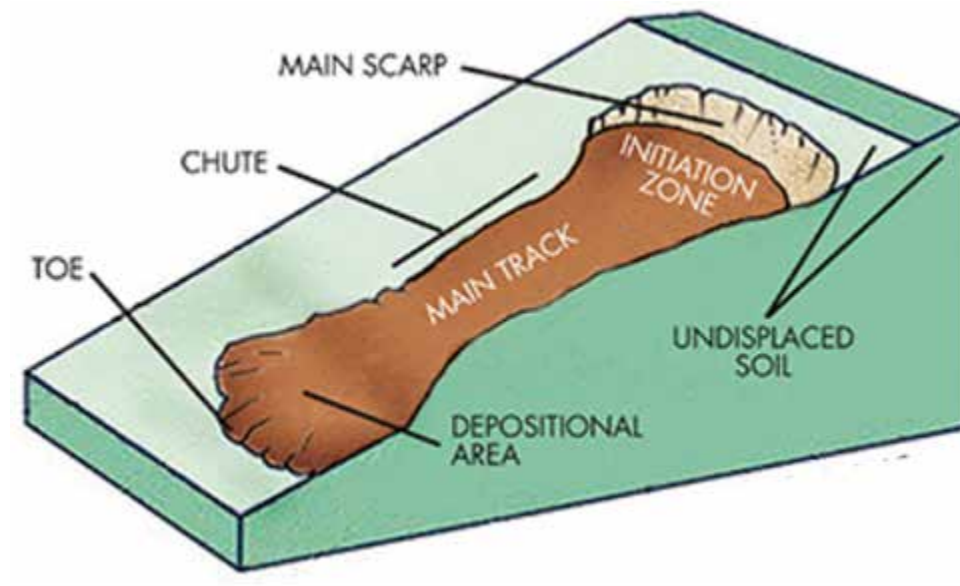


Figure 8.3 Features of a mudflow

Landslides

You might have seen a landslide or watched a movie or news bulletin on television. If so, try to describe the nature of landslides and how they occur. And then compare what you have with our discussion here.

A landslide is whereby large quantities of loosened surface rocks and soil suddenly slide down a steep slope such as a cliff face or a valley side. This is as a result of the lubricating effect of water and the pull of gravity. Human activities such as quarrying and deforestation on steep slopes can cause landslides. Landslides can also be triggered by an earthquake or prolonged heavy rains. During in 2019, when Cyclone Idai struck Zimbabwe landslides are common in the Eastern Highlands.



Figure 8.3 *The occurrence of a landslide*

Rockfall

You might have heard about rockfalls before. What do you think is a rockfall? As the name suggests, this is when a mass of rock falls from a steep slope. This is the most rapid form of mass wasting. Sometimes the fallen rocks breakdown and accumulate at the bottom of the slope forming a mound called talus. However, if rockfall occurs close to a settlement, it may destroy homes and cause loss of life. Imagine your homestead was located at the foot of a hill or mountain, and a rock fell from the peak and landed on one of your huts. What do you think would happen?

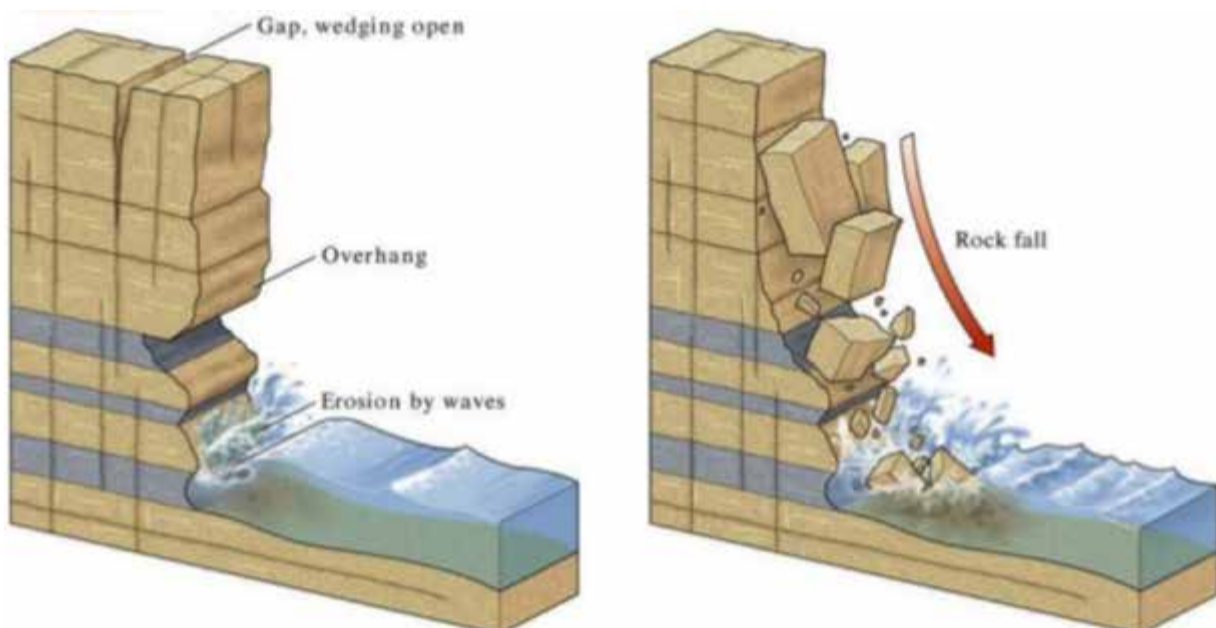


Figure 8.4 *The occurrence of a rockfall*



Activity 8.3: Effects of Mass wasting

1. Briefly describe the following mass wasting processes.
 - a) soil creep
 - b) landslide/avalanche
 - c) rock fall
 - d) mudflows
2. What do you think are the conditions necessary for the occurrence of these processes?
3. Outline the effects of mass wasting on human activities.

8.5 Flooding

Floods occur when heavy rains fall and rivers overflow their banks into the surrounding plains. In Zimbabwe floods are very common in areas like Muzarabani, Mt Darwin as well as the Save Valley. Tropical cyclones also trigger massive flooding as they are associated with heavy rainfall. The recent Cyclone Idai that occurred in Manicaland during the 2018/2019 rain season caused massive flooding particularly in Chipinge and Chimanimani. Did you ever witness or have you ever heard about this disaster on the television or radio? Certainly, you could have heard about Cyclone Idai. If so, quickly list down its effects that it caused in the areas affected. If you mentioned that many people and livestock died, roads and bridges were damaged and homes were reduced to rubble, you are a star!



Figure 8.4; Effects of Cyclone Idai floods.



Activity 8.4: Effects of cyclones

Study the photograph on Figure 8.4 above.

Describe the scene on the photograph.

8.6 Disaster risk management of volcanoes, earthquakes, flooding and mass wasting.

In this section we discuss the disaster risk management of the hazards associated with landform development. Disaster risk management, in this context, are the measures to mitigate the hazards. It is important for you to note that it is impossible to completely eradicate the hazards but we can only reduce their impact.

Now let us go through some of the measures to mitigate effects of any hazard.

Early warning system (EWS): This is when the authorities monitor all signs of volcanic eruption and warn the local people of the upcoming disaster. Such signs include rock cracks, hot patches on rock surfaces and abnormal animal behaviour. People should also be warned of the rising water levels in rivers and be prepared for a possible danger of floods. This can be done through radios, television or social media.

Evacuation: Despite the hazards posed by volcanoes, earthquakes and floods, many people are still attracted to settle in volcanic areas, coastal areas and flood plains because of the rich agricultural soils, minerals and other opportunities offered by such areas. In the event of an earthquake, volcano or floods, the people must be moved from these densely populated areas to safer places. This is called evacuation.

Resettlement: This involves moving the affected people from their original homes to the newly allocated areas on a more permanent basis.

Rescue operations: These are done to minimise the number of deaths when a volcano, flooding or an earthquake occurs. Upon occurrence of such disasters some people will be trapped in collapsed buildings, roof tops or trees and they need to be rescued. In Zimbabwe, rescue operations are often done by the military using their helicopters, boats and other rescue equipment. When Cyclone Idai disaster hit Zimbabwe in 2019, the military, volunteers and other disaster management teams played a crucial part in rescuing the people in trouble.

Building disaster resilient structures: People must be encouraged to build structures that are resistant to these disasters. For example, putting rubber shock absorbers on foundations and using light weight material when building to reduce the effects of earthquakes. In areas that are prone to floods they must use strong materials for building.

Education and awareness: People in areas that are prone to the hazards must be taught what to do before, during and after the disaster.

Aid: The government or local, authorities, well-wishers and non-governmental organisations (NGOs) can provide aid to the affected people in the form of coffins to bury the dead, ambulances and medicine for the injured, clothes, blankets, food, clean water and tents for the homeless.

8.5.1 Action to take in areas at risk of a volcano

If you lived near areas of volcanic activity, what action would you take to reduce the effects of a volcanic eruption? Authorities and scientists should predict volcanic eruptions. If there are any signs of eruption, they should give an early warning to people. The people should leave the area and return when it is now safe to do so. The people should be assisted to evacuate from the place.

8.5.2 Action to take in areas at risk of earthquakes

What do you think people should do in areas where earthquakes are common? Here are some important advices you can give to people living in earthquake-prone areas. It is important to have a fire extinguisher, a first aid kit, a torch and a battery powered radio. You must also have some first aid knowledge. Gas or electric stoves should be switched off. Heavy objects must not be left on shelves because if an earthquake occurs, they may fall. During an earthquake, stay calm and remain where you are. Do not stand near lose heavy objects but stand near the centre of the building. People should also stay away from windows. When outside stay away from power lines and from weak buildings which might easily fall. Then after an earthquake check yourself and others for injuries and provide first aid where necessary. You must quickly check for any damage on water pipes or electricity lines. One should also check for smell of gas and switch it off. One must turn on the radio and follow instructions if there are any from the radio.

8.5.3 Action to take in areas associated with floods

What do you think should be done in areas at risk of flooding in order to reduce the effects? Definitely something could be done, right! In the event that floods are predicted, people in low lying areas, their livestock and valuable property must be moved to a higher ground. Houses can also be barricaded with sandbags to protect them from flash floods. How is this done? This is done by filling bags with sand and laying them around the house. They can as well divert some flood water by digging drainage ditches so that it does not affect houses. During a flood, if flood water rises rapidly, people should get on top of strong buildings or even climb a tree. Always remember! Your life is more important than your possessions. Save your life first before you think of saving your property.

8.5.4 Action to take in areas at risk of mass wasting

Now let us discuss ways of reducing effects of mass movement. One should always be alert after heavy rains because heavy rains trigger landslides. Look for signs of movement on slopes. If possible, one should live the area in danger until rainfall has stopped and the ground has dried up. People are also advised to keep away from steep slopes with loose rocks. Do not use heavy machinery which causes vibration because they might trigger a landslide or a rockfall.



Summary

In this unit we described hazards associated with landforms development. We also outlined the various ways of disaster risk management of these hazards particularly volcanoes, earthquakes, flooding and mass wasting. Ways of mitigating against the hazards were also discussed in this unit. We hope you benefited a lot from this unit. Please continue to revise this section to have a full grasp of the concepts you have learnt. Wish you the best in the units that follow.

End of unit Assessment

Section A: Multiple Choice

1. What immediate action can a government take to help flood victims?
 - A. Early warning systems
 - B. Evacuating them to higher area
 - C. Educating them on dangers
 - D. Rebuilding their structures
2. The most important step to take whilst indoors during an earthquake is to
 - A. Check yourself and others for injury
 - B. Turn on the radio for news
 - C. Make an escape plan for the family
 - D. Protect oneself from falling objects

3. In the event of a major cyclone such as Idai, which of the following is **not** an immediate form of assistance by the government?
 - A. Giving tents to the homeless
 - B. Giving food handouts
 - C. Building more towns
 - D. Providing medicine to the injured

4. Which of the following can help to reduce the impact of floods?
 - A. Deforestation
 - B. Ploughing along river banks
 - C. Dredging
 - D. Growing drought- resistant crops

5. One way of mitigating earthquake hazards is
 - A. Building houses with light material
 - B. Planting vegetation
 - C. Terracing steep slope
 - D. Building high rise buildings

Section B: Structured Questions

1. What do you understand by disaster risk management in the study of hazards. (2)
2. Explain any two ways of mitigating the risk of floods. (4)
3. a) Suggest measures you would take to reduce the effects of earthquakes. (4)
b) What problems are you likely to face in implementing these measures? (3)

Research Work

Visit a nearby area affected by Cyclone Idai and find out the effects of the cyclone in that area.



Progress Check list

Now take this time to go through the objectives we listed at the beginning of the unit and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet to achieved. Then for any that you put an X against, find the section dealing with it in the unit and go over it again.

Objective Are you now able to...	Check Box
• describe the hazards associated with development of landforms	
• identify ways of disaster risk management of volcanoes, earthquakes, floods and mass wasting	
• describe mitigation measures for these hazards	

Unit 9 Ecosystems: Wetlands and soils in the tropics

- 8.1 Importance of wetlands
- 8.2 Benefits of wetland areas
- 8.3 Components of soil air, water, organic matter and minerals
- 8.4 Soil forming processes gleization and cheluviation
- 8.5 Soil types sand, clay and loam
- 8.6 Soil profile
- 8.7 Soil properties texture, structure, colour, pH and organic matter
- 8.8 Mineral content

Introduction

You have learnt about soils and ecosystems in the previous units. What do you think are the importance of wetlands to human beings? Ecosystems play a vital role in our life. In this unit we are going to learn about the importance of ecosystem. You will also learn about the components of the soil, soil forming processes, soil types, soil profile, soil properties and their mineral content.



