step ahead

Geography

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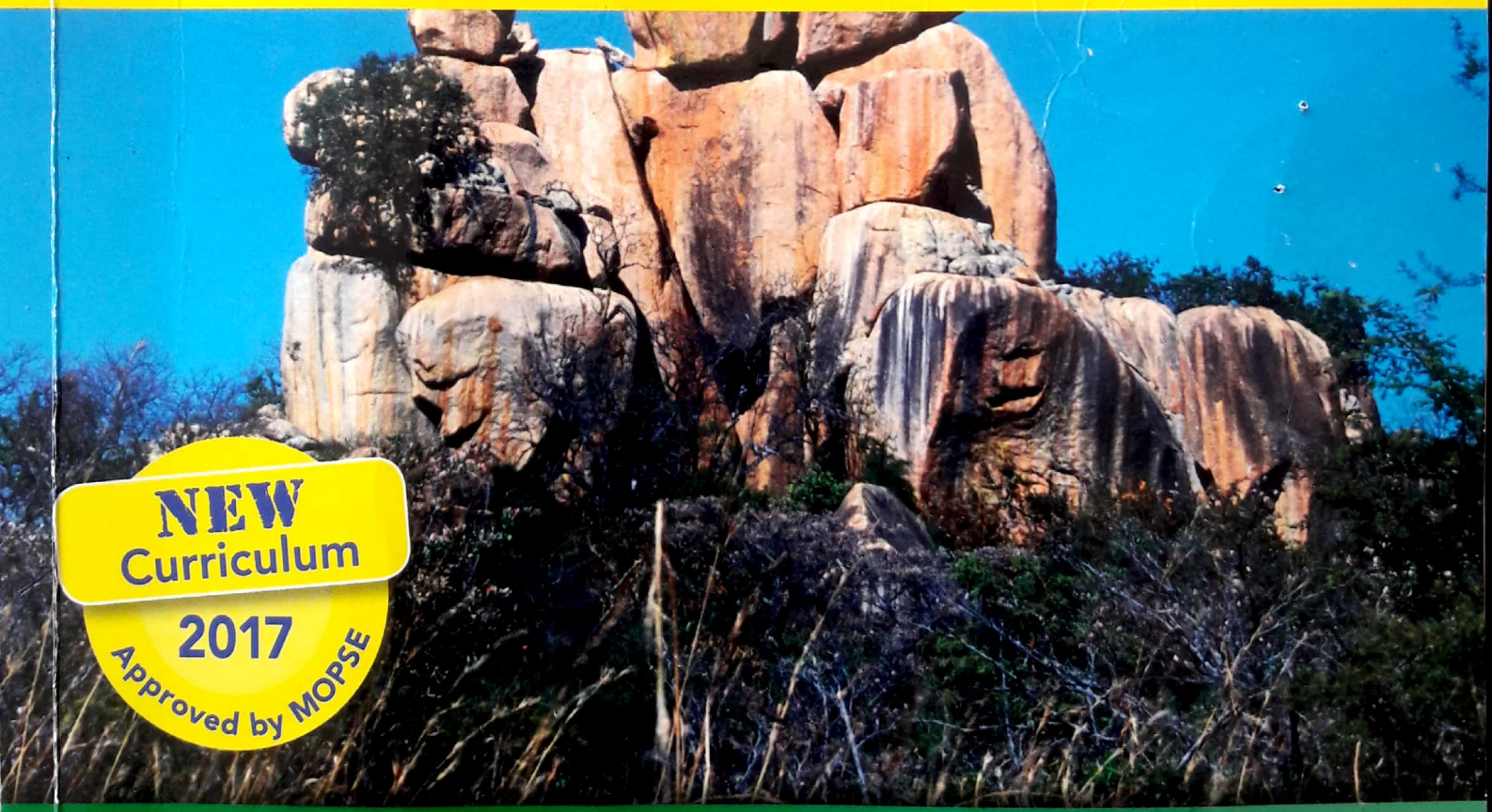

NEW Curriculum 2017 Approved by MOPSE

Learner's Book

Pearson

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Geography

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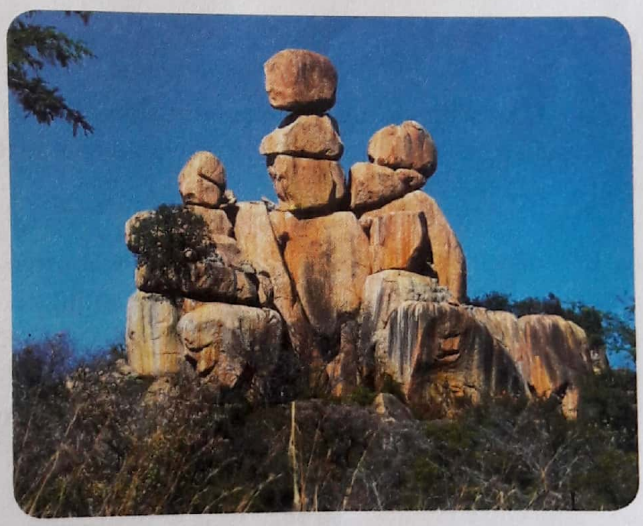

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Contents

Topic 1 Weather and climate

Objectives

By the end of this topic, 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
- describe weather conditions associated with the Intertropical Convergence Zone
- explain the basis for climatic classification on a global scale
- describe the characteristics of the world's climatic regions
- interpret climatic graphs and tables.

You know that the atmosphere is a layer of air surrounding Earth. You learnt in Form 1 that air masses in different locations have different temperatures and humidity. You also learnt that a front is the zone of separation between different air masses. In this chapter, we classify air masses and examine the air masses that affect Zimbabwe's weather.

Air masses

An air mass is a large body of air with distinctive characteristics in terms of temperature and humidity. It is uniform or homogeneous horizontally and covers large areas. As air masses move, they can sometimes collide. If air masses with different characteristics collide, they do not mix freely with each other, but form a sloping boundary surface between them. The boundary formed is called a **front**.

When two air masses collide, the lighter or less dense warmer air tends to rise up over the dense cold air creating a **warm front**. Cold dense air may force itself under a mass of warmer air, thus pushing it up to create a **cold front**.

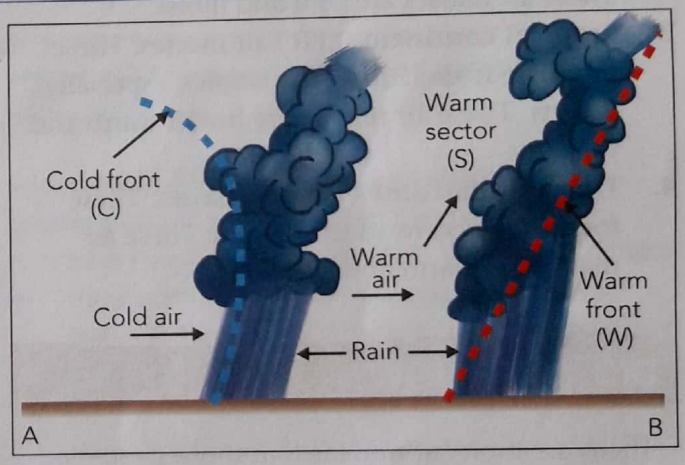

Figure 1.1 Colliding air masses cause cold fronts and warm fronts

Air masses are caused by air that rests undisturbed for a long time, upon either land or water surfaces that have uniform temperatures and humidity. Areas where air masses are created are called **source regions**. The source regions determine the characteristics of the air masses. The source regions could be seas, oceans or land masses. Air masses that originate from water surfaces are moist, that is, they have high humidity. Those from the land are dry. The air masses from the water surfaces are called **maritime air masses** and those from the land are called **continental air masses.**

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The source regions could be the poles or the tropics. These source regions determine the temperature of the air masses. Those from the poles are cold and are called **polar air masses**, and those from the tropics are warm or hot and are called **tropical air masses**. The polar and tropical source regions could be land or sea surfaces.

Types of air masses

Using the temperature and humidity characteristics of the source regions, air masses are classified into four main categories:

1. **Polar continental (Pc)** air masses: These originate from cold continental masses of the higher latitudes. These air masses are cold and dry since they come from the land.
2. **Polar maritime (Pm)** air masses: These are formed over cold seas in the high latitudes. These air masses are cool and moist.
3. **Tropical continental (Tc)** air masses: These originate from land in the tropics, especially deserts. These air masses are hot or warm and very dry.
4. **Tropical maritime (Tm)** air masses: These form over oceans in the tropics. These air masses are warm and moist.

DID YOU KNOW?