Objectives

After going through this unit, you should be able to:

- name soil forming processes
- outline the benefits of wetlands
- identify components of the soil
- describe the processes of cheluviation
- explain the importance of wetlands



Key Words

Wetlands	are waterlogged areas. Common names include marshes, dambos and swamps
Soil PH	an indication of the alkalinity or acidity of a soil
Gleization	a soil forming process which occurs in waterlogged areas. Anaerobic respiration occurs and results in formation of gley soils

Cheluviation	a soil forming process which involves downward movement of minerals. It occurs due to the presence of chelating agents
Soil texture	coarseness or fineness of a soil
Soil structure	the arrangement of soil particles



Time

You are expected to take an average of **10** hours to go through this unit.



Study skills

- You should note that in this unit we are going to study about wetlands and their importance.
- You will also need a good understanding of the environment in order to understand the aspects of soil formation and their properties. If you have any doubts about the previous concepts go back and have a relook.

9.1 What are the Importance of wetlands?

You have already come across the definition of the term wetland. We said a wetland is a waterlogged area. A number of animals can be found at wetlands these include buffaloes, small game like gazelle, lion and giraffe. Attempt the activity below in order to have a better understanding of wetlands.



Activity 9.1 Wetlands

Study the photograph below that shows a wetland, describe what you see in the picture?

Photograph showing different types of animals in a wetland



Figure 9.1 A wetland

From the Figure 9.1, you can see that there are a number of wild animals and plants, so wetlands are important because they are a habitat for wild animals and plants. Animals like the water buffalo and the black rhino depend on this type of ecosystem for survival. Birds like the fish eagle survive on these wetlands.

Wetlands are important because they are the breeding grounds for fish. These areas are also nursery grounds for young animals as it offers good protection. Wetlands shelter wild animals from attack.

Wetlands slow down run off from storms; their plants bind the soil together and protect shorelines from wave erosion for example in north western Africa in the Niger Delta.

Can you think of any other reasons why wetlands are important? Yes, they are beautiful and unique places of interest especially to wildlife enthusiasts, bird viewing and artists. Examples include the Okavango swamp in Botswana and areas along the Zambezi valley.

Now that we have seen that wetlands are important as breeding grounds for fish and water loving animals, they slow down rates of water movement and that they are good as unique areas of interest we now want to look at the benefits of wetlands. Can you think of any benefits?

9.2 The benefits of wetlands

Wetlands are beneficial to mankind because they improve the water quality of an area. Aquatic plants found in these areas remove nitrates, phosphorus, and pesticides from agricultural runoff. You may not have heard about “aquatic”. This simply means water loving plants and animals. Plants and animals in these areas act as a filtering system as they remove dirt through filtration and sedimentation.

Wetlands help in trapping and slowly releasing water. Trees and grass help by reducing the speed of moving water, this helps in distributing water into the flood plain.

Tourism is also promoted by the presence of wetlands. These areas offer good recreational opportunities like canoeing, fishing and swimming. This is beneficial to human beings as people get employed and a lot of foreign currency is gained from these activities. Infrastructural development occurs as people come to enjoy these tourist attraction centres.

Now attempt the task below before we move on to soils.



Activity 9.2 Benefits of ecosystems

1. What are the benefits of ecosystems?

2. Define the term aquatic and give examples of aquatic animals and plants

9.3 What are the soil components?

Do you still remember the definition of the word soil? Take a sample of dry soil, study the sample and write down the components. You can see that the soil is a complex mixture of different kinds of particles. Each of the components is important in supporting plant growth. The soil components are:

9.3.1 Minerals

Reflection

As you can see from Figure 9.2 minerals make up 45-49% of the soil. It is the largest component of the soil. There are two types of minerals which are primary and secondary. Primary minerals are found in sand and silt areas where the soil materials are similar to the parent rock. You would see that the materials are usually round or irregular in shape. On the other hand secondary minerals are formed from weathering of stable minerals like silicate clay. These soils hold more nutrients.

9.3.2 Water

Figure 9.2 shows that water is the second biggest component of the soil, it constitutes about 25% of the soil. What do you think is the role of water in the soil? Yes, you were supposed to say water moves nutrients from one part to another and it also helps in biological and chemical decay. Water holding capacity depends on the size of its particles. The smaller the particles the more they can hold water. Clay has the biggest water holding capacity whilst sand has the lowest. Look around the place where you stay you can see that soils with large particles quickly drain off whilst those with smaller particles hold water.

9.3.3 Organic matter

In Figure 9.2, we can see that organic matter makes about 5% of the soil. The organic components of soils include the residue of dead plants the ones that you see in the fields after harvest, animals like bacteria and worms. For us to have healthy plants in the fields it needs to have organic matter. Soils rich in organic matter have potassium, nitrogen and magnesium. Soils that have a more than 30% organic matter are referred to as organic soils whilst the others are called mineral soils.

9.3.4 Air

In Figure 9.2, we can also see that another component of the soil is Air. It makes up 25% of the soil. Why do you think we need air in the soil? Yes, air is a very important component of the soil. Sandy soils have the highest percentage followed by loam soils and then clay at the bottom. Air is very important component because it is used by micro-organisms for respiration and for movement of nutrients. Air in the soil has similar amounts of nitrogen except that of oxygen, carbon dioxide and water vapour. Components of the soil can be summarized by the Figure 9.2

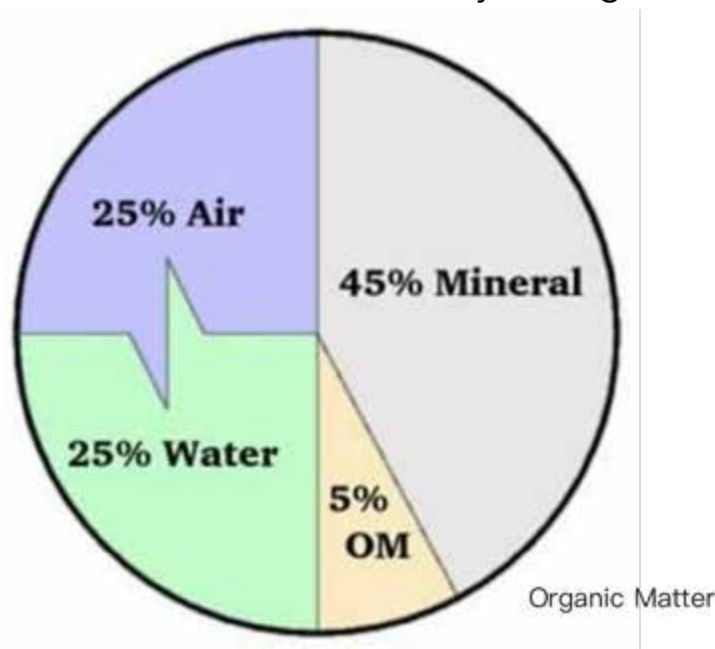


Figure 9.2 Soil components

9.4 Soil forming processes

In this section we want to look at the different soil forming processes. Can you name any processes that are responsible for soil formation? Yes, these processes involve movement of nutrients from one part of the soil profile to another; these include chelation, salinization and leaching.



Activity 9.3 Soil forming process

We have seen that soil is a habitat, a place where organisms live. Look around you. Where do you think the soil could have come from? Discuss your answers with a colleague.

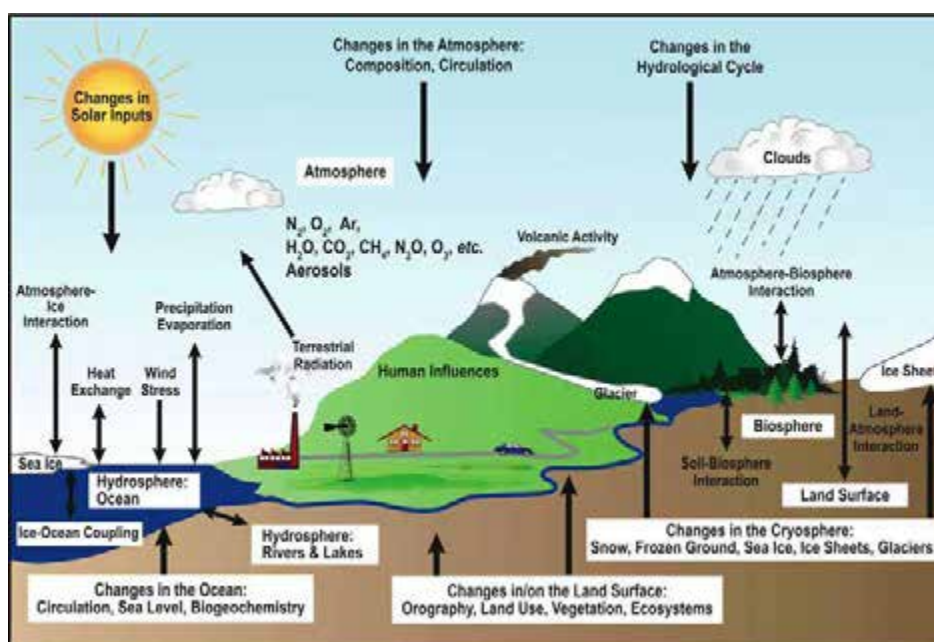
Soil is formed by the weathering or breakdown of the parent rock. Do you still remember what we said about weathering? Yes, we said that. Weathering is a result of chemical, physical and biological agents such as running water in rivers and streams, stones are rolled and rub against each other and break to give soil which can be physical or organic in form. For example, take two pieces of rock let the rock pieces crush against each other. What do you see? Rock pieces become smaller and grains of soil are produced, that is one way in which the soil can be formed.

Can you think of other ways in which soil can be formed? Look at the diagram in Figure 9.3 which shows a process of soil formation. Look at how carbon is used in the process of soil formation.



Activity 9.4 The Carbon cycle

1. Describe the main feature of Figure 9.3.



You can see that the Figure 9.3 shows how Carbon dioxide in the atmosphere can help in soil formation. We produce carbon dioxide when we breathe out and this gas mixes with water to form weak carbonic acid, this acid mixes with sedimentary rocks like limestone to give calcium bicarbonate. This is a solution which can easily flow down the river. So, this process helps to explain how soils are formed in chalk and limestone regions for example in areas like Chinhoyi caves. Besides weathering the soil can also be formed through other processes. Which other processes do you think are also responsible for soil formation? We now want to look at two major processes of soil formation which include **gleization** and **cheluviation**.

9.4.1 Gleization

Another important soil forming process is gleization. This process usually occurs due to the prevalence of certain environmental conditions. The areas are usually waterlogged therefore lack oxygen promoting the process of anaerobic respiration. It can also be called reduction because oxygen is removed. This process has an effect on soil colour and nutritional status of a soil. Now you can attempt the activity below.



Activity 9.5 Soil Gleization

Study the figure 9.4 and attempt questions that follow



Figure 9.4 Soil Gleization

1. What is the colour of the soil in the top layer?

2. Can you see the colour changes as you go down the soil layer? Briefly describe the soil colour changes.

As you can see from the diagram above, the soil layers become lighter as you go deeper. Why? Because the soil layers in the upper horizon lack oxygen so they have been reduced of oxygen. The main biological process taking place here is called anaerobic respiration so the soils turn dark black\blue and are referred to as grey soils or valley peat soils. The process occurs in areas of high rainfall with a lot of waterlogging. The grass that usually grows in the upper horizons are usually green in colour because there are a lot of nutrients and an abundance of water as shown by Figure 9.5



Figure 9.5 The results of the process of cheluviation

Another important process of soil formation is **Cheluviation**. Do you still remember the definition? Yes, it is a soil forming process, which involves the downward movement of nutrients due to the presence of chelating agents in areas with thick vegetation. How is the definition different from **Gleization**? Remember the differences in environmental conditions.

9.4.2 Cheluviation

From the definition, you can see that it is also a soil forming process like gleization. Study the illustrations below and try to identify the different environmental conditions that affect the processes.

So, you can see from the illustration **Cheluviation** is a soil forming process whereby plant acids help in the movement of metallic compounds like + aluminium and iron

from the upper horizon to the lower horizons of the soil profile. The soils then develop a brick like layer which can also be referred to as a lateritic layer. The process is also similar to leaching. Study the Figure 9.6 which shows the process of **cheluviation**.



Activity 9.6 Soil Cheluviation

Describe what you see from the Figure 9.5: What type of soil is likely to be formed by the soil forming process above?

We can see that there is green grass, pieces of dead grass and thick layer of dark soil. Soils are dark in colour and are structure less, sticky and boggy-blue in colour. These soils are found in vleis and dambos. The soils are commonly called hydromorphic soils.

9.4.3 Salinization

It is another soil forming process that is typical of areas with greater evapotranspiration than precipitation. It is also found in areas with dry climates.