There are more air masses that those described above. Some authorities believe there are Arctic or Antarctic air masses and also Equatorial maritime and continental air masses. Air masses can be stable and unstable. The cold air masses are regarded as stable, since they are heavy and have sinking air. The warm air masses are regarded as unstable since they are associated with less dense air that rises, initiating up currents.

Within the tropics, air masses of the same temperature and humidity meet over low pressure areas to form a convergence zone rather than a front. A typical example is the Intertropical Convergence Zone (ITCZ), which is the 'thermal Equator', which migrates within the tropics following the movement of the sun.

Air masses affecting Zimbabwe and Southern Africa

Africa is found between 37° N and 35° S. The areas with overhead sun experience intense heat, which gives rise to a zone of low pressure. The changing position of the sun results in movement of a zone of high temperature and low pressure. Due to low pressure, trade winds which can be south-easterlies (SE), south-westerlies (SW), north-easterlies (NE) or north-westerlies (NW) blow into the zone.

The air mass that is normally found over Zimbabwe is tropical continental. Other air masses that reach Zimbabwe are polar maritime and tropical maritime. The polar maritime air mass, which originates in the Antarctic, is experienced as south-eastly trade winds. These normally occur in winter when they bring in cooler and moister air than tropical continental air mass. If the south-easterly trade winds blow in summer, they are cooler than the local air, but also drier.

North-eastly trade winds blow over Zimbabwe during the summer. These are associated with the tropical maritime air masses that originates from the northern hemisphere subtropical anticyclone that is usually centred over the central Indian Ocean (over the equator).

The Intertropical Convergence Zone

Unlike in temperate regions where different air masses meet and form fronts, air masses that meet in tropical regions have the same characteristics. Therefore, such air masses meet and mix without any boundaries in a broad zone between the two tropics, in a zone known as the **Intertropical Convergence Zone (ITCZ).**

The ITCZ follows the apparent path of the sun in Africa. These seasonal changes are evident over land, but remain subtle over the oceans. This is because the land quickly responds to high insolation levels by producing high temperatures, ideal conditions for ITCZ locations. The seas, on the other hand, respond slowly to high insolation levels. This is why temperatures remain subdued over the oceans, creating high pressure (anticyclones) cells that block the movement of the ITCZ and prevent it from following the apparent position of the sun.

In January, the position of the ITCZ and the intense low pressure over Central Africa make the ITCZ a destination for NW monsoons (Congo air), northe-asterlies and the prevailing 'traditional' south-easterlies.

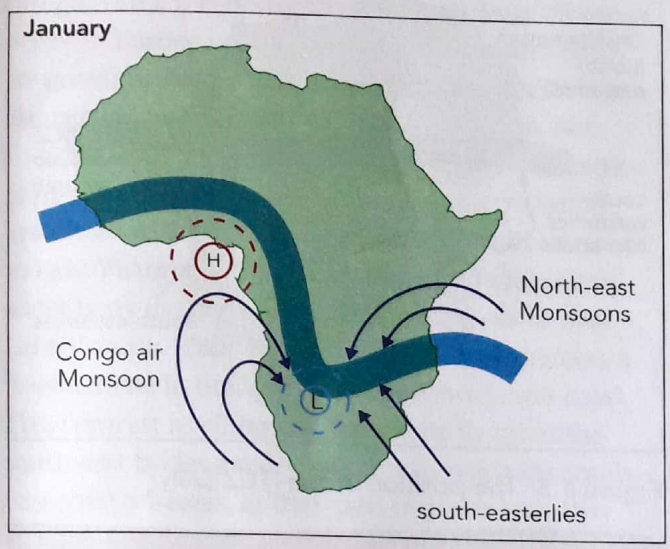


Figure 1.2 The position of the ITCZ (January)

Weather conditions associated with the ITCZ

- The direct sun causes very high temperatures.
- Excessive heating by the sun causes an intense low-pressure belt.
- North-westerlies, north-easterlies and south-easterlies converge. These are very moist air masses and therefore the relative humidity values are very high. (This normally happens over central southern Africa.)
- Upon arrival, the moist air masses rise convectionally, creating towering cumulonimbus clouds.
- Heavy rains result from the towering clouds.
- Diurnal temperature ranges are low due to the greenhouse effect of the clouds. (This is because of warm nights and subdued daytime temperatures).

January conditions

Figure 1.3 shows the pressure, the ITCZ and wind movement in January. The overhead sun is in the southern hemisphere. As a result, intense heating produces a zone of low pressure over most of southern Africa, which also covers Zimbabwe.

The ITCZ is mainly in the south although, as shown on the map, it extends north of the equator.

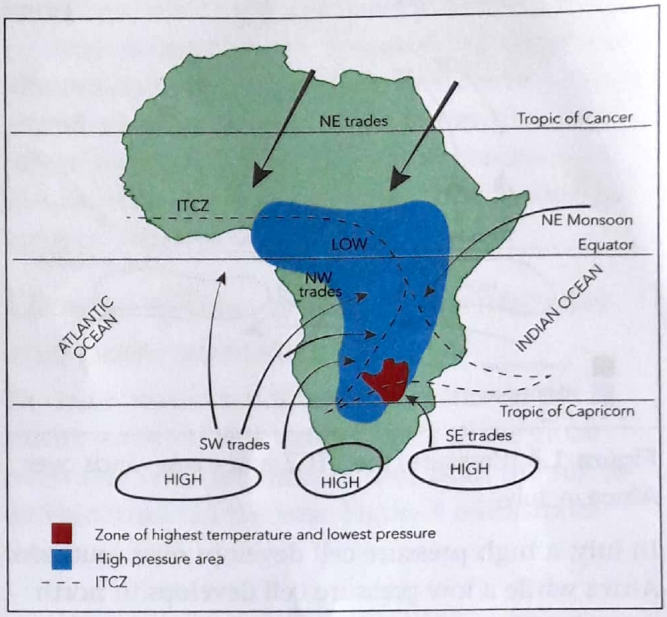


Figure 1.3 Pressure, the ITCZ and trade winds over Africa in January

In southern Africa, the main air streams that converge on the ITCZ during this time are:

- moist south-east trades from the Indian Ocean
- the north-east trades or **monsoons**, which reach south central Africa including Zimbabwe as the Congo Air. The north-west trades, as can be seen on the map, begin as south-east trades which later turn inland towards the south-east. The Congo Air and south-east trades are the source of most rainfall in southern Africa.

In the northern hemisphere, the ITCZ is more or less along the equator. With the moist south-west trades and the dry north-east trades converging over it, the overall results are that the southern hemisphere experiences its summer while in the northern hemisphere it is winter.

July conditions

Figure 1.4 shows the pressure, ITCZ and wind pattern over Africa in July.

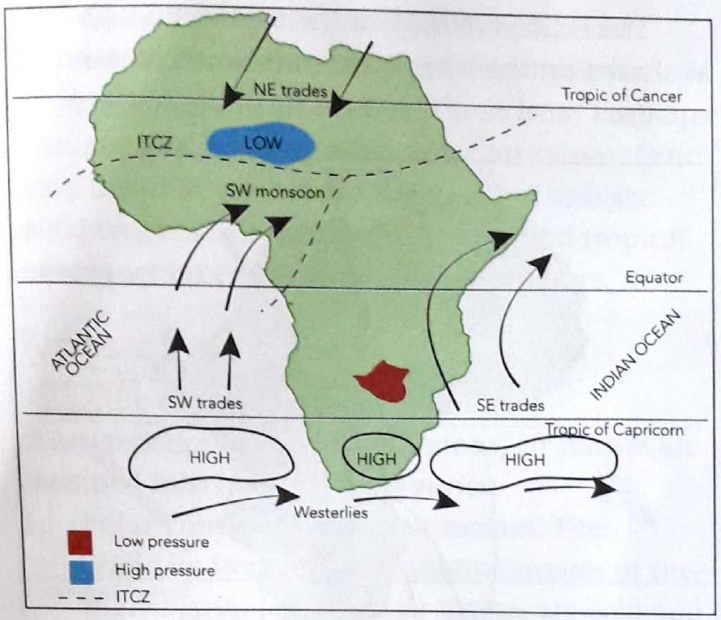


Figure 1.4 Pressure, the ITCZ and trade winds over Africa in July

In July, a high pressure cell develops over southern Africa while a low pressure cell develops in north central Africa, since the sun is overhead in the northern hemisphere.

In southern Africa, dry winds generally blow out of the subcontinent, hence little or no rainfall. The south-east trades blowing over the subcontinent, including Zimbabwe, are mostly dry except in the lower levels. As a result, the south-east trades can occasionally bring light rain as they pass over the Eastern Highlands in Zimbabwe and other mountain ranges in the eastern part of the subcontinent. It is worth noting that the southern tip of Africa, namely the Cape of Good Hope area, comes under the influence of westerlies, which bring rain to this area in winter. (Refer to Figure 1.4).