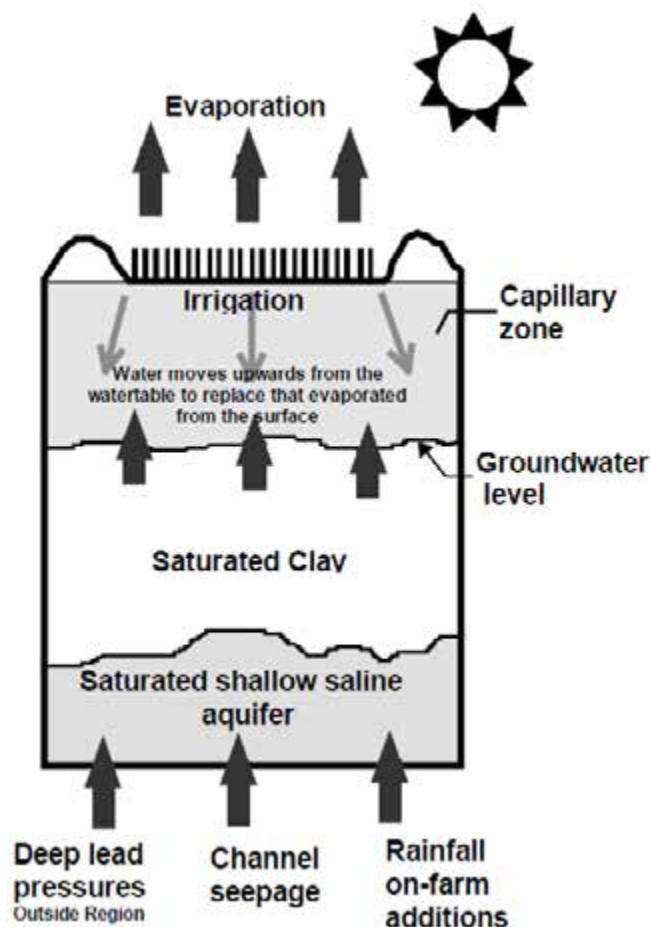


Figure 9.7: The process of salinisation

This process occurs in dry regions where precipitation is less than evaporation. Salts in the soil move from the B horizon to horizon A through the process of capillary action. The salts are deposited in the upper layers of the soil. The salts move from the zone with saturated saline aquifer to the capillary zone where there is irrigation as you can see on the diagram. The resultant soil is saline which means it is salty if tasted and whitish in colour, this type of soil is of little value to the farmer as it contains little nutrients the soils are collectively called saline soils because they are salty. The diagram below explains the process of salinization. Go through the Figure 9.6 9,7 and 9.8 a number of times in order to grasp the concepts.

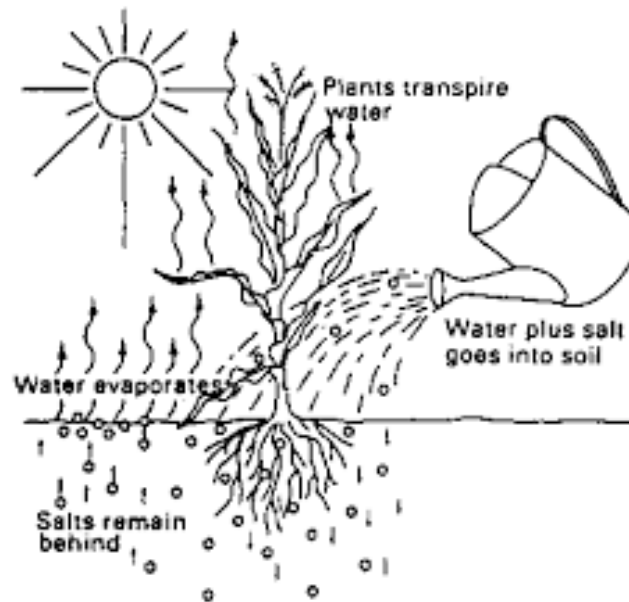


Figure 9. 7 Salinization process



Figure 9. 8 Soil salinization

9.4.4 Leaching

So far, we have looked at three main processes of soil formation that are gleization, cheluviation **and salinization** we now want to look at the process of leaching. Nutrients usually move down the layers of the soil after the soil has received a lot of moisture. It occurs in areas with good drainage. It involves the breakdown of clays and dissolving of soluble salts that are also called bases. Calcium and magnesium are moved downwards to the lower horizons.



Figure 9. 9 Soil leaching



Activity 9.7 Leaching

1. List down the types of nutrients that move down the soil horizon.?
2. Describe the type of movement taking place?
3. Identify the environmental conditions that promote this process.?

From the activities that you have done above you can see that leaching is a soil forming process that involves the removal of soluble materials in solution. It occurs in areas where precipitation exceeds evapotranspiration. Calcium and magnesium are removed from the A horizon and then deposited in the B horizon. The upper layer of the soil becomes acidic as it is replaced by hydrogen ions. The layer becomes poorer as it lacks nutrients.

9.5 Soil types

Now that we have looked at components of the soil and soil forming processes, we now want to look at the soil types. There are different types of soils that farmers and gardeners use. These different types of soils are a combination of three weathered rock particles, which are sand, silt and clay. A combination of these particles determines the soil type.

Study the Figure 9.10, which shows soil type, and attempt questions below.



Figure 9. 10 Soil types



Activity 9.8 Soil type

1. Collect samples of soil types listed in figure 9.10 and describe their characteristics as you feel and see them?

From Figure 9.10, you can see that there are three major soil types, which are sand, clay, and loam. The soils are dry and gritty with huge spaces in between. Sandy soils hold little water and drain quickly. Nutrients quickly move down since they are carried away by runoff.

9 5.1 Sandy soils

Sandy soils are usually formed in areas with a lot of granite rocks, these soils have large crystals and are usually used to grow leguminous crops. These are dry and gritty which means they are rough when felt in between the fingers. Sandy soils have the largest soil particles, they hold little water because the gaps that are found in between the particles allow water to move through very fast. These soils are very easy to work with and are good for crops like groundnuts. Movement of nutrients is very fast as this soil has large pore spaces.



Activity 9.9 Soil types

Revisit figure 9.10 and answer the questions that follow

1. What is the colour of the sandy soils?
2. What type of crops can be grown in these soils?
3. What type of tools can be used to work these soils?

These are dry and gritty which means they are rough when felt in between the fingers. Sandy soils have the largest soil particles; they hold little water because the gaps that are found in between the particles allow water to move through very fast. These soils are very easy to work with and are good for crops like groundnuts. Let us look at clay soils.

9.5.2 Clay soils

Study the Figure 9.10 and attempt questions that follow.

Clay soils have the smallest soil particles and its particles have a tendency of settling together. These soils have a tighter hold on nutrients and this makes fertile. The disadvantages of these soils are that they are badly aerated and heavy to work with as its particles stick together.

9.5.3. Loam soils

We have looked at clay and sandy soils we now want to move on and look at loam soils.

These are the most ideal type of soils. Soil particles are of varied nature and are able to hold soil moisture. These soils drain quickly because they are well aerated. Plants are able to access moisture in these soils. After looking at the soil types we now want to move on and look at the soil profile.

9.6 Soil profile

We are a selfie-obsessed and a photogenic generation. Today everything and anything has a profile somewhere or the other. Do you know even soil has one? Don't believe in this! The soil profile is defined as a vertical section of the soil that is exposed by a soil pit. A soil pit is a hole that is dug from the surface of the soil to the underlying bedrock.



Activity 9.10 The Soil profile

Visit the river nearby and look at the sides of the river. Do you notice any layers? Are there any changes in soil colour as you move down to the river bed?

I am sure you noticed that soil is found in layers, which are arranged during the formation of soil. These layers are called horizons – the sequence of layers is the soil profile. The layers of soil can easily be observed by their colour and size of particles. The main layers of the soil are topsoil, subsoil and the parent rock. Each layer has its own characteristics. Did you know that these features of the layer of soil play a very important role in determining the use of the soil? Now let us together look at soil horizons.

9.6.1 Top soil

It is also called the humus layer, which is rich in organic material. This layer consists of decomposed material and organic matter. This is the reason why the topsoil has a dark brown colour. The hummus makes the topsoil soft, porous to hold enough air and water. In this layer, the seeds germinate and roots of the plants grow. Many living organisms like earthworms, millipedes, and centipedes, bacteria, and fungi are found in this layer of soil.

9.6.2. The sub-soil

Just below the topsoil lies another layer called subsoil or Horizon-B. It is comparatively harder and compact than topsoil. It is lighter in colour than the topsoil because there is less humus in this layer. This layer is less organic but is rich in minerals brought down from the topsoil through leaching. I hope you still remember leaching from section 9.4.4. if you have forgotten, please revisit the concept. It contains metal salts, especially iron oxide in a large proportion. Farmers often mix horizon-A and Horizon-B when ploughing their fields.

9.6.3. Parent material

Parent is also known as bedrock rock and lies just below the subsoil. It contains no organic matter and made up of stones and rocks, so it is very hard. This layer represents a transition zone between the earth's bedrock and horizon A and B. The soil profile is illustrated in Figure 9.11.

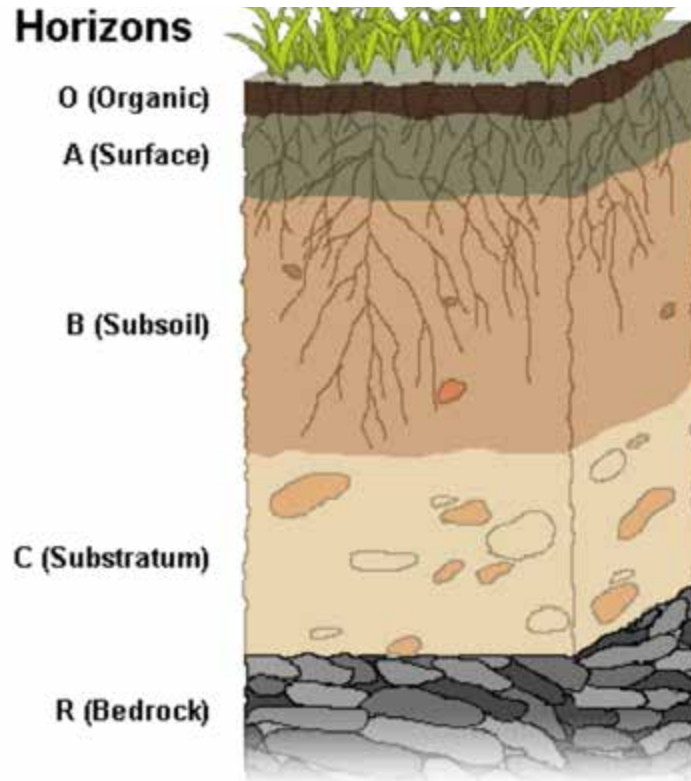


Figure 9. 11 Features of a soil profile

In this section we have seen that soil profile refers to the arrangement of the layers of the soil from the topsoil to the parent rock. The most important layer is the topsoil where all plant growth takes place. We now want to move on to the soil properties.

9.7 Soil properties

In section 9.3 we said all soils contain mineral particles, organic matter, water and air. The combinations of these determine the soil's properties, that is, its texture, structure, porosity, chemistry and colour which eventually have an effect on plant growth. We will start by looking at the soil texture. Attempt the activity below that deals with soil texture, you should go through all the questions.

9.7.1 Soil texture



Activity 9.11 Soil texture

Take a soil sample almost the size of a tablespoon. Rub it against your fingers, what do you feel? Write your observations down.

From the above activity, you can see that we are able to come out with feelings such as:

- The soil is coarse/rough
- Is fine/smooth

This describes the soil texture. So, you can now define soil texture as the coarseness or fineness of a soil type. It is a very important property of the soil as it determines activities to be done in a type of soil. For example, if the soil has small particles then there is a need to add more nutrients to the soil, to increase the size of soil particles

You should know that soil texture can influence whether soils are free draining, whether they hold water and how easy it is for plant roots to grow.

- Sand particles are quite big. The pore spaces between the particles in sandy soils are also quite large. This allows water to drain quickly and air to enter the soil. Sandy soils tend not to get waterlogged in winter but can be subject to drought during summer.
- Silt particles are too small for us to see with our eyes. Silt soils have much smaller pore spaces but a lot more of them.
- Clay particles are smaller than 0.002 mm in diameter. Clay soils are poorly drained and hold on to the water in their pore spaces for much longer. However, they can become very hard if they dry out.