In the northern hemisphere, where the ITCZ is developed, the main air streams converging over the ITCZ are:

- the moist south-east trades from the Atlantic subtropical high pressure, which reach North West Africa as south-west monsoons after having curved north-eastward on crossing the equator
- the north-east trades, which include the Hamattan and are dry winds, since they pass over the Sahara Desert on their south-westward journey.

The overall results of the July conditions are that the southern hemisphere experiences its winter, while it is summer over the northern hemisphere.

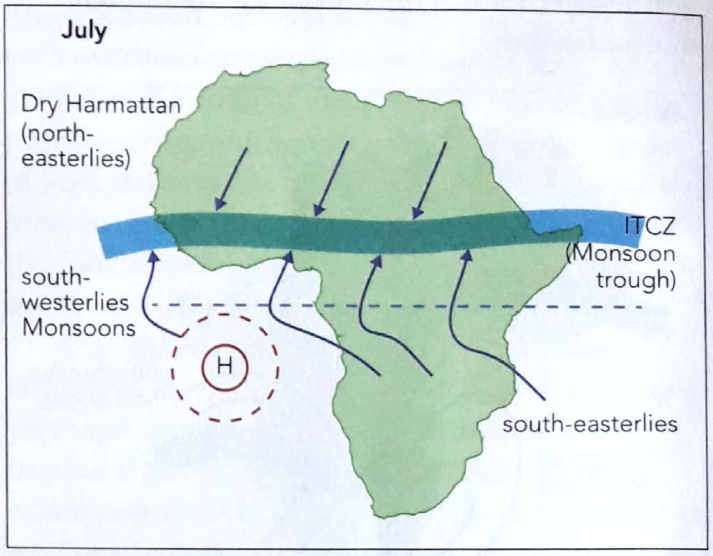


Figure 1.5 The position of the ITCZ (July)

DID YOU KNOW?

The word *monsoon* means season. Monsoon winds such as the north-east trades, in East Africa and the south-west trades in West Africa, are seasonal winds blowing over large areas for many months.

Activity 1

1. A report by the Meteorological Office says winds over Zimbabwe will be mainly from the south-east. Research what the expected weather conditions will be like in January and December.
2. Give reasons for the expected weather conditions.
3. Work in pairs. Look at Figure 1.2 and Figure 1.5, showing the position of the ITCZ in summer and winter.
   a) Describe to a partner how the position changes from January to July and explain why this change in position occurs.
   b) Discuss how this change in position affects Zimbabwe's weather in summer and winter.

Climate types on a global scale

Different places on Earth experience different climates. This is global climatic variation. For example, we know that in the Democratic Republic of Congo (DRC) it is hotter than in Zimbabwe. However, places in Europe such as the United Kingdom (UK) are generally colder than those in Africa, including Zimbabwe. An example of climatic variation over short distances is that associated with the occurrence of inland lakes and mountains. Climatic variation associated with lakes can be illustrated with reference to Lake Victoria, which is the largest natural inland water body in Africa. South trade winds blow over Lake Victoria. The south-eastern coast experiences a drier climate in contrast to the north-western coast. This contrast in climate is due to the fact that the south-east trades are dry when they reach the south-east coast whereas, as they pass over the lake, they gather lots of moisture from the lake. Thus, the north-western coast receives high rainfall, which is brought by the now moist south-east trades as they make landfall on, or reach, the north-west coast.

For a place or area, the average weather conditions (climate) change within the year. Such annual changes give rise to the climate pattern of an area. The climate pattern is the yearly match of weather conditions for an area. In Zimbabwe, for example, there are hot, wet summers and cool, dry winters.

Climate types: tropical, temperate and polar climates

The main reason for different climates on the Earth's surface is that various parts of the globe receive different amounts of heat from the sun at different times in the year. Figure 1.6 illustrates this.

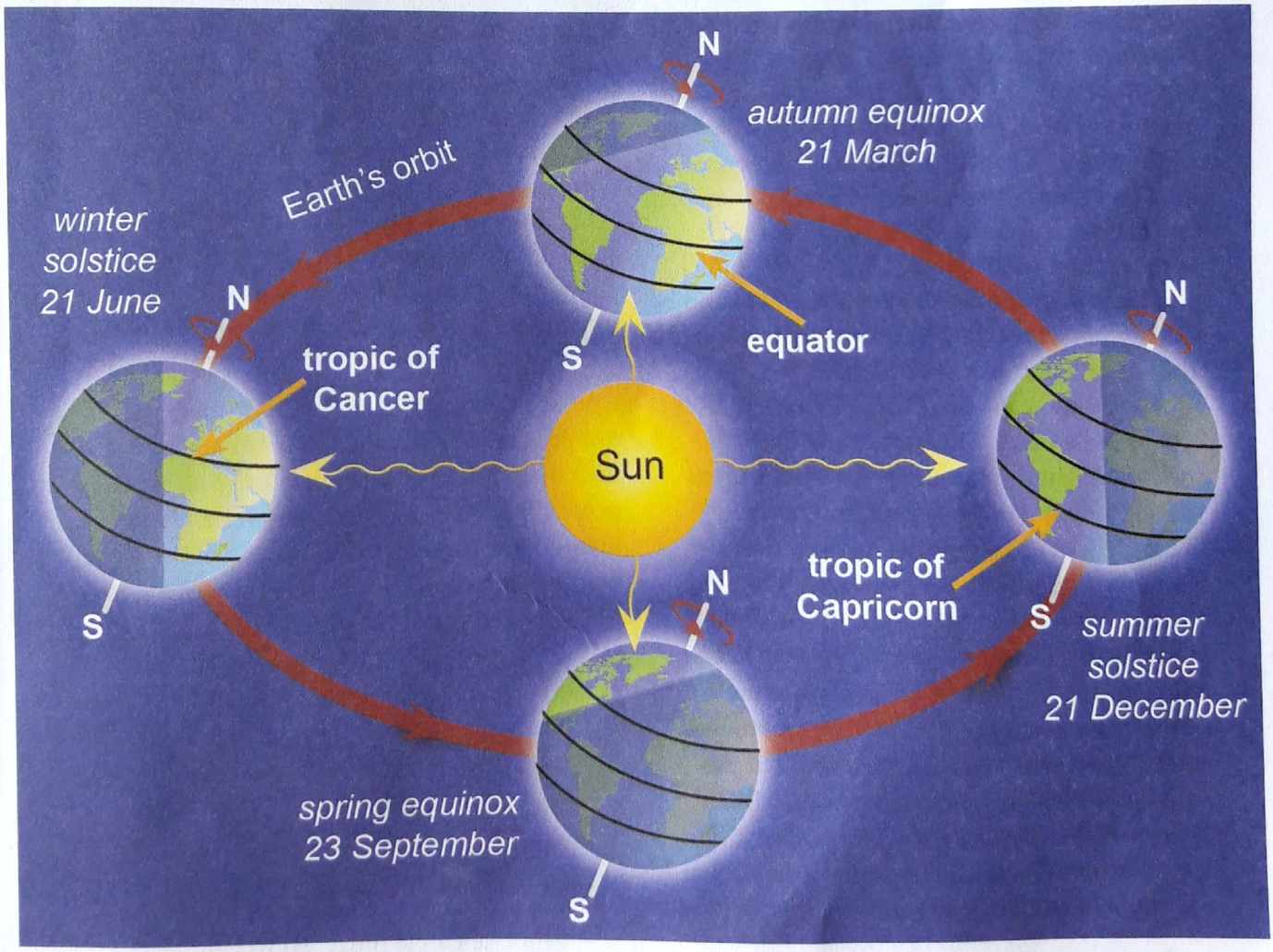


Figure 1.6 The Earth's orbit around the sun and the change of seasons

As the Earth revolves around the sun, its axial tilt (inclined at an angle of 23,5° N from the vertical, as shown in Figure 1.6, causes different parts of the globe to receive varying amounts of heat from the sun at different times. The four main changing periods and positions are shown in the diagram. The broad climatic results are as follows:

- Between 21 March and 22 September, the sun is overhead in the northern hemisphere, that is, moving between the equator and tropic of Cancer (23,5° N). On 21 June, the sun is directly overhead on the tropic of Cancer, its furthest extent north. This means that most areas in the northern hemisphere receive a lot of heat from the sun and experience high temperatures and rainfall. This is their summer period. The opposite is true for the southern hemisphere, where it is winter with low temperatures and generally low rainfall.
- Between 22 September and 21 March, the sun is overhead in the southern hemisphere, that is, moving between the equator and the tropic of Capricorn (23,5° S). On 21 December, the sun is overhead directly on the tropic of Capricorn, its furthest extent south. At this time, most areas in the southern hemisphere receive a lot of heat from the sun and therefore experience high temperatures and rainfall. This is the summer period. In the northern hemisphere, it would be winter time characterised by low temperatures and, in most cases, low rainfall.
- In any given year, the places between 23,5° N or S of the equator experience the overhead sun twice. These areas are within the tropics where the temperatures vary from warm to hot. They have tropical climates. Areas along the equator, that is, between 0 to 10° N and S experience the overhead sun almost always throughout the year. This zone has hot temperatures and experiences high rainfall due to lots of heating. This is the **equatorial** zone. Between 10° and 23,5° N and S of the equator, are the other tropical areas, which, as already mentioned, have moderately high temperatures due to the overhead sun, which they experience at some time during the year.
- North and south of the 23,5° latitudes (the **tropics**), the sun's rays are always received at an angle of less than 90°. This angle becomes even more acute towards the poles. The result of such difference in solar heating, is that areas between 23,5° and 30°/35° N and S have moderately lower temperatures compared to the tropics and are termed **subtropical** areas. Between 35° to around 50° N and S, the average temperatures get even lower or colder than the tropical and subtropical areas. This broad zone is called **temperate** to emphasise the moderate to low temperatures, which characterise them. Northward and southward of 50° are the polar regions. In particular, the areas above 66,5° N and S are the polar zones which are cold and covered by huge accumulations of ice called glaciers. The cold temperatures are due to lower amounts of solar heat received in any given year.

Activity 2

Places above the Arctic and Antarctic Circle, that is, above 66,5° N and S respectively, experience six months of continuous light with another six months of continuous darkness.

Bear in mind the axial tilt of the Earth and use information from Figure 1.6 to identify when these six-month periods occur at the North Pole and the South Pole respectively.

Climatic types are mainly determined by temperature and rainfall. Climates can be divided into three broad groups: tropical, temperate and polar climates. These groups can be further sub-divided into smaller units, based on the dominant factor determining either temperature or rainfall.

- Between the Tropic of Cancer and Tropic of Capricorn the climate is tropical.
- The temperate zone is between 23,5° S and the Antarctic Circle in the southern hemisphere and between 23,5° N and the Arctic Circle in the northern hemisphere.
- The polar zone in the northern hemisphere is from the Arctic Circle (66,5° N) to the North Pole and in the southern hemisphere from the Antarctic Circle (66,5° N) to the South Pole.

Although the latitude of a place is a major factor in determining the type of climate experienced, it is not the only factor. Other factors such as distance from the sea, altitude and ocean currents influence the temperatures of a place. These factors, combined with the effect of latitude and many other factors, result in a world pattern of climatic types as shown in the map in Figure 1.7.

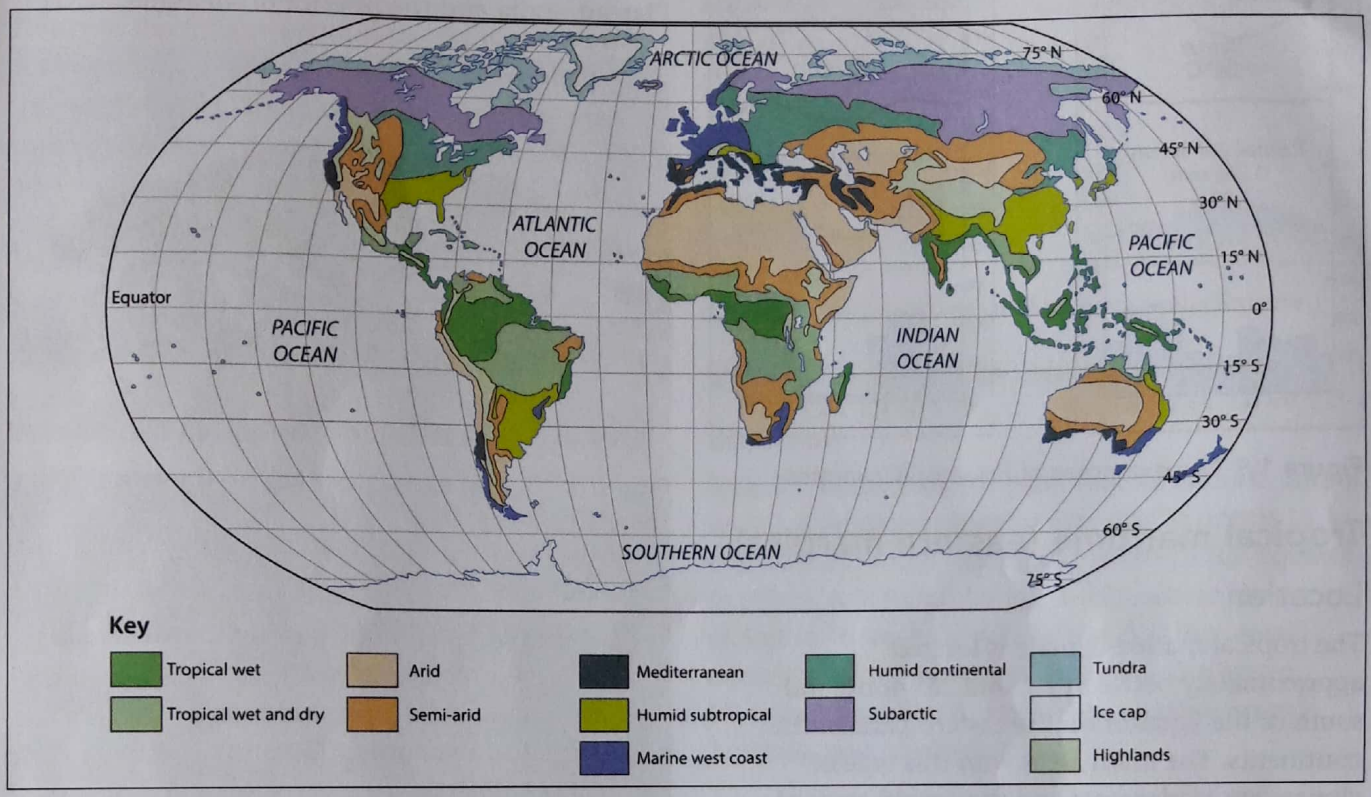


Figure 1.7 World climates

Equatorial (hot, humid, tropical climate)

Location

This climatic zone lies approximately between 5° north and south of the Equator. Some of the areas with this type of climate include the Congo Basin, the southern coastal areas of West Africa and the Amazon Basin in South America.

Figure 1.8 The Amazon rainforest is found along the equator.

Characteristics

- There is little or no seasonal variation in the climatic conditions.
- Temperatures are uniformly high throughout the year, ranging between 26 °C and 28 °C.
- The diurnal and annual ranges of temperature are very small, ranging between 1 °C and 3 °C for both annual and diurnal temperatures.
- Rainfall is high throughout the year, averaging above 2 000 mm annually.
- Humidity is high, above 90%.
- The rainfall is heavy and associated with the ITCZ.
- Some areas experience a **double maxima** of rainfall or temperature. The double maxima represents two peak periods of rainfall or temperature in the Equatorial climate. This usually coincides with the equinox periods when the sun is over the Equator. These periods are around 21 March and 23 September each year. Figure 1.9 shows typical graphs.

During the year, the sun crosses the Equator twice, bringing the high temperatures and the associated convectional rains twice.

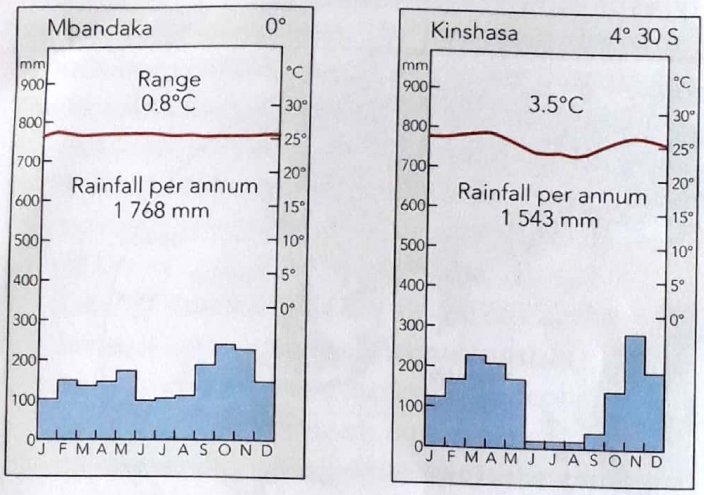


Figure 1.9 Two examples of Equatorial climates

Tropical maritime (eastern margins)

Location

The tropical marine climate is located approximately between 10° and 25° north and south of the Equator on the eastern parts of the continents. The main areas with this type of climate are Madagascar and the coastal areas of Mozambique. Another area with this climate is the east coast of Queensland in Australia.