9.7.2. Soil structure



Activity 9.12 Soil structure

Study the figure 9. 12 showing different soil structures:

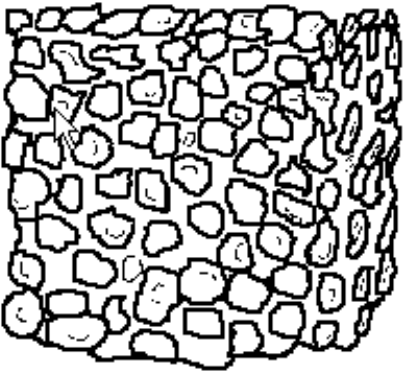
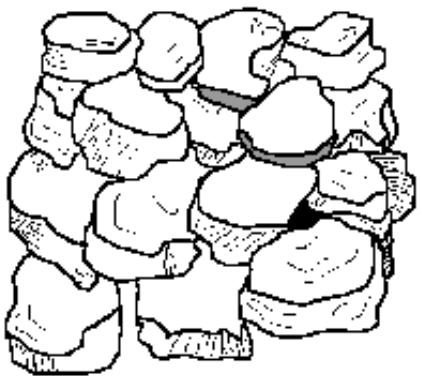
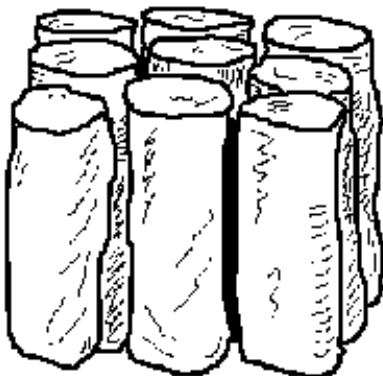
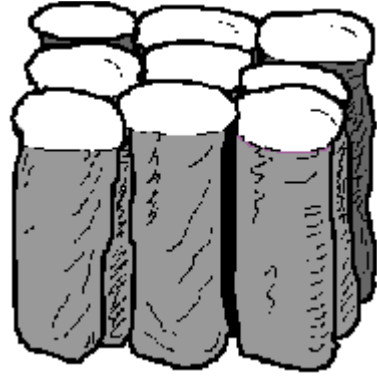
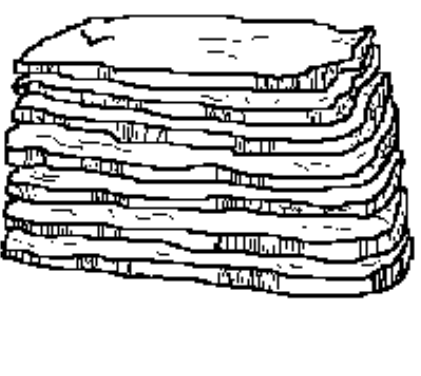

		
<p>Granular: Resembles cookie crumbs and is usually less than 0.5cm in diameter. Commonly found in surface horizons where roots have been growing.</p>	<p>Blocky: Irregular blocks that are usually 1.5 - 5.0cm in diameter.</p>	<p>Prismatic: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.</p>
		
<p>Columnar: Vertical columns of soil that have a salt 'cap' at the top. Found in soils of arid climates.</p>	<p>Platy: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.</p>	<p>Single Grained: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.</p>

Figure 9. 12 Soil structures

1. List the types of soil structure?

2. Describe the importance of the different soil structures in agriculture?

Soil structure describes the way the sand, silt and clay particles are clumped together. Organic matter (decaying plants and animals) and soil organisms like earthworms and bacteria influence soil structure. Clays, organic matter and materials excreted by soil organisms bind the soil particles together to form aggregates. The soil structures can be crumb; the particles are small and individual and are porous. This structure is the most ideal for agricultural production.

Granular structure has small individual particles, which are usually non-porous and are usually found in the A-horizon. This type of structure is fairly productive but has problems with drainage.

9.7.3 Soil PH

Another soil property that is important is soil ph. It is a measure of a soil 'acidity or alkalinity. The scale ranges from 0-14.

0 is extremely acidic whilst 14 is extremely alkaline and 7 is neutral. When a farmer wants to grow crops, s/he chooses crops according to the Ph. values in a soil or the farmer change the Ph. value to suit the crop. The scale is shown in Figure 9. 13 What do you think are the importance of soil ph. values in a soil.? Go through the diagram below and identify the value of soil ph.

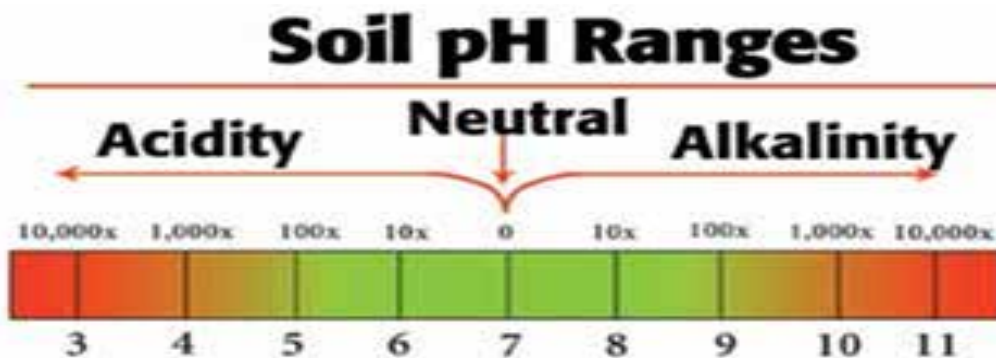


Figure 9.13 The soil pH range

From what we have seen in the diagram above soil **ph.** is very important as it helps the farmer decide on what to grow and also on the types of nutrients that need to be added on to the soil. Let's move on to look at another soil property which is important which is soil colour.

9.7.4 Soil colour



Activity 9.13 Soil colour

Go back to Figure 9.10 and study the soil colours

1. Write down any 3 colours of soil that you can see?
2. What is the importance of soil colour to a farmer?

If you thought that all soils are brown, think again. Soil colours range from black to red to white. Sometimes it can even be blue! Soil colour mostly comes from organic matter and iron. Topsoil is often dark because of organic matter. An even, single colour indicates the soil is well drained. In contrast, rusty spots and grey patches (sometimes even a light blue in colour) indicate poor drainage. Red soils will show that the soils have been oxidized

It is important for you to note that the colour of the soil will indicate the composition of the soil and will give an idea to the condition that the soil could have undergone. So, soil colour also helps in determining the amount of nutrients in the soil. The next important soil property is the amount of organic matter in a soil.

9.7.4. Organic matter in the soil

In the previous section we looked at soil colour as an important soil property, organic matter also plays a vital role in the soil. Before we discuss their importance can you attempt the questions below:

For you to be able to attempt this activity make sure you have gone through section on components of the soil in the first part of this unit.



Activity 9.14 Organic matter in the soil

Go back to Figure 9.10 and study the soil colours

1. Write down any 3 colours of soil that you can see?
2. What is the importance of soil colour to a farmer?

Did you know that organic matter may be divided into aboveground and below ground fractions? Aboveground organic matter comprises plant residues and animal residues; below ground organic matter consists of living soil fauna and microflora, partially decomposed plant and animal residues, and humic substances.

You can see that the best soils are those with high organic content. It helps in nutrient cycling and adds minerals like nitrogen, phosphorus and iron. Presence of organic matter helps the rates of water movement in the soil and reduces evaporation. High organic matter helps in increasing the water holding capacity of the soil.

Organic matter also helps to improve the arrangement of the soil particles thereby reducing soil erosion and minimizing soil compaction thereby raising aeration rate. Presence of organic matter helps plants by providing a source of nutrients and reducing chances of crop failure.

From what we have discussed above it can be seen that organic matter is important to soils as it provides nutrients and help in the aeration rates of the soil. We now want to look at mineral content as an important soil characteristic.

9.8. Soil mineral content



Activity 9.15 Soil mineral content

Remember that for us to have a good soil it is supposed to have all the different minerals.

1. Do you know any soil mineral? If you do, name those you know?
2. Describe the role of the different minerals in the soil?

Soils contain important mineral contents, which are iron, potassium, magnesium calcium and sulphur. Minerals play an important role in soils as they help plants in absorbing water adjusting the soil **pH**. values and providing plants with nutrients. The most important minerals are nitrogen, phosphorus and potassium. The soil also contains different sizes of organic matter, water and air.

Well done, you have come to the end of this unit. It is my hope that you have understood all the concepts in this unit. It is now time to remind you of all that we covered in this module. Go over the points in the summary below and check if you have understood the concepts listed there. If they are concept you are not sure of, please revise the sections with those concepts or ask your teacher.

Summary

Here is a reminder of what we have covered in this unit

- Wetlands are waterlogged areas, which absorb pollutants and act as a sponge to the environment.
- Wetlands provide a habitat for wild animals and plants
- Wetlands control floods as they allow water to filter through in times of flooding.
- The components of the soil are air, organic matter, water and minerals.
- The major soil forming processes are **leaching**, **salinization**, **gleization** and **cheluviation**.
- The major soil properties are **texture**, **structure**, **colour**, **pH**, and **organic matter** content. We ended the unit by looking at the mineral content

End of Unit Assessment

Now that you have gone through this unit check out how much you understand by attempting the questions below

Fill in questions

1. Wetlands can be referred to as
2. Soil components include air,, and.....
3. On a soil ph. the value 14 means the soil is
4. The most important minerals in the soil are nitrogen, and
5.is the coarseness or fineness of soil particles.

Structured questions

1. Draw a well labelled diagram to show a soil profile
2. Describe how soils are formed through the process of salinization?



Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding. I have listed them here below. Go through them and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it in the unit and go over it again. Right mark yourself!

Objectives: Can you now:	Check box
• name soil forming processes	
• outline the benefits of wetlands	
• identify components of the soil	
• describe the processes of cheluviation	
• explain the importance of wetlands	

Further reading

Here is a list of some of the textbooks you can refer to for further understanding

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 10 Biogeochemical cycles

10.1 Biogeochemical cycles (Nutrient cycle, Nitrogen cycle and Carbon cycle)

10.2 Conservation methods

10.3 Restoration measures

10.4 What is the importance of ecosystems?

In the previous unit you learnt about Ecosystems and Wetlands in the Tropics. You were also able to list the benefits of Wetland areas. If you have any doubts go back to the unit and read again. In everyday life we all need, water, nitrogen and carbon to survive. In this unit we will study about the Biochemical cycles, Conservation methods in an ecosystem, restoration methods and importance of the ecosystem.



Objectives

After going through this unit, you should be able to;

- Draw diagrams to show different nutrient cycling models
- Outline the benefits of restoring ecosystems
- Identify methods of conservation of the ecosystem
- Explain the biogeochemical cycles
- Explain the importance of ecosystems



Key Words

Ecosystem	is a self-containing system of interdependent organisms in an environment
Nutrient cycling	is the movement that occurs when chemicals are exchanged between the living and non-living components of the earth
Denitrification	is a process which refers to the reduction of nitrates to molecular nitrogen
Nitrification	is the addition of oxygen to ammonia to form nitrites
Conservation	is the wise use of natural resources



Time guide

You are expected to take an average of **10** hours to go through this unit.



Study skills

You now have an idea on biogeochemical cycles and nutrient cycling. We want to look at nutrient cycles in detail. The mineral nutrient cycles were developed by P.F. Gersmehl in 1976 to show the differences between ecosystems in terms of nutrients stored in and transferred in the different compartments. Nutrients can be found in our surrounding.



Activity 10.1: Biotic and Abiotic components Activity

Choose an area you know very well it can be a dam or pond, field or a garden. Investigate the biotic (living) and abiotic (non-living) components of found there. Describe how the nutrients move from one form to another.

10.1. What is Nutrient Cycling?

From the activity you have done above, you were expected to come out with transfers that occur between living and non-living components. As plants die, they release nutrients to the soil, when we grow crops nutrients are transferred to the living organisms, when the animals die the nutrients are transferred back to the soil. The continuous movement of nutrients is always in a state of equilibrium as nothing is lost or gained. Nutrient cycling is then referred to as the continuous chemical movement of nutrients. It can also be called matter cycling.



Activity 10. 2: Gersmehl's Nutrient Cycles

Study the Figure 10. 1 and attempt the questions that follow as this will help you to have a better understanding of the concept.

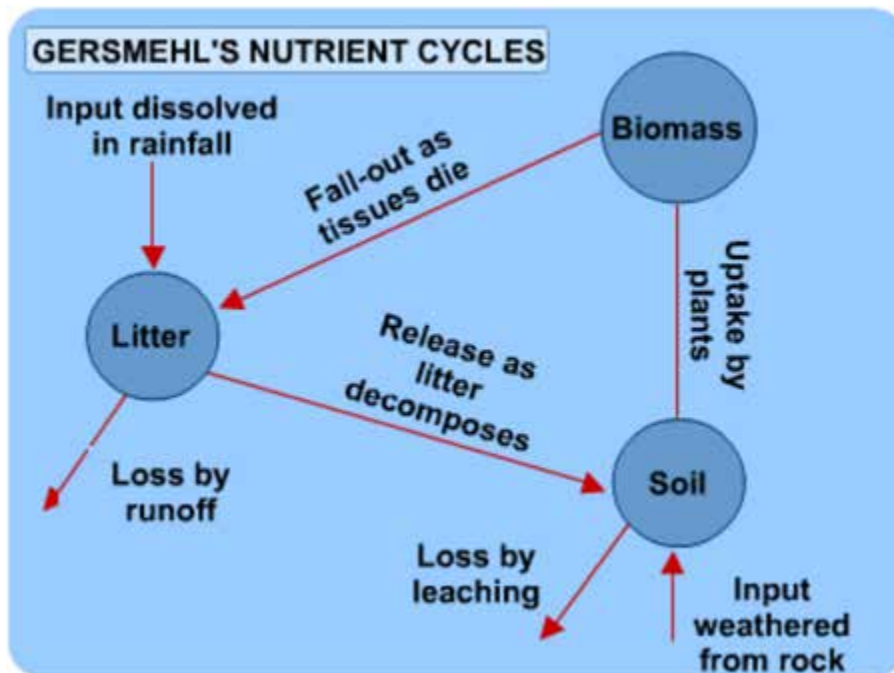
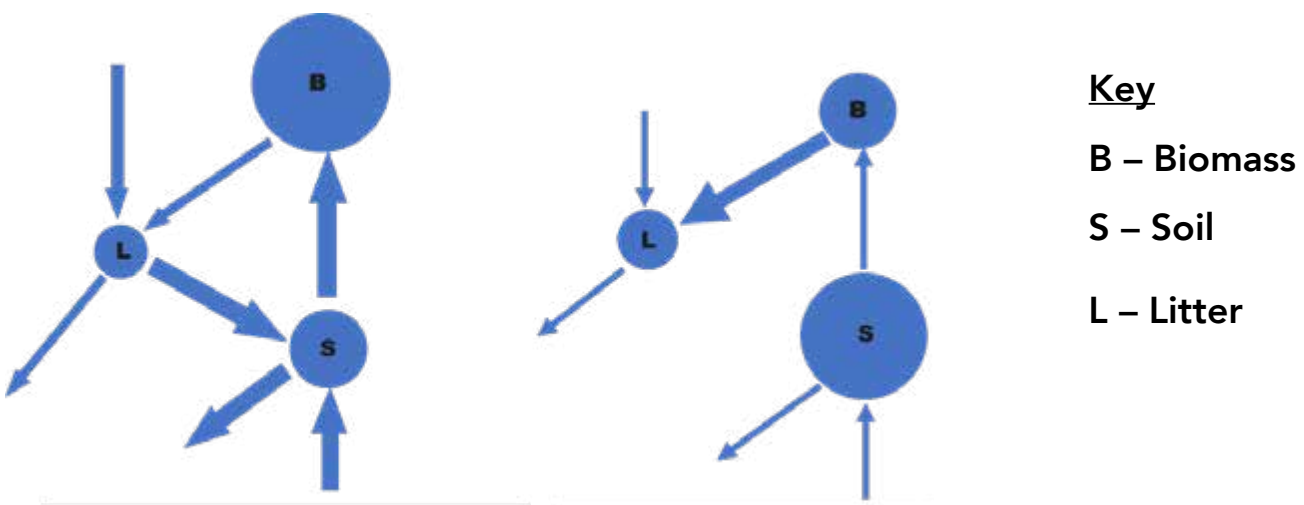


Figure 10. 1 Gersmehl's Nutrient Cycles

From the Figure 10.1 you can see that nutrients are stored in three forms which are Biomass, Litter and Soil. The nutrient stores above are determined by the availability of moisture, heat, fire and density of vegetation, competition and length of growing season. Figure 10. 2 shows the various forms of nutrient cycles in different climatic regions.