Characteristics

- The climatic features are similar to the Equatorial climate, in that temperature and rainfall are fairly high and uniform throughout the year.
- There is rain throughout the year, mostly as a result of trade winds blowing over warm currents.
- Temperatures are high throughout the year, but modified by the effects of ever-present sea breezes.

Tropical continental or seasonally humid tropics (savannah)

Location

This zone lies approximately between 15° and 22° north and south of the Equator and the tropics. On the East African plateau, this type of climate is found on the Equator. Areas experiencing this climate type in Africa include Sudan and most of central Africa.

Areas outside Africa include the Brazilian Plateau, India and the interior of Australia.

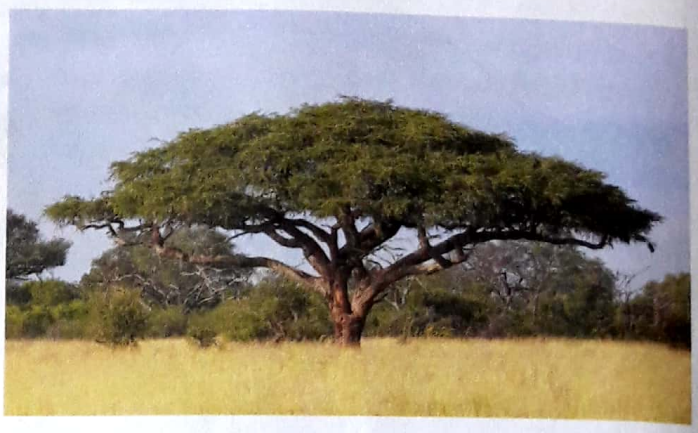


Figure 1.10 Acacia trees are typical vegetation in the African savannah.

Characteristics

- Temperatures are high throughout the year (25 °C) but cooler in winter (17 °C).
- The temperature range averages 8 °C.
- Rain falls in summer (920 mm) and the winters are dry.
- The rainfall is associated with the movement of the ITCZ.
- The weather is dry, windy and dusty in the winter and hot, humid and calm in the summer. Refer to Figure 1.11 for the typical graphs. It should be noted that the term 'savannah' refers, in its strictest sense, to the vegetation found in the tropical continental or seasonally humid tropics.

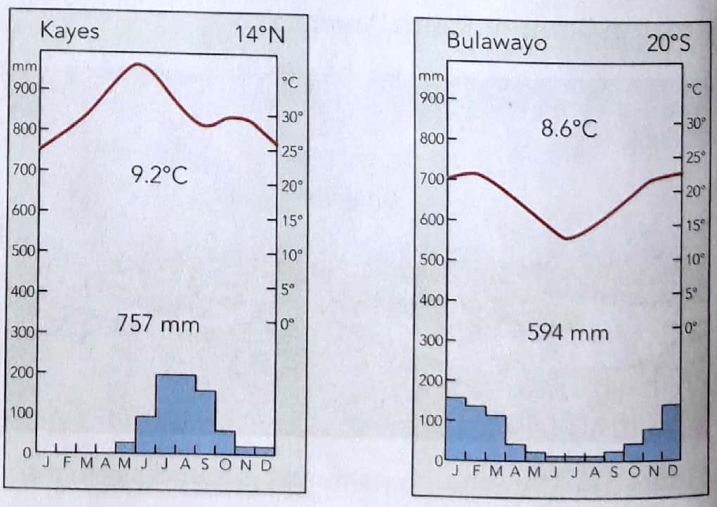


Figure 1.11 Examples of tropical climates (savannah)

Mediterranean (warm temperate western margin climate)

Location

This type of climate is found on the western side of continents, approximately 30° to 40° north and south of the Equator. Typical areas in Africa are the Western Cape in South Africa and the north-western part of north Africa. Other areas include California in the USA, central Chile in South America and some European areas along the Mediterranean Sea.

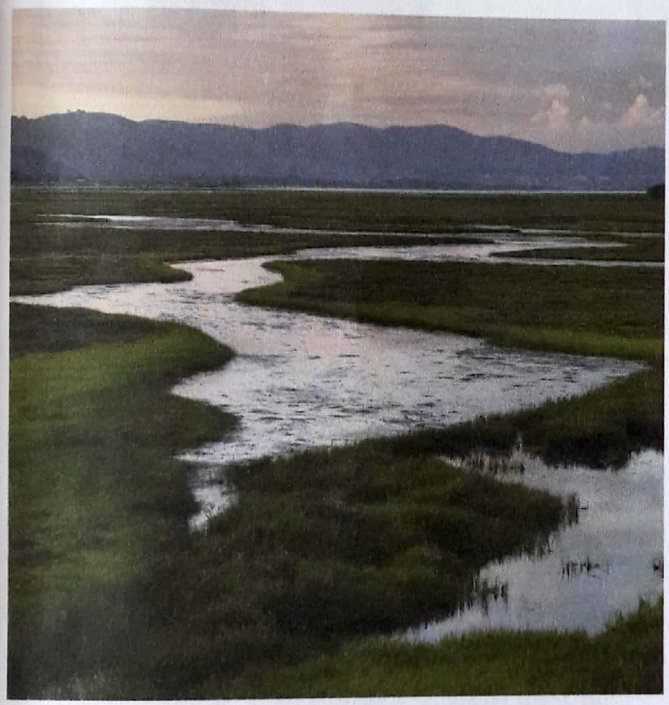


Figure 1.12 Knysna in the Western Cape of South Africa has a temperate climate.

Characteristics

- There are marked summer and winter seasons.
- Winters are wet as a result of cyclonic storms, and summers are dry due to anticyclonic conditions and associated offshore winds.
- There are sunny conditions especially in summer.
- The annual temperature range is large, ranging between 10 °C and 15 °C.
- The rains are, on average, low, about 400 mm to 600 mm. See Figure 1.13 for typical graphs.

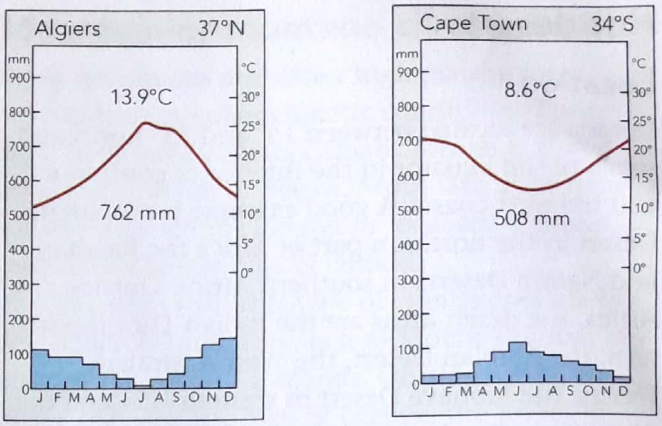


Figure 1.13 Examples of Mediterranean climatse

Warm temperate eastern margin

Location

This is a humid, sub-tropical type of climate, found on the eastern continental margins. It occurs in latitudes 20° to 35° north and south of the Equator. In Africa, it is found in the south-eastern part of South Africa, in KwaZulu-Natal. Other areas outside Africa are central China, south-eastern USA, southern Brazil, Argentina, south-eastern Australia and southern Japan.

Characteristics

- Summers are long, hot (27 °C) and humid, winters are cold (18 °C), but there are great variations due to the influence of tropical air masses.
- There is rainfall throughout the year, although it occurs mostly in summer.
- The annual rainfall is about 1 000 mm. Refer to Figure 1.14 for a typical graph.

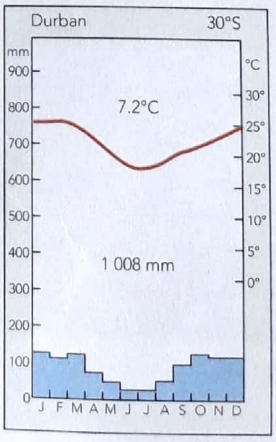


Figure 1.14 An example of a sub-tropical climate

Hot deserts

Location

Deserts are located between 15° and 35° north and south of the Equator in the interior of continents and the west coasts. A good example is the Sahara Desert in the northern part of Africa the Kalahari and Namib Deserts in southern Africa. Outside Africa, the desert areas are the Indian Thor Desert area, the Arabian Desert, the West Australian Desert, the Mohave Desert in western USA and the Atacama in South America.