(left) Figure 10.2 Selvas (Equatorial rainforest)

(right) Figure 10.3 Tropical grasslands

We hope you have noticed that the sizes of the circles are equal to the quantity of nutrients. Thickness of the lines is proportional to the movement of nutrients. For example, the Equatorial rainforest has the largest store of nutrients in the biomass this is because the area experiences very high rainfalls and temperatures and this results in active plant growth. Soil store is the second largest followed by litter store. Litter store is the lowest in this region because chemical nutrients are quickly turned to biomass and soil store because of high rates of leaching, rapid uptake of nutrients by green plants and presence of microorganisms which quickly turn the chemical nutrients. We are going to briefly look at the nitrogen and carbon cycles as they represent the nutrient cycling processes.

10.2 The Nitrogen cycle

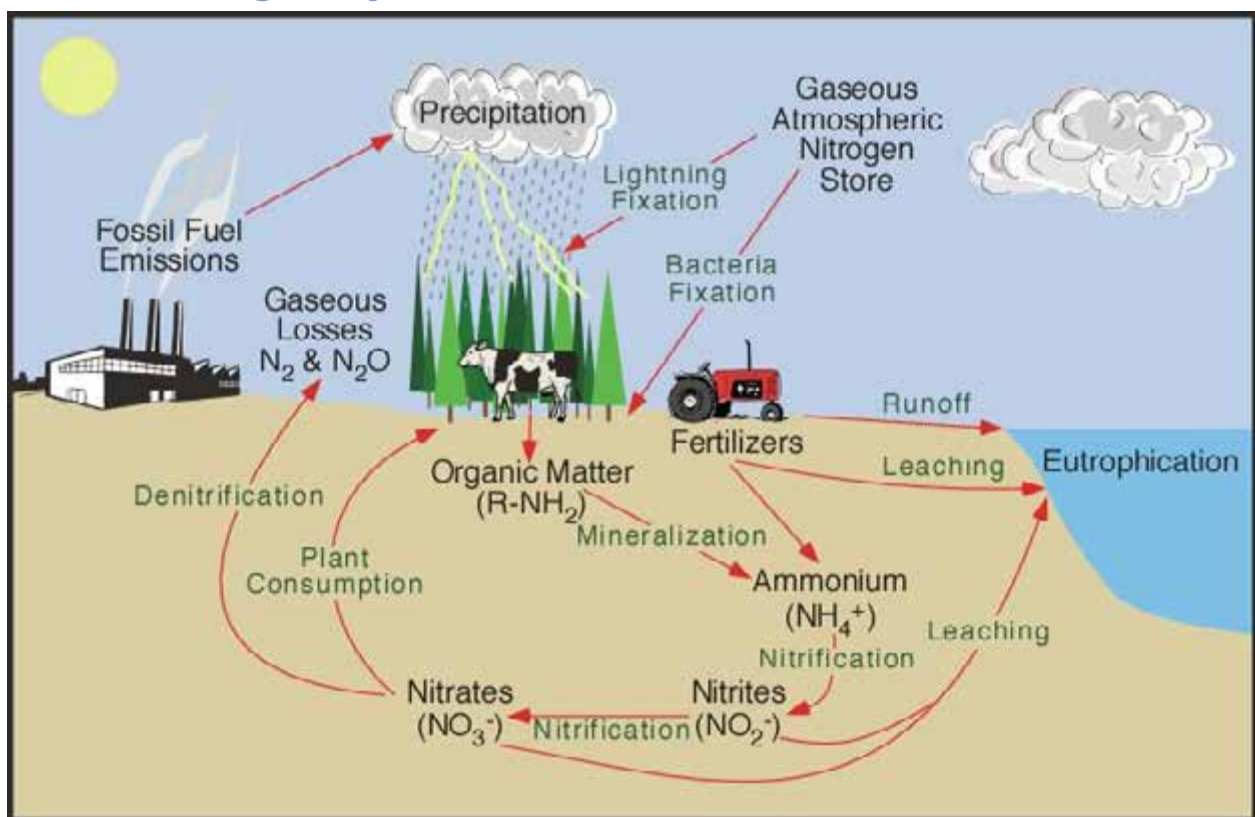


Figure 10. 4 The Nitrogen cycle

Nitrogen is the most important gas in the atmosphere where it constitutes 78% of the air. It is found in molecules and oxides.

Nitrogen found in the atmosphere is fixed into soil through lightning. It is also fixed in the form of ammonia and is transferred to nitrates by nitrogen fixing bacteria. Where do you think the nitrogen fixing bacteria is found? Yes, it is found in plants like beans, clover and alfalfa.

Another process which is important as shown above is ammonification. What do you think it means? You can use the internet to get the answers. It is the decomposition of biological wastes by bacteria releasing ammonia into the atmosphere. The ammonia

is then dissolved in rain or converted to molecular nitrogen. Animal excrement and urinary wastes also add to ammonia.

Nitrification is another important process in the cycle. Can you identify the process on the diagram? It occurs in two states which are nitrites and nitrates. Once ammonia is formed it mixes with oxygen to form nitrites. These nitrates are then transferred to animals through grazing by plant eating animals called herbivores.

Another process that is important on the cycle is denitrification. It is the change of nitrates to molecular nitrogen. It is done by denitrifying bacteria. The process is a reverse of nitrification. These bacteria help in the return of nitrogen back into the atmosphere. Attempt activity 4 to check on your understanding of the nitrogen cycle. Go through all the questions carefully if you have any problems go back to the section.



Activity 10. 4: Nitrogen cycle

1. Describe the main processes in the nitrogen cycle?

After completing the activity on the nitrogen cycle let us move on to look at the carbon cycle.

10.1.2 Carbon Cycles

What is a carbon cycle, how is it different from the nitrogen cycle? Brainstorm on these questions as we move to have a deeper understanding of the process. Well done if you were able to say that It is the movement of carbon elements between the organic and inorganic components. Sources of carbon include volcanic emissions. It is also found in living matter as well as in their remains. Fossil fuels like petroleum, coal and graphite also have carbon.

Carbon is important because when it mixes with oxygen it forms carbon dioxide which is important for photosynthesis. Do you still remember photosynthesis? If not discuss with your colleague.

Carbon also helps in the formation of carbohydrates, fats and proteins, it is also the main mineral in the formation of limestone rock. The Figure 10.5 shows the main processes in the carbon cycle.

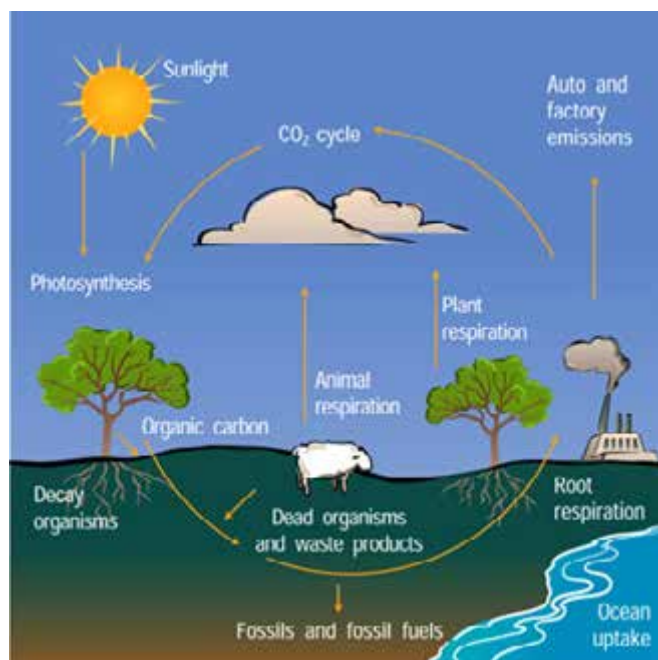


Figure 10. 5 Carbon Cycles

Study the Figure 10.5 and list the main processes in the carbon cycle. Can you identify the effects of human beings on the cycle? The main processes in figure 10.5 include carbonification, respiration, photosynthesis and combustion. Human beings can affect the cycle through increased burning of plastics and industrial gases, burning of forests and over extraction of minerals.

After attempting the activity, we now want to move on and look at measures that we can take to preserve the ecosystem.

10.3 What measures can be used to conserve the ecosystem?

Reflection

Do you still remember what the word conservation means? If not go back to the key words and have a relook at them. Can you identify ways of conserving the ecosystem? From the activity that you have done above you have seen that ecosystems can be conserved through the following ways.

10.3.1 Terracing

It is the creation of bench like features on steep slopes. These features can also be referred to as field embankments. The terraces help in reducing the steepness of the slope, especially in mountainous regions like Mutare thereby reducing rates of soil erosion.

10.3.2. Use of alternative sources of energy

Many sources of energy can be used by human beings instead of firewood. Can

you think of any sources? Yes, people can use solar and biogas which are cleaner than firewood. Use of other sources of energy besides firewood helps to reduce deforestation and land degradation.

10.3.3 Destocking

Is a measure that can be taken to reduce the number of cattle, sheep and goats in an area. It can be done through culling. In this case the farmer kills or sells the unwanted livestock at home. This measure helps to reduce rates of deforestation.

10.3.4. Legislation

A number of laws have been put forward to protect the ecosystem. For example, section 73 of the Environmental Management Act subsection (1) and (2) which talks about prohibition of discharge of hazardous substances, chemicals and materials or oil into the environment. Subsection (1) of section 73 states that no person shall discharge any hazardous substance, chemical, oil or a mixture containing oil into any waters or any other or any parts of the environment contrary to any criteria prescribed in terms of section seventy-two. Subsection (2) states that a person who discharges a hazardous substance, chemical, oil or a mixture containing oil into any waters or any parts of the environment in contravention of subsection (1) commits an offence and if convicted of that offence shall pay the cost of the removal of the hazardous substance, chemical, oil or a mixture containing oil including any cost which may be incurred by any Government agency or organ in the restoration of the environment damaged or destroyed as a result of the discharge; and pay the cost of third parties in the form of reparation, restoration, restitution or compensation as may be determined court on application of such third parties. (Can you think of any other laws that were put in place to protect the environment? Do not worry if you cannot remember any; let's briefly look at some of the laws?

10.3.4.1. Mines and Minerals Act

It is a law that controls the exploitation of minerals. It overrides most of the acts. It also awards permits to miners, this reduces overexploitation of the mineral resources as miners have to follow the due procedures. It deals with issuing of licenses, cancellation or suspension and registration of mining rights. The mines and minerals act also deals with prospecting and pegging of the ground.

10.3.4.2. The Forest Act

It is aimed at protecting, management and utilization of the forests in a sustainable manner. It discourages deforestation and controls cultivation. Cultivation has to be done 100m away from the stream bank. It also supposed to establish and promote public education to improve understanding of the forests and their contribution to the economy. It also protects and conserves the wetlands.

10.3.4.3. The Water Act

It looks at the utilization of water in a sustainable manner. Its issues permit to individuals and corporates to access water. It also ensures that pollution to water bodies is minimized. It also gives powers and procedures of catchment councils and grants permits to users of water.

10.3.4.4 The Environmental Management Act

It brings together all laws. And measures that protect, conserve and manage the environment and its resources. This is the most important piece of law that protects the environment.

10.3.4.5. The Parks and Wildlife Act

A law that is responsible for National Parks and Wildlife. It is a law that established the Parks and Wildlife board. It helps protect the ecosystem as it reduces overexploitation of natural resources. You are now in a position to list down the laws that protect the environment. Can you list them?

10.3.5. Indigenous Knowledge Systems

In rural areas local people have been able to protect the environment through a number of ways. Can you list the ways of protecting the environment that have been used in your area? Yes, these are called indigenous knowledge systems.

These are knowledge-based systems which have been developed by a community to protect their natural environment. It is the local basis for decision making in the rural communities. These measures include the following:

Taboos are also part of the indigenous knowledge used. There are certain areas and animals where people believed that certain spirits resided there. It was a taboo to cut a big tree as this could cause the death of a family member. It was also regarded a taboo for one to go hunting without permission of ancestors. Taboos helped to reduce exploitation of natural resources. Can think of any other examples?

In Zimbabwe people have different totems and these come from the natural environment. People who have a certain animal as their totem refrain from eating it, this protects animals from extinction. For example, the following have been used as totems in various parts of Zimbabwe shiri \ inyani /bird, nzou \ indlovu\ elephant, shumba \ isilwane\ lion, leg\gumbo\gumpo dube\mbizi\zebra and monkey\shoko\ncube Can you think of any other totems that have taken their names from animals? A number of places in Zimbabwe have been set aside for religious purposes like prayers, rituals and sacrifices. Njelele hills in Matobo are an example. Other examples include Mutemwa leprosy centre in Mutoko where people go to pray, Ngomakurira caves and Muchinjikwa in Domboshava. This protects the environment as chiefs and kings are obliged to guard and put laws that safeguard these spiritual possessions. The Chinhoyi caves and Makate ruins have also been declared as sacred areas. In doing so, biodiversity (different plant and animal life) is protected.

Certain areas in Zimbabwe have been declared no go areas and certain birds and animals should not be killed as they are seen to bring bad luck when killed for example pythons and eagles. All fruit trees were not allowed to be cut down.

In rural areas people have been forbidden to use soap at waterholes/springs as it is believed that soap destroys the natural pores where water flows through

10.4. Restoration methods

A number of measures can be taken to restore the ecosystem. Can you think of any measures that can be used to restore degraded ecosystems? There are numerous measures that can be used and these include:

10.4.1. Gully Reclamation

It is a process of improving land that has been disturbed by excess run off back to its original condition and reducing further damage on it. Gully reclamation is done through planting vegetation and infilling of the gulleys. This is done to stabilize the banks and to reduce further headward erosion.

10.4.2. Grass planting

A variety of grass species can be planted to restore the ecosystems. These include vetiver grass. Grass planting is good as it reduces splash erosion and holds the soil particles together. The effect of animal movement is also reduced when grass is planted.

10.4.3. Tree planting

Tree planting is a very important way of restoring ecosystems. The roots of the trees help in anchoring the soil particles. Large and healthy ecosystems will lead to an increase in precipitation. As plants release vapour through transpiration this increases the amount of moisture in the atmosphere leading to an increase in precipitation and rainfall. I hope you still remember that the planting of vegetation is called afforestation but when you are planting vegetation where it was once there, it is called reforestation. Now do you remember the term that describes the process of cutting down trees without replacing them? Discuss with your friend and write notes on the effects of the process.

We have looked at ways of conserving the ecosystem which include declaration of sacred areas and reforestation we want to move on and look at the importance of ecosystems. You have to attempt the activity below before we can identify the importance of ecosystems.

10.5 What are the Importance of Ecosystems?

Ecosystems play a vital role in our life. Ecosystems regulate temperatures as they act as good heat sink. It was going to be very difficult for human beings to survive in harsh environments.

The food that we eat comes from the environment so there is need for a good interrelationship between the living and non-living components of the earth. From what you have learnt in this unit, what are the importance of ecosystems? You were expected to come out with the following

- A healthy ecosystem is a good carbon dioxide reducer. Trees trap carbon dioxide in the atmosphere when they use it during the process of photosynthesis; they act as a good heat sink
- Ecosystems are important because they bring in revenue to the government through tourism. People can pay to view the forests and mountains in the area including recreational parks. The above concept can be referred to as Ecological tourism Can you think of any other activities that you can do as part of ecotourism?
- Firewood is also obtained from the forests especially in the rural areas of Zimbabwe. Forests are also a source of food as they provide a variety of fruits.
- Medicines are also obtained from forests which include quinine that cures malaria. Aloe is obtained from the natural vegetation and has been used to cure skin ailments You can also ask the local leaders about any other medicine that we can get from plants.
- A healthy ecosystem is also very important because human beings get oxygen. It is a waste product of the process of photosynthesis and also provides clean air

Well done, you have come to the end of this unit. It is my hope that you have understood all the concepts in this unit. It is now time to remind you of all that we covered in this module. Go over the points in the summary below and check if you have understood the concepts listed there:



Summary

In this unit we discussed about the biogeochemical cycles. We explained on Nutrient cycling and included known cycles such as nitrogen and carbon. We then looked at conservation methods like terracing, destocking legislation and indigenous knowledge systems. Finally, we focused on Restoration methods like gully reclamation, tree planting and the importance of ecosystems.

End of Theme Assessment

Fill in the gaps provided below

1. The two main nutrient cycles you have studied in this unit areand
2. Write down any restoration technique in ecosystems study
3. Approximately % of the air is nitrogen
4. The commonly used form of nitrogen by plants is
5. One benefit of ecosystems is.....

Structured Questions

1. Draw and label the nitrogen cycle?
2. Describe any four benefits of ecosystem?

Research Work

1. Imagine that you are a resident of a large area that has been affected by gullies and dongas what measures would you take to restore the damaged ecosystem?



Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding. I have listed them here below. Go through them and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it in the unit and go over it again. Right mark yourself!

Objectives: Can you now:	Check box
• draw diagrams to show different nutrient cycling models	
• outline the benefits of restoring ecosystems	
• identify methods of conservation of the ecosystem	
• explain the biogeochemical cycles	
• explain the importance of ecosystems	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). *Total Geography Book 3*. Harare: Priority Publishers.

Mbizi, N. a. (2019). *New Trends in Geography Form 4*. Harare: Edu light books.

Unit 11 Natural Resources – Conservation of resources and Wildlife Management

- 11.1 Resources
- 11.2 Conservation methods (Fish and Water)
- 11.3 Types of Wildlife management
- 11.4 Human wildlife conflict
- 11.5 Causes of human wildlife conflict
- 11.6 What is CAMPFIRE?

Introduction

In the previous unit, we discussed about the biogeochemical cycles. We explained on nutrient cycling and included known cycles such as carbon and nitrogen. In this unit, we are going to look at natural resource conservation. In our everyday life, there are materials that we need. Can you list them? Yes, these include fish, water, forest, wildlife and many others. We are going to study about the conservation methods, types of wildlife management, human wildlife conflict, and solutions to human wildlife conflict and benefits of campfire. We guess you may have heard about some of these concepts before, but however, we will go through them together in this Unit. Get ready for another exciting Unit.



Objectives

After going through this unit, you should be able to:

- Describe resource conservation measures
- Identify ways of conserving resources
- Describe wildlife management
- Identify advantages of wildlife management
- Distinguish problem animals from dangerous animals
- Identify the causes of human –wildlife conflict
- Suggest solutions to human-wildlife conflict
- Give reasons for the establishment of **campfire**
- Discuss benefits of **campfire**
- Discuss the sustainability of **campfire**



Key Words

Natural Resource	Is that which exists in a country such as soil, water, minerals, forests and wildlife for which can be used to improve wealth of a country
Conservation	Sustainable use and management of natural resources including wildlife, water, air and earth deposits
Conservancy	An area of land kept in a natural state for wild animals
Sanctuary	A place where birds and animals are kept and are allowed to move freely
Safari area	An area where animals are kept and photos of them can be taken
Campfire	Communal areas management programmed for indigenous resources
Reserve	An unused part of a resource, which can be used to benefit people



Time guide

You are expected to take an average of **10** hours to go through this unit.



Study skills

You have to note that this unit is about natural resources. Look around and identify any materials that you think could be important in our everyday life. These include water, forest, soil and fish.

11.1 What are natural resources?

You have already come across the definition of a **Natural resource**. What did we say it means? If you have forgotten, go back to the key words section. We said a natural resource is that which exists in a country such as soil, water, minerals, forests and wildlife and can be used to improve people's life. Now that you have understood what natural resources are let us move on to look at how the natural resources can be classified.

11.1.2. Classification of natural resources

Before we classify the natural resources, you need to study the diagram below.



Activity 11.1 Classification of natural resources

Study Figure 11.1 and attempt questions that follow.

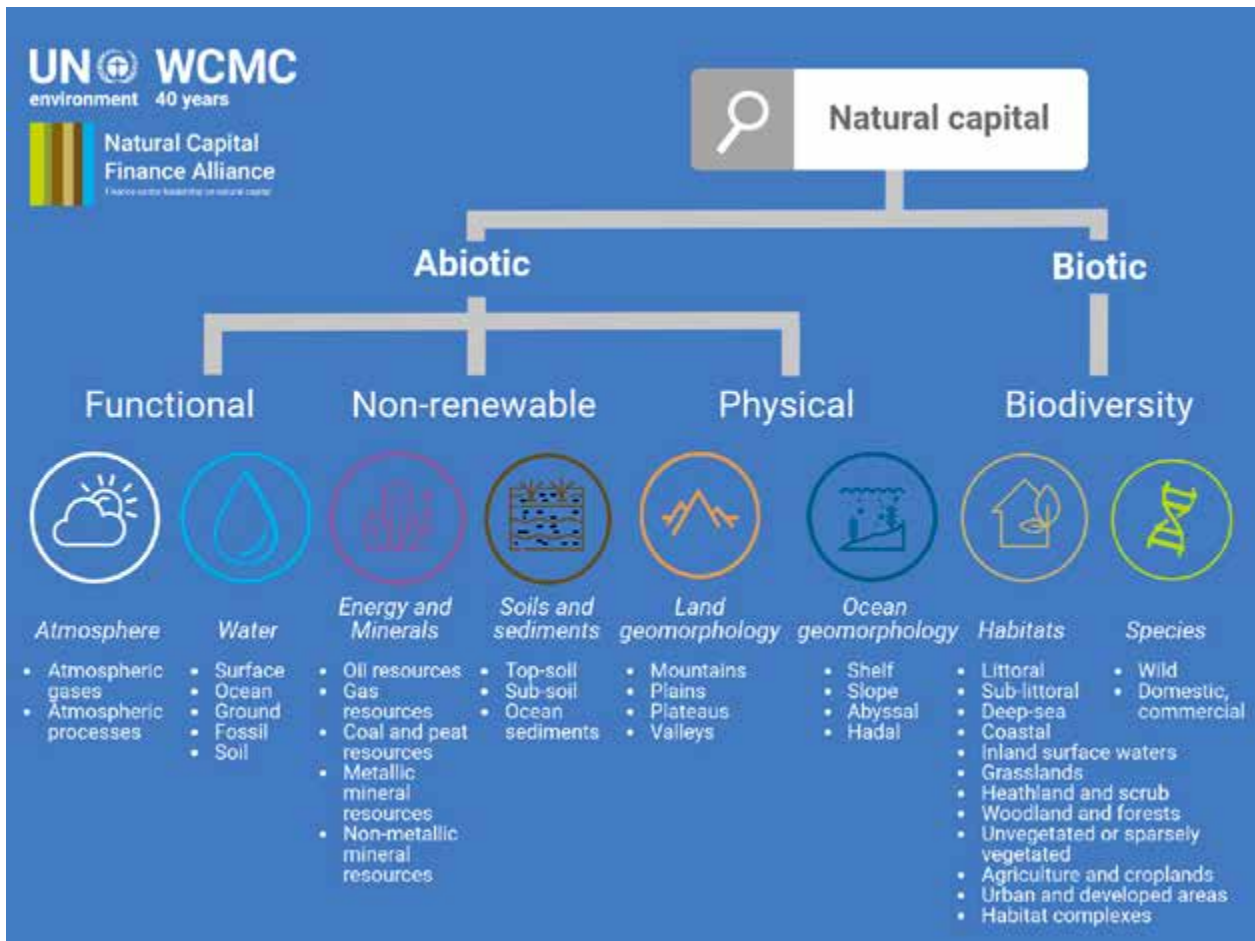


Figure 11.1 Classification of natural resources

1. Define the term natural resource?
2. Describe the main classes of natural resources?
3. Give 3 examples of natural resources?

From the study of the Figure 11.1, you can see that **natural resources** are mainly made of perpetually, potential, and non-renewable resources. A renewable resource is one that can be replaced by natural processes and is never used up; it can be reused or increased. Examples include water, forests and fisheries. Renewable resources like plant are important natural resources though we tend to underestimate

their real value to us. Forests protect our soils from erosion, provide constructional timber, wood fuel, food to domestic and wild animals and protect catchment areas. A non-renewable resource is one that cannot be replaced once it has been used up. Examples include minerals. The value of minerals is well known. Unfortunately, they are not renewable because once mined new minerals do not quickly form in their place. It is therefore necessary to conserve whatever mineral resources we have. This could be done by recovering as much as possible from a given deposit, extracting the maximum amount of mineral from a particular ore and use of substitutes (e.g. aluminium or fibre optics instead of copper). Now that you have an understanding of natural resources let's move on to look at how these natural resources can be conserved. We will start by looking at conservation of fish.

11.2 How are Fish conserved?

Fish are a natural resource due to that it is found in its natural state and could be useful to people. Fish are a renewable resource that can be exploited without being finished because it is constantly replenished (to supply again what has been used up). Before we look at ways of conserving fish let us look at the knowledge that we have about fish. Attempt activity 11.2.



Activity 11.2 Fish conservation

Attempt questions that are below

1. List down the importance of fish?
2. Identify any four fish types found in dams in Zimbabwe?
3. Describe measures that can be taken to conserve fish?

Fish can be conserved through a number of ways which include:

- (a) Quota system:** This is introduction of controls on the amount of fish to be exploited. This has been practiced in countries like South Africa and Namibia
- (b) Aquaculture:** This the practice of fish farming in order to protect the fish species. This practice has been done in many parts of Zimbabwe.
- (c) Licensing:** Local people have been given permits and licenses; this has helped to reduce overfishing as the locals are limited by the amounts of money paid. The fishing permits are renewed every year. Ownership of these resources has been given to the local people and this has helped in conservation. Let's move on to another measure that has also been taken which is the setting up of restricted fishing areas.
- (d) Restricted fishing areas:** Certain areas in Africa have been left out as breeding grounds. Areas around Cape Town and Walvis Bay have been left out as breeding grounds for fish, this has helped to conserve the fish as they are given enough time to breed. Now that you have looked at ways of conserving fish let us move on to look at ways of conserving water sources.