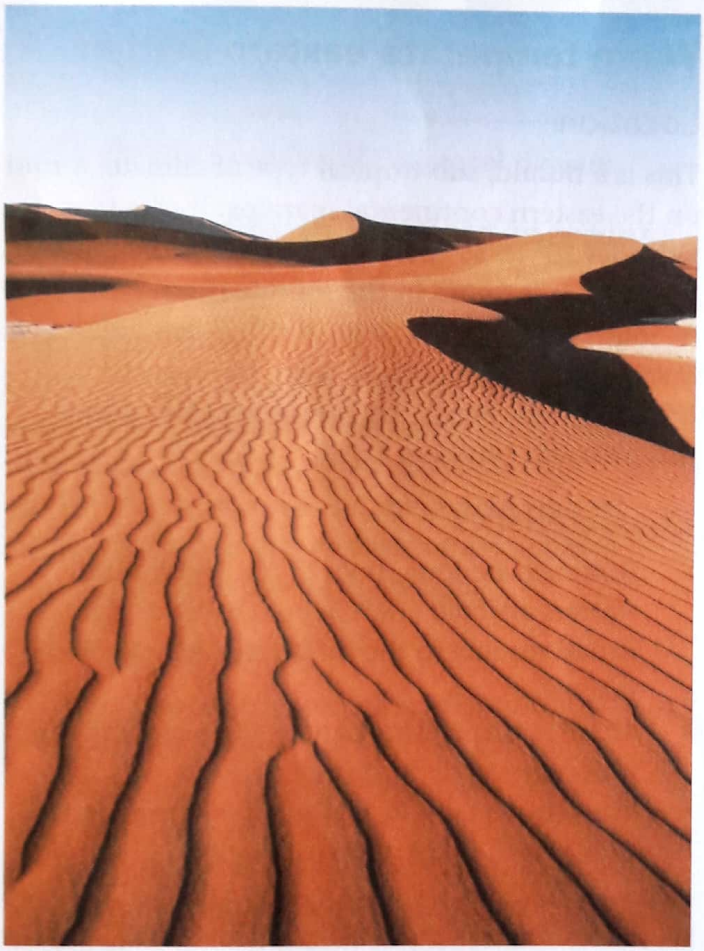


Figure 1.15 The Namib Desert in Africa

Characteristics

- Rainfall is low, about 250 mm annually.
- There are very high temperatures during the day, averaging about 30 °C, and very low temperatures during the night, about 10 °C. The high temperature range of 25 °C is due to the lack of cloud cover.
- There are clear skies and low humidity.
- Windy conditions occur.
- Anticyclonic conditions occur as the areas fall along the **horse latitudes**.
- Evaporation rates are high due to high daytime temperatures.

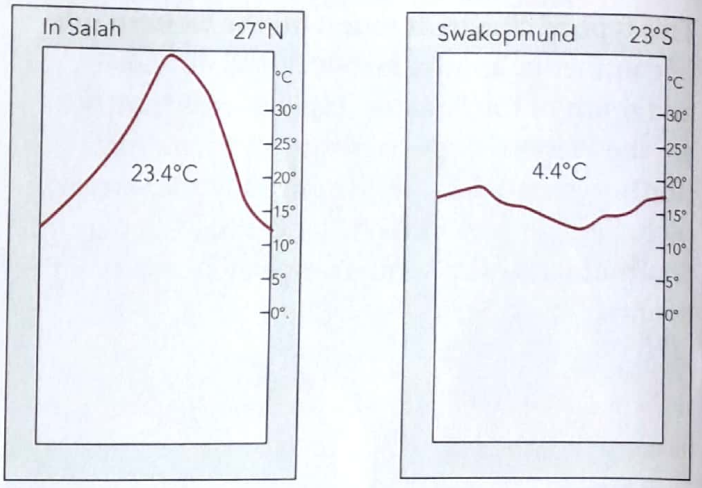


Figure 1.16 Examples of desert climate

Temperate deserts

Location

These deserts are located in the mid-latitudes, which is 25° and 40° north and south of the Equator. They are located in the interior of continents. Good examples include central Asia, the south-western parts of the USA and the Patagonia region of South America.

Characteristics

- High temperatures of about 31 °C occur in the summer and winters are very cold with temperatures of below –10 °C being recorded.
- The temperature range is very high (over 32 °C).
- Rainfall is very low, about 110 mm. Snow falls in the winter.

Temperate continental

Location

The temperate continental climate is also known as the warm continental climate. It is found 30° to 50° north and south of the Equator. A typical area in Africa is the highveld of South Africa. The other areas in the world are North America, the prairies of Canada, the Pampas of South America and the Murray-Darling Plains of Australia.

Characteristics

- There are seasons.
- It is very cold in winter (–3 °C) and frost may occur.
- In summer, the days may be hot (22 °C).
- There is low rainfall, ranging between 500 mm and 1 000 mm.
- The summer is very short.

Tundra (cold desert)

Location

Cold deserts are found along the polar margins. They occur along the Arctic Sea in North America and the Antarctica Peninsula, parts of Finland, Norway, Sweden, Russia and Iceland.

Characteristics

- Cold deserts have long winter nights and lack any warm season.
- Temperatures range between –29 °C and –40 °C in winter.
- The sun does not rise above the horizon for weeks.
- Summers are short and cool, with maximum temperatures of 10 °C, and the sun remains above the horizon for several weeks.
- Rainfall is low (about 250 mm annually) and mostly occurs in summer.
- Snow cools the ground for nearly six months.

Figure 1.17 Polar bears inhabit the Tundra regions.

Mountain or montane climate

Many mountains and other high plateau areas tend to have peculiar climatic conditions. These high areas have varying climatic elements that change quickly with height. Mountain areas have a number of micro-climates or localised climates, instead of a single type of climate.

The areas with this type of climate include the East African mountains such as Mount Kilimanjaro and the Ethiopian Highlands. Outside Africa, the plateau of Asia, the Alps of Europe, the Andes of South America and the Rockies of North America have montane climates.

Characteristics

- Pressure and temperature are low, due to the high altitudes.
- Rain increases and then decreases with altitudes due to the effect of leeward and rain shadow areas.
- The conditions are always cool and the diurnal temperature range is small.
- There are local winds that blow up the valley (anabatic) during the day and down the slope (katabatic) during the night.

Figure 1.18 The Ethiopian Highlands have varying climates due to the mountains.

Climatic types of Africa

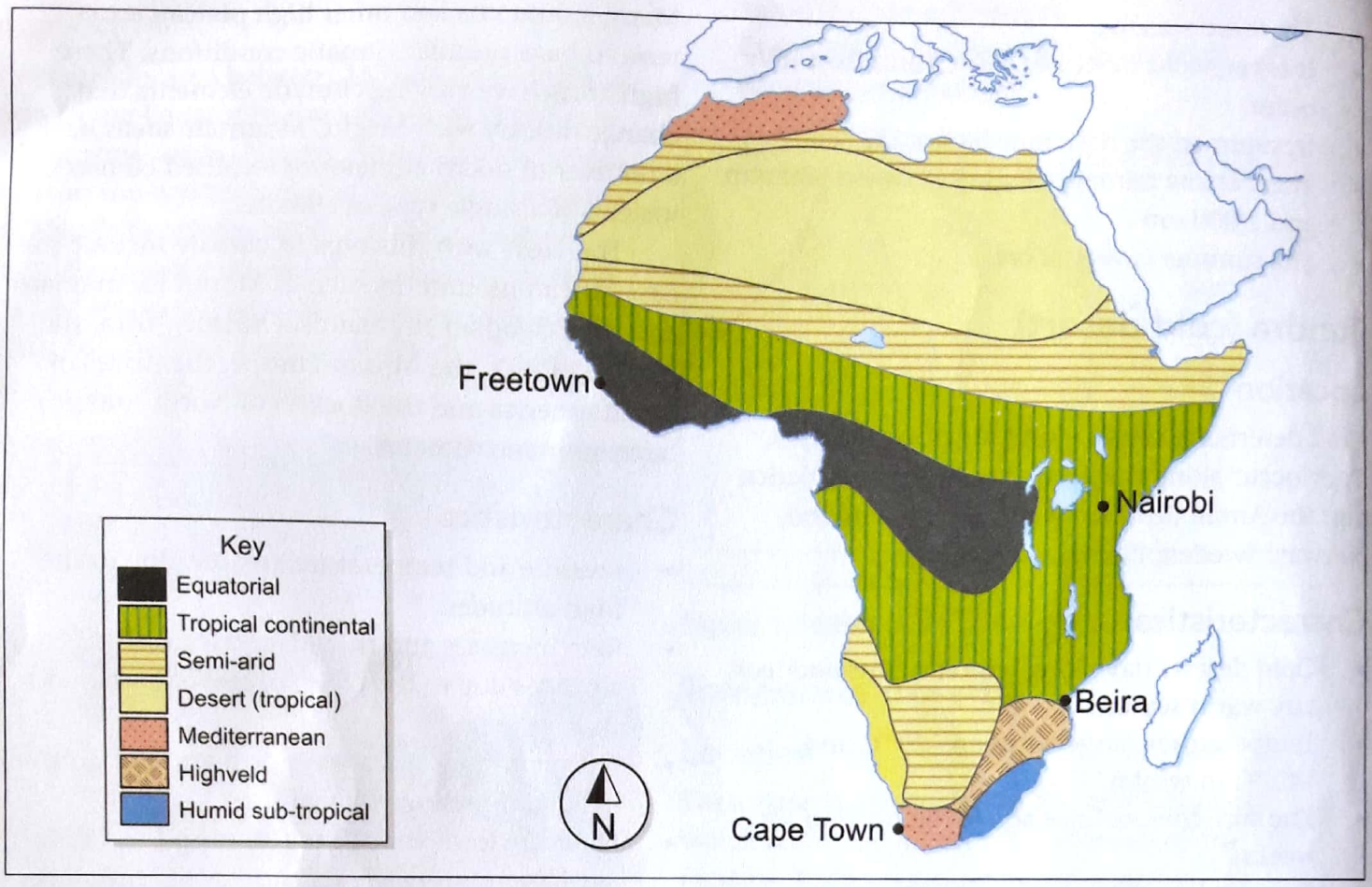


Figure 1.19 Climatic regions of Africa

Interpreting of climatic data

Rainfall and temperature records taken over a year or longer periods are the basis for showing and describing the main features of the climate at any station or area. Although each of us can say whether it is 'hot or cold' and 'wet or dry', we have to be sure we mean the same thing when we use these descriptions of the weather and climate. Geographers use the following guidelines, which relate our descriptions to specific temperature and rainfall figures. This ensures that we mean the same thing when we describe the rainfall and temperature experienced.

Table 1.1 Rainfall and temperature figures

Rainfall and temperature figures	Description
Monthly amount (mm)	
Below 50	dry
50–250	wet
Above 250	very wet
Annual amount (mm)	
Below 250	very dry
250–500	dry
500–1 000	moderate
1 000–1 500	wet
Above 1 500	very wet
Average monthly temperature (°C)	
–10 °C and below	very cold
–9 °C–0 °C	cold
1 °C–10 °C	cool
11 °C–20 °C	warm
21 °C–30 °C	hot
31 °C and above	very hot
Annual temperature range (°C)	
Up to 5 °C	small
5 °C –20 °C	moderate
Above 20 °C	large

Using the above guidelines, we can describe the rainfall and temperature and hence the climatic characteristics or pattern of any station. Let us see how we can do this for Bulawayo in the form of an assisted or guided revision exercise.

Activity 3

Table 1.2 Temperature and rainfall figures for Bulawayo

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (°C)	21	21	20,5	19,5	17	14	14	16,5	18,5	22,5	22	21,5
Rainfall (mm)	130	110	70	30	10	0	0	0	0	20	90	130
Climatic characteristics	Description											
Temperature	a) hot				b)				c)			
Rain	d)				e)						f) wet	
Seasons	Hot-wet, rainy/summer season				Warm-dry post-rainy season		Warm/cool-dry winter				Hot-wet rainy/dry summer	

1. a) Copy Table 1.2. Periods a) and f) have been labelled as examples of the associated temperature and rainfall descriptions. The seasons associated with these temperature and rainfall characteristics are given.
   b) Choose words from the word list below to supply the correct word to describe the temperature and rainfall experienced in the periods labelled b), c), d) and e).

   warm wet dry hot

2. Describe the four identified seasons on the basis of the following:
   a) the period in which they occur **b)** the average temperature **c)** the total rainfall
3. Using the values calculated from the table of (a) mean annual temperature, (b) annual temperature range and (c) mean annual rainfall, describe these climatic characteristics of Bulawayo. An example of total rainfall and its distribution is given below.

Example
Bulawayo has a moderate annual rainfall total of 590 mm, which falls between October and May. From June to September, it is dry as no rainfall is received.

The climatic data is usually recorded in tables, which are then used to draw graphs. The rainfall and temperature figures can be plotted against each other to create a rainfall bar graph and a temperature line graph on one diagram. Diagrams or graphs that show any two elements of the climate of a place are referred to as **climographs**. The combined rainfall and temperature graph is the most common type of climograph used to describe the climatic characteristics or pattern of a station.

The rainfall and temperature graph in Figure 1.20 represents climatic information for Bulawayo, which we have already been working with in Activity 4.

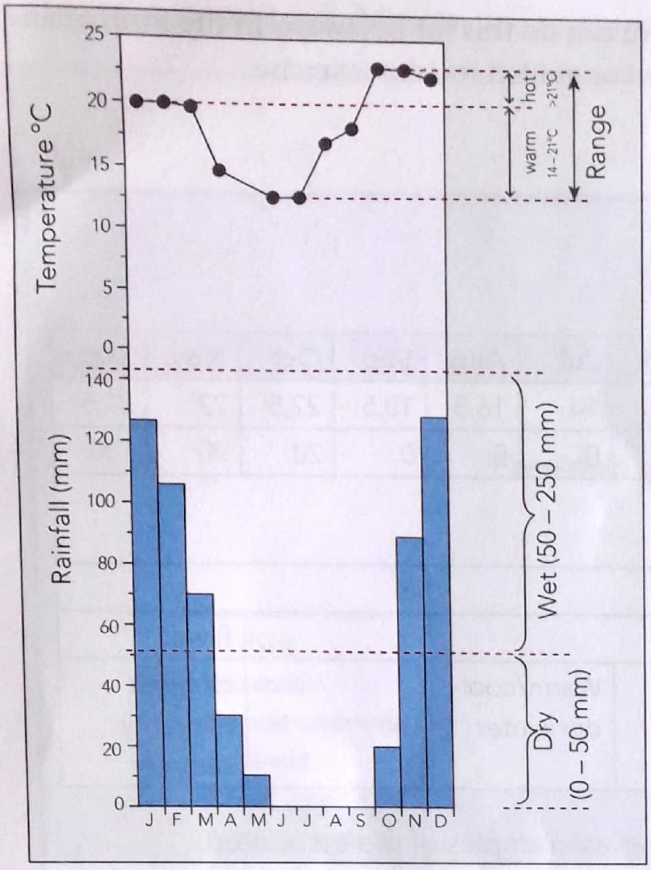


Figure 1.20 Climate graph (climograph) for Bulawayo

The climograph shows the station Bulawayo, which is located in the southern hemisphere.

Other characteristics relating to the altitude and latitude of a station are clues as to the type of climate. Altitude affects temperature in that low-lying places and are generally hotter than high-lying ones. Places in low latitudes (near the equator) are warmer than those further away from the equator.

Characteristics and uses of the climograph include the following.

- Time in months is shown on the horizontal axis.
- Rainfall and temperature are shown on the vertical axis. Rainfall for each month is shown by vertical bars of equal width, which touch each other and temperature for each month is shown by a line graph above the bars.
- Using the guidelines describing temperature and rainfall figures, it is possible to show which months experience hot or warm temperatures or those that are dry or wet. The range of temperature can also be established.
- The period where temperature is high or low points to the hemisphere in which the station is located. (In this case, the low temperatures are in May to August, which indicates the station is in the southern hemisphere.)

SUMMARY

- An air mass is a large body of air with distinctive characteristics of temperature and humidity.
- Source regions determine the nature of an air mass. Tropical air masses are warm or hot while polar air masses are cold. Continental air masses are dry and maritime air masses are moist.
- The ITCZ is a broad zone of low pressure, formed due to heating, and it is where winds converge.
- Recorded weather elements can be used to come up with a climate of an area and the world continents can be divided into climatic regions.
- Climate refers to the average weather conditions experienced at a place over a long period of between 30–35 years.
- The main difference in climates of given areas, is that parts of the globe receive different amounts of heat from the sun at different times of the year.
- The main factors that determine the type of climate of an area include temperature, altitude, latitude, distance from the sea, ocean currents, cloud cover and so on.
- Climates can be divided into three broad groups: tropical, temperate and polar climates.
- Climatic data (relating to rainfall and temperature) is recorded in tables, which are converted to graphs known as climographs.