11.2.0 Water

We all know water and we use it on almost daily basis. We have heard that water is life and we need to conserve it. It is therefore everyone's responsibility to conserve water or use it wisely, without waste. It is also important to note that we need to keep our water clean. We guess you know that, only 3% in the world is fresh water and a very small amount of the 3% is accessible and usable by us. Therefore, we really need to conserve water. May be you need to first ask yourself what you are doing as an individual to avoid wastage of water or polluting the precious resource?

Water is a single most valuable natural resource. In fact, all forms of life – plant, animal and human – would perish without water. Due to the rapid economic growth (industrial and agricultural) the demand for water has also risen making it easily available and supply sometimes problematic especially in areas prone to drought. Water is a renewable resource because it can be exploited without being finished. Before you learn about water conservation attempt the activity 3 that will help you during this section. Study the picture in Figure 11.2. Water conservation is the careful management and wise use of water. Remember conservation does not mean we should stop using water but demand a responsible and sustainable use of the resource. Water can be conserved in dams and by protecting their vleis. Vleis are like sponges because they collect water. Water in urban areas can be conserved by the use of springer for water gardens instead of an open hose.



Activity 11.3 Water conservation

Study Figure 11.2 and answer the questions that follow



Figure 11.2 Source of water

1. Suggest three methods of conserving water?
2. Using your family as basis of study estimate the amount of water used by one person per day and what it will be used for?
3. Suggest areas where your family can reduce the amount of water used?

11.2.2 What are the methods of conserving water?

After going through this topic, you should be in a position to come out with the number of strategies to conserve water.

At household level we can save our water through employing water saving technologies like to reduce the amount of water per flush. Water can also be conserved through recycling of used water. Can you think of any other ways of conserving water?

You can also ask your family members to use drip irrigation rather than flooding as Figure 11.3 Under this method water is used to irrigate plants effectively as small drops of water soak into the soil slowly. Loss of moisture is reduced as pore spaces remain open in the soil reducing erosion.



Figure 11. 3 Drip irrigation

Water can also be conserved through empowering the local community especially women about managing their local resources. Giving them control over ownership of resources will help reduce over exploitation of the resource. One way of empowering women in your local community is through giving them control at water sources like boreholes, dams and wells.

Building of dams can also be used as a strategy in conserving water and conserve water for the future use. Dams like Tokwe-Mukosi and Manyuchi have been constructed to store water for use in the south-eastern lowveld in places like Triangle, Mkwesine and Hippo Valley. Can you think of any other ways of conserving water?

Another natural resource that is very important in our everyday life is soil, why? Because it is the medium of plant growth. In the next section we look at how it can be conserved.

11.2.3. Soil conservation methods

You have looked at soil formation in unit 9 now study the Figure 11.4 and attempt questions that follow as a way of preparing you for the conservation methods.



Activity 11.4 Soil conservation



Figure 11. 4 Areas with gullies

1. Describe the scene in the figure 11.4.
2. Imagine you are the local Councillor what steps would you recommend to the people to conserve the soil?
3. What dangers are the people in the area likely to face?

Conservation of the soil can be done through gully control and reclamation. People in the picture shown above are likely to face problems like collapsing of houses, loss of agricultural land and vegetation. We can conserve the soil by constructing barriers across the gully to reduce speed of the water. Another method that can be used is backfilling and planting of grass to stabilize the surface. Terracing of steep slopes and enforcing laws which are designed to protect the environment. We can move on to look at ways of conserving forests.

11.2.4. What can be done to conserve forests?



Figure 11.5 showing severe destroyed forest.

Forest conservation is the careful management use and wise use of forests. Forests should be conserved to protect our soil from erosion, provide timber for construction, food to wild and domestic animals and protect catchment areas. We hope you still remember the importance of forests, if not so go through the internet and find out the importance of forests before you attempt the questions below.

1. List down the importance of forest
2. Describe the effects of deforestation

From the tasks above you can see that forests help to provide food like honey and fruits, building materials like roof tiles and wooden poles, fuel from wood, raw materials for industries and regulation of oxygen and carbon dioxide in the atmosphere. Forests are like the “lungs of the earth”.

On effects you were supposed to have come out with effects like soil erosion, low agricultural production, migration of animals and increasing droughts.

Forests can be conserved through recycling of forest products like paper and use of substitutes. Laws can also be implemented to control industrial emissions

Note that forest resources can also be conserved through the recycling of forest products and good management approaches. These include efficient processing of cut timber. So far, we have looked at conservation methods of fish, water, and forest we now want to look at how wildlife can be conserved

We should conserve forest due to that trees reduce our “footprint” and can prevent catastrophic climate change. They absorb harmful carbon dioxide; give off oxygen vital for life; shade and cool the Earth’s surface; attract and increase rainfall; prevent erosion of carbon-rich humus and topsoil.

Trees are essential in conserving biodiversity vital for human existence. For example, bees are pollinators vital to our food chain. One-third of the food we eat would not be available but for bees. Bees are declining worldwide and the major reason is the loss of biodiversity. Just as you and all of us need a varied diet, so do bees. The loss of biodiversity is adversely affecting their immune systems.

You should take note of the fact that there are two principal pieces of legislation that guide forest management and conservation in Zimbabwe. One of these two is the Forest Act 19:05 which covers state forests and private forest and also regulate and, control trade in forest produce and burning of vegetation. The other is the Communal Land Forest Produce Act 19:04 covers the communally “owned” forests, including A1 resettlement forest areas.

11.3. Types of wildlife management

Wildlife in Zimbabwe is found in protected areas. Can you name any of these areas?



Activity 11.5 Wildlife management

Wildlife Management provides valuable information on the biology, ecology, management, and control of various species of wildlife (e.g., alligators, armadillos, bats, bears, beavers, birds, chipmunks, coyotes, deer, foxes, quail, mice, moles, muskrats, opossums, rabbits, raccoons, rats, skunks, snakes, squirrels, voles, wild hogs, wild turkey, woodchucks). It is also the process in protecting endangered and threatened species.

Study the Figure 11.5 which shows Parks and Wildlife Estates of Zimbabwe. Name three areas where national parks are found. Which one is the largest national park in Zimbabwe? This activity will help you to have an idea on how wildlife has been managed in Zimbabwe.

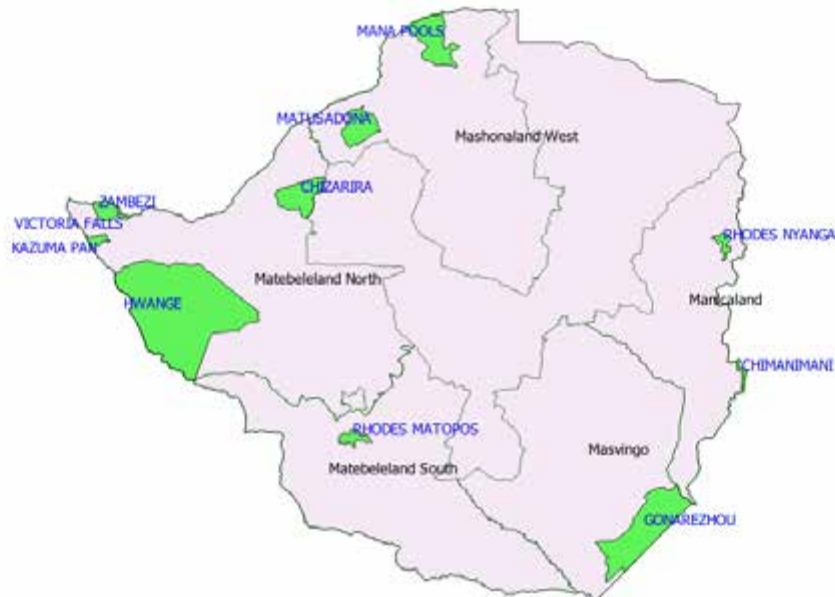


Figure 11.6 National Parks in Zimbabwe

11.3.1 Game parks

You could have heard about game parks or probably you have visited one and saw what kept there. In Zimbabwe, we have several game parks with a variety of wild animals. We receive many tourists who come just to see animals in their natural environment. A game park is a large area of land, especially in Africa, where wild animals can live safely.

As you can see from Figure 11.7 these are areas where small wild animals are kept and they differ from national parks in that they are privately owned and managed. The animals that are kept in these areas include the following kudu, impala, eland and antelope Figure 11.7 shows the various game parks in Zimbabwe.

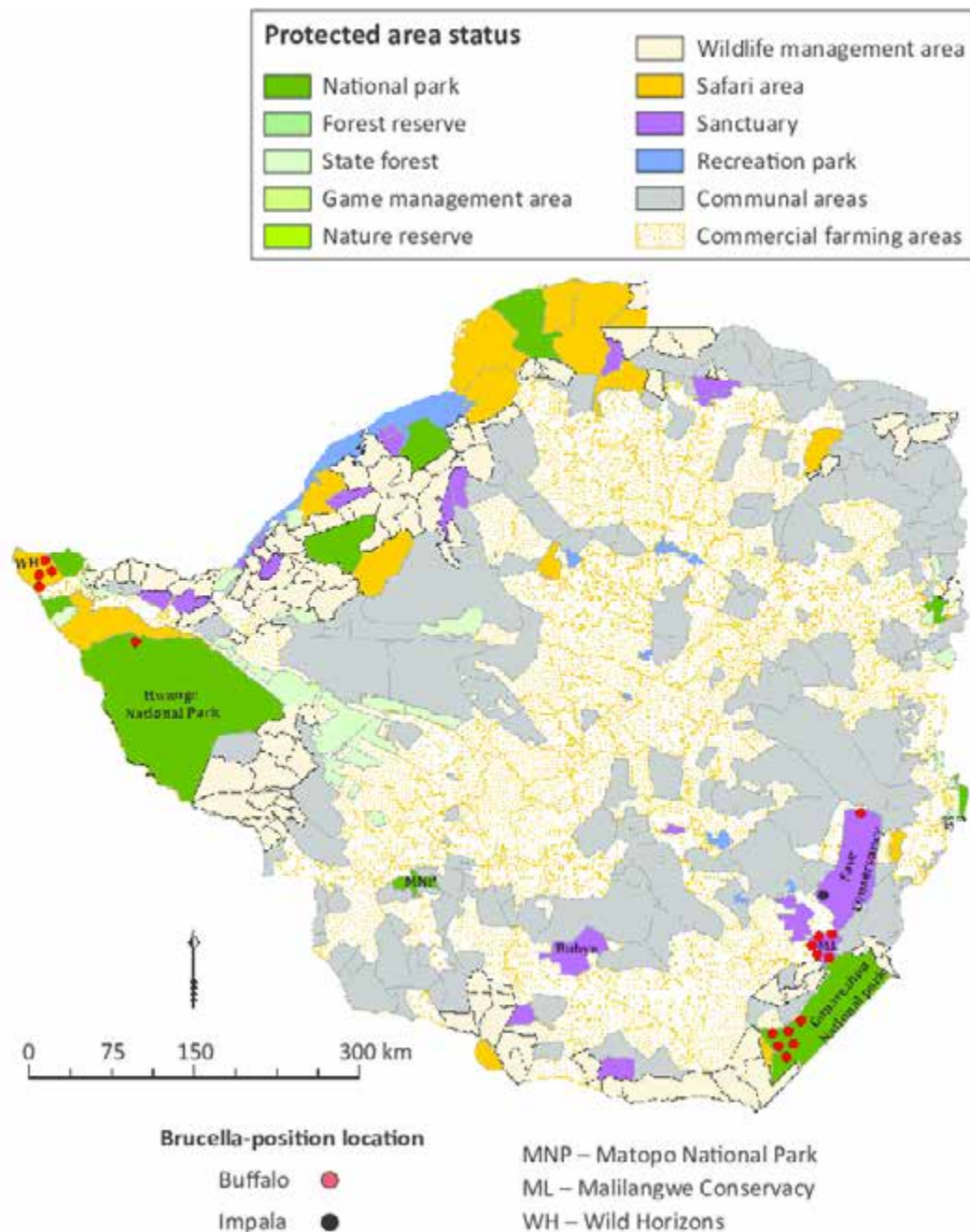


Figure 11.7 Game Parks, sanctuaries and safaris in Zimbabwe

Examples of game parks in Zimbabwe include Mukuvisi woodlands and Mbizi game park. Now that we have studied about game parks let's move on to Conservancies.

11.3.2 Conservancy

We can define a conservancy as **a land kept in its natural state in order to protect wild animals and plants**. In Zimbabwe the major conservancies are the Save valley conservancy and Makuwe conservancy. These areas offer hope to the survival of wild animals and plants. Let's move on to look at Safari areas.



Activity 11.5: Conservancy

Study the Figure 11.6 which shows Parks and Wildlife estates of Zimbabwe and complete the tasks below

1. What is a conservancy?
2. List down the Conservancies shown on the map?

11.3.3. Safari Areas

You should take note that a Safari can be defined as an area that has been set aside for recreational hunting and cropping of wild population. Examples include **Dande**, **Doma Sapi** and **Enwarigg** in Zimbabwe. In these areas people can go for hunting, crocodile research, and outdoor recreation. These areas can also include observing and photographing of wildlife, hiking and sightseeing. In Zimbabwe, the best place is Victoria Falls whilst Africa boasts of the **Serengeti** and **Masai Mara** national parks. In the next section we look at **Sanctuary**.



Activity 11.6 Safari Areas

Go back to the Figure 11.5 of Zimbabwe and attempt the following questions so that we prepare on our next section which looks at safari areas.

1. Identify Safari areas on the map Figure 11.5.
2. What are the major attractions to these areas?

11.3.4. Sanctuaries

What do you think sanctuaries are? You can research on the internet or discuss with your colleague. Yes, these are areas where animals have been protected from extinction. After going through the activity, you will have more knowledge on sanctuaries.



Activity 11.7 Sanctuaries

1. What is a Sanctuary?
2. Identify sanctuaries on the map above?
3. Name the animals protected in each of the sanctuaries?

We have seen that **Sanctuaries** are areas where animals are protected from extinction. These areas include **Chimanimani Eland, Mbadze Pan** sanctuary where a variety of birds are kept and **Tshabalala Sanctuary** which is used for game viewing and educational purposes.

The last type of wildlife management is we are going to study is **National parks**.



Activity 11.8 National Parks

Study the map 11.2 which shows national parks in Zimbabwe and then attempt the questions that follow;

1. Name at least 5 National Parks shown on map 11.2?
2. Identify the main visitor activities shown on the attractions?
3. Which animals are kept in these areas?

From the map 11.5 you can see that **Zimbabwe** has many **National parks**. These have scenic views spectacular relief and areas of historical significance. These areas include Hwange national park, Mana pools national park, Chizarira national park and Gonarezhou national park.

Perhaps you have heard cases of people coming into contact with wildlife. In most of the cases people have been attacked or wild animals have been killed why? In the next section we want to look at human-wildlife conflict.

11.4 What is Human and Wild life conflict

Human-wildlife conflict (HWC) refers to the interaction between humans and wildlife that negatively affect humans or wildlife. Human-wildlife conflict is always experienced when human populations grow and encroach on wildlife established territory, and therefore reducing resources for wildlife. The conflict between wildlife and humans come in different forms and could range from loss of human life, death of wildlife, injury of humans, or wild animals as they compete for scarce resources. The conflict would also affect domesticated animals. Previously, conflict management approaches included lethal control, regulation of population, translocation, and preservation of endangered species.

In order for you to have a better understanding of this section let us start by doing the activity below; Study the picture first and then attempt the questions below.



Figure 11.7 Wild animals attacking human



Activity 11.9 Human-wild life conflict

1. Describe the scene in the photograph?
2. What could have caused the scene in figure 11.6?

From the study of the figure 11.7 you can see that human beings are fighting the wild animals. In other words, the human beings in this area are in total disagreement with the wild animals. The animals are causing havoc to human settlements. Human-wildlife conflict is any interaction that causes harm whether it is to the human, the wild animal or the property. The animals and human beings are in conflict over living space. Some animals are dangerous to human beings such as the lions and elephants whilst other animals are referred to as nuisance or problem animals these damage crops and property and sometimes livestock. Animals like the leopards, wild cats and jackals have been known to prey on unattended livestock. Another group of nuisance animal are the baboons and monkeys that can steal cooked and uncooked foodstuffs. What do you think are the causes of the conflict? Have a moment to reflect on the causes. In the next section we are going to discuss on causes of human-wildlife conflict.

Attempt the activity below.

Table 11.1 Protected, problem and dangerous

Protected animals	Problem/ nuisance animals	Dangerous animals
<ul style="list-style-type: none"> • Aardwolf • Cheater • Pangolin • Black rhino • White rhino • Python • Bat-eared fox 	<ul style="list-style-type: none"> • Elephant • Wild dog • Spotted hyena • Baboon • Monkey • Black backed cackle 	<ul style="list-style-type: none"> • Lion • Black and white rhino • Leopard • Hippopotamus • Buffalo • Black member

Did you know that they are also specially protected plants? These include:

- Flame lily
- Leopard orchid
- Mangrove fern
- Sabi star

11.4.1. Causes of Human – Wild life conflict?



Activity 11.10 Human wildlife conflict

Imagine you stay at the margins of Gonarezhou national park in the south eastern part of Zimbabwe what problems are you likely to face from the animals in the national park?

Note that the main cause of human-wildlife conflict worldwide is the competition between growing human populations and wildlife for the same declining living spaces and resources. The transformation of forests, savannah and other ecosystems into agrarian areas or urban agglomerates as a consequence of the increasing demand for land, food production, energy and raw materials, has led to a dramatic decrease in wildlife habitats. This is particularly true in Africa where the human population came close to tripling in the four decades from 1960 and where, in consequence, settled agriculture has spread to more marginal rangelands leading to encroachment into wildlife habitats. Under these conditions, conflict between wildlife and local communities has inevitably increased.

Perhaps you might be aware of the fact that generally, people living in rural Africa have little sympathy for wildlife and see animals purely in terms of their meat value. This is illustrated by the fact that, in several Bantu idioms, the word *niyama* used for wildlife also means "meat". Rural communities consider wildlife, particularly large mammals, as threats to their safety and food security. This adverse perception is particularly strong near protected areas where the presence of wildlife populations inflicts daily costs on local communities, which can erode local support and tolerance. In turn, local people can develop a negative attitude towards reserves and wildlife, increasing conflict and undermining conservation efforts.

Migration of peoples for reasons of security or food safety. Drought, floods, civil unrest, natural disasters or war disrupt the normal production and distribution of food, resulting in famines. This phenomenon is on the increase; the number of food emergencies in Africa each year has almost tripled since the 1980s. Across sub-Saharan Africa, one in three people are undernourished (McCarthy, 2006). These factors spur the continuing migration of rural people into areas where resources could be obtained, and which are frequently occupied by wildlife. The resultant occupation of the habitat of wild animals by humans leads to conflict. War and civil unrest force people to seek shelter in protected areas where they exert a strong pressure on natural resources and enter into competition with wildlife. For example, it is estimated that more than 120 000 people displaced by civil war are currently living in protected areas in Mozambique (Government of Mozambique, 2006).

As you have correctly stated, problems can come because of the following reasons. Due to expansion of rural settlements into the natural forests conflicts as a result can occur with wild animals on the grazing space, as there will be shortage of grazing land.

Another area of conflict can come as a result of a drought, during times of drought there will be food shortages so wild animals especially baboons and monkeys move towards the nearby rural areas looking for food and steal food items from homes. You are probably aware that expansion of a settlement can also lead to human wildlife conflict, when a human settlement expands it takes away the habitat for wild animals and this causes conflict as the animals fail to find alternative shelter wild animals like elephants and lions can directly affect the people as they feel threatened with the expansion.

Human-wildlife conflict can also occur as people move into the forests hunting for games this threatens the existence of wild animals. In the next section we look at some of the solutions to human wildlife conflict. Think about the possible solutions to the problems as you attempt the activity below.

11.4.2. What are the solutions to Human wildlife conflict?



Activity 11.11: Solutions to Human wildlife conflict

Imagine you are the minister of tourism and have been tasked to address people on ways of reducing human wildlife conflict, what major points would you include in your presentation?

These are some of the measures that can be taken to reduce human wildlife conflict.

- Farmers who stay close to national parks can use strobe lights during the night, these lights can scare away wild animals as animals are scared of electricity. The flashing scares away wild animals
- Natural barriers can also be used, elephants are scared of bees and hot pepper so farmers who live close to them can use bee fences as a protection measure.
- Disguise can also be used when dealing with areas with a lot of tigers. As shown by the Figure 11.8.
- Tigers attack from the back so people can wear masks in the back to scare away these wild animals as shown by the Figure 11.8.



Figure 11.9 Disguise

- Texting is another measure. Elephant collars are embedded with SMS (a text messaging component) chips which automatically text nearby residents
- Corridors can also be used, these routes which can be used to guide the movement of animals to developed areas, they can also be referred to as development corridors as shown by the Figure 11.9.



Figure 11. 9 Animals corridor

Let us move on to campfire as one of the solutions to human wildlife conflict.

11.5. What is CAMPFIRE?

In the key words section do you still remember what we said about CAMPFIRE? If you are not sure go back to that section and look at it again. CAMPFIRE stands for Communal Areas Management Programme for Indigenous REsources. Let's refresh by attempting the following questions.



Activity 11.12 CAMPFIRE

1. List down the natural resources you can still remember?
2. Name any two renewable and non-renewable resources?
3. How can we benefit from these natural resources?

The programme was initially designed by the government in order to give local people control of wildlife and their management and habitat conservation. So, you can see that campfire was aimed at mitigating human and wildlife conflict through conservation by utilization.

CAMPFIRE was also done in order to reduce the conflict that occurred between human beings and wildlife and to reduce the number of wild animals in an area.

The programme was also aimed at reducing, poverty and heavy reliance on rain fed agriculture. The programme was administered by the rural district council. Under this programme villagers worked with government agencies.

Profits from the programme are then used by the community or given to individual households in their districts on behalf of their communities. Districts that are part of the CAMPFIRE project include Hwange, Jambezi, Dete, Victoria falls and rural areas surrounding Bikita. What are the benefits of campfire to the local people? In the next section we are going to look at the benefits of campfire.

11.5. 1 What are the benefits of CAMPFIRE?

Attempt the questions below before we look at the benefits of campfire.

1. From the knowledge that you have gained so far about natural resources what do you think are the benefits of campfire?
2. Can you think of a project you can start in your area to benefit the local people using resources available?

CAMPFIRE has brought about many advantages to the local people. It has created jobs for thousands of people who stay in areas surrounding the game parks and this has helped to reduce dependency on rain fed agriculture.

It has greatly improved the lives of people in rural areas as they have been empowered and have gained confidence that they have been denied in the past.

CAMPFIRE has also provided incentives for rural communities to conserve wildlife and to diversify their means of survival

Infrastructural development has also been key in campfire projects. Infrastructure like roads, clinics, grinding mills boreholes and roads have been constructed using benefits from campfire

Let's move on to look at sustainability of campfire Before we can define sustainability let us do the activity below.

11.5.2 How sustainable is CAMPFIRE?



Activity 11.13: How sustainable is CAMPFIRE?

Attempt the questions below

1. What do you understand by the term sustainable use of resource?
2. Can you think of any economic activity that you can carry out using the local resources for your own benefit?

From the questions that you have answered above you can see that sustainability involves the wise use of resources for the benefit of the present and future generations. What is the main aim of CAMPFIRE? Yes, it is meant to conserve wildlife and fight poverty by giving rural communities the authority to manage and use their resources especially wildlife in a positive manner.

Now take note of the following of the following successes recorded by CAMPFIRE:

- Between 1989-2004 it has raised more than US\$30million which has been ploughed back into the community
- Income has continuously flowed from FAO (Food and Agriculture Organization) Safari and Kellogg Foundation
- It has managed to promote management and conservation of wildlife and other natural resources
- 58 administrative districts are now part of the CAMPFIRE project in Zimbabwe

Campfire has managed to promote the living standards of people who stay close to the wild animals and also gave themselves confidence thereby helping in the conservation of the environment.

Summary

In this unit we have been able to learn about natural resources. Natural resources can be renewable or non-renewable. The unit also looked at:

- Ways of conserving natural resources like fish, water, soil and forest
- Wildlife management methods which included **Game parks, Conservancies, Safari areas, Sanctuaries, and National parks**
- Dangerous animals like elephants and lions were identified and nuisance animals like monkeys and hyenas were named.
- Campfire has brought a number of benefits which include empowerment, self-control, infrastructural development and above all the protection of the environment

End of Unit Assessment

1. Natural resources

- A. Are the problem of the government
- B. Can be used
- C. Have to do with money
- D. Recycle themselves

2. Which one is non-renewable?

- A. Coal
- B. Water
- C. Trees
- D. Fish

3. Another term for renewable is

- A. Finite
- B. Infinite
- C. Dirty
- D. Replenishment

4. Which in is a national park

- A. Matopos
- B. Enwarigg
- C. Mbizi
- D. Mukuvisi

5. Hyena is an example of a

- A. Dangerous animal
- B. Peace-loving animal
- C. Nuisance animal
- D. Poor animal

Structured Question

- 1 (a) For a named natural resource in your area suggest how you would earn a living from it (6)
(b) Identify ways of conserving it (5)
- 2 (a) Identify reasons why humans and wildlife come into contact (3)
(b) Name 3 possible ways of solving problems associated with human – wildlife conflict (3)



Progress Check list

Do you remember the objectives of this unit? Do not worry if you need reminding. I have listed them here below. Go through them and check how many of them you have achieved. Tick against those you are sure you have achieved. Put an X against those you feel you have not yet achieved. For any that you feel you have not yet achieved, find the section dealing with it in the unit and go over it again. Right mark yourself!

Objectives: Can you now:	Check box
• describe resource conservation measures	
• identify ways of conserving resources	
• describe wildlife management	
• identify advantages of wildlife management	
• distinguish problem animals from dangerous animals	
• identify the causes of human –wildlife conflict	
• suggest solutions to human-wildlife conflict	
• give reasons for the establishment of campfire	
• discuss benefits of campfire	
• describe resource conservation measures	
• discuss the sustainability of campfire	

Further reading

Chabikwa, B., Phiri, F., & Mapungwana, M. (2020). Total Geography Book 3. Harare: Priority Publishers.

Chabikwa, B., Phiri, F., & Mapungwana, M. (2019). Total Geography Book 3. Harare: Priority Publishers.

Mbizi, N. a. (2019). New Trends in Geography Form 4. Harare: Edu light book.