Glossary

climate – average weather conditions of a place calculated over 30–35 years
climograph – a graph showing two elements of climate, usually temperature and rainfall
cold front – a boundary formed where cold dense air forces itself under a mass of warmer air, thus pushing it up
continental – associated with the land
double maxima – two peak periods for rainfall or temperatures as is the same for equatorial stations around the equinoxes
equatorial – an area along the equator between 0° and 10° N and S, which has high temperatures and high rainfall
equinoxes – periods of equal daylight and night time hours all over the world as the sun is overhead the equator on 21 March and 22 September
front – a boundary between two contrasting air masses
horse latitudes – high-pressure belts located north and south of the Equator between the latitudes of 30° and 35°
humidity – the moisture content of the air
Intertropical Convergence Zone – low pressure belts over Equatorial and tropical regions where trade winds meet, rise and result in rainfall
maritime – influenced by the sea
monsoon – a seasonal wind like the north-easterly and north-westerly winds (Congo Air) in Zimbabwe
polar – an area north and south of 50°; covered by glaciers in the areas above 66,5° N and S
solstice – when the sun is overhead either at the Tropic of Cancer (21 June) or the Tropic Capricorn (22 December)
source region – the area where an air mass is created
subtropical – an area between 23,5° and 30°/35° N and S, with moderately lower temperatures than the tropics
temperate – an area between 35° and 50° N and S, with moderate to low temperatures
tropical – an area between 23,5° N (Tropic of Cancer) and 23,5° S (Tropic of Capricorn), which has temperatures that are warm to hot
tropics – areas between the Tropics of Capricorn and Cancer
warm front – a boundary formed where lighter or less dense warmer air rises up over the dense cold air

Topic test

1. Climate is:
   - A the average weather condition of a place taken over 30–35 years
   - B the daily condition of a place
   - C the average weather condition of a place taken over a short period of time, about 5–7 years
   - D the plants and grass of a place over a long period of time.
2. The Intertropical Convergence Zone is overhead the Tropic of Cancer in the northern hemisphere in:
   - A June–July
   - B November–December
   - C August–September
   - D March.
3. 'It receives rainfall throughout the year. Temperatures are high and almost the same throughout the year.' This description relates to:
   - A a hot desert climate
   - B an equatorial climate
   - C a savannah climate
   - D a Mediterranean climate.
4. a) Define climate.
   b) Altitude, latitude, distance from the sea and ocean currents are some of the factors that affect the climate of an area. Choose two factors from the above and explain how they affect temperature.
   c) Explain how altitude and latitude affect the temperature distribution in Zimbabwe.

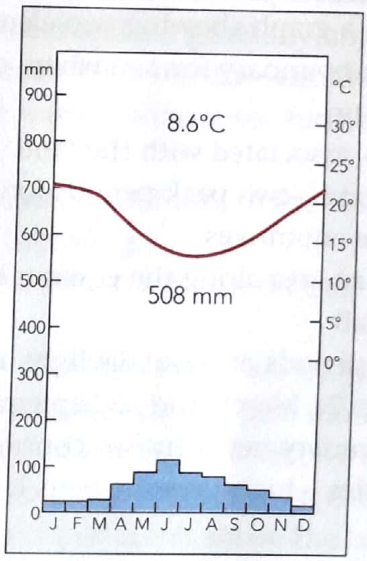


Figure 1.21 A graph of annual temperature and rainfall patterns

5. The graph in Figure 1.21 shows temperature and rainfall patterns for a place in Africa.
   a) In which hemisphere is the station located?
   b) Describe the climate of the place shown by the graph.

Topic 2

Landforms and landscape processes

Objectives

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

- outline the continental drift theory
- describe tectonic movement
- explain the implications of plate tectonic movements on climate
- describe the processes of folding and faulting
- describe resultant landforms
- outline the distribution of volcanoes and earthquakes
- explain the causes of volcanoes and earthquakes
- identify effects of volcanic activity and earthquakes
- identify measures to reduce effects of vulcanicity and earthquakes.

Look at a world map. You will see that the land masses are separated from each other by oceans. Look at the west coast of Africa and the east coast of South America. You will notice that they fit into each other like jigsaw pieces. The way that these landmasses fit led people to believe that the continents once were one land mass and have since drifted apart. What led to the break-up of the land into separate land masses and what caused them to drift apart? In this topic, we examine what causes this movement and what the results of this movement are.

Continental drift theory

The earth's outer 100 km is made up of separate blocks, which are continuously moving. Such movements are called Earth movements or **tectonic movements**. These lighter blocks float on the denser mantle below and are in constant movement relative to one another. The movements are very slow. Large masses of the earth's crust are affected by these movements and are believed to have influenced the present distribution of oceans, continents and major landforms such as big mountain ranges. The first theory used to explain the distribution of continents was that of **continental drift**, which was put forward by Alfred Wegner at the beginning of the 20th century.

It is agreed that the jig-saw fit of continents had been noted by Francis Bacon as far back as 1620. Later on, Suess came up with the idea of a one-time large southern continent, which he named **Gondwanaland**, after a place in India.

Gondwanaland consisted of South America, Africa, southern India, Australia and Antarctica. However, according to Alfred Wegener in 1912, all the continents once formed a huge landmass called **Pangea**.

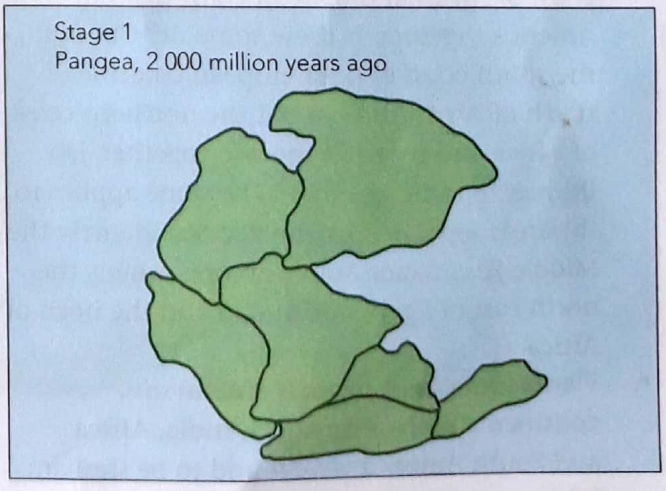


Figure 2.1 (a) The composition of Pangea

This large 'super continent' included all continents and not only the southern continents as in Gondwanaland. Pangea comprised **Laurasia** in the north (with its continents that included Europe, North America and Asia) and Gondwanaland in the south (with India, Africa, South America and Australia). About 200 million years ago (the late mesozoic era), Pangea began to break up as the continents drifted.

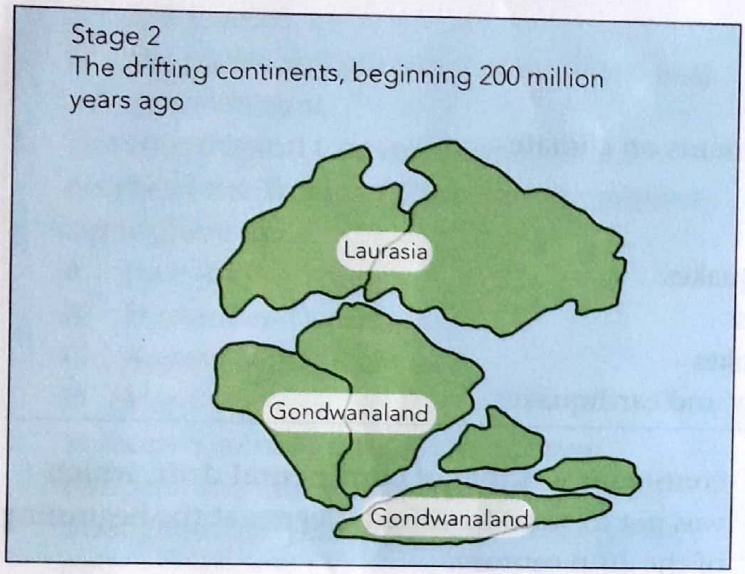


Figure 2.1 (b) The break-up of Pangea, the 'super continent'

Scientists believed that continents were once joined together but drifted apart for a number of reasons. The following points are pieces of evidence for this **continental drift**.

- Some coastal areas of continents seem to fit together. Trace out the world map and cut out Africa and South America. Try to fit the west coast of Africa and the east coast of South America together. Is there some fit? Cut out the south coast of the European countries north of Afric. Also cut out the northern coast of Africa and try to fit the two together. Do they seem to fit together? The same applies to the areas separated by the Red Sea, namely the Middle East, Saudi Arabia among others, the north east of Egypt and Sudan and the horn of Africa.
- Plants (flora) and animals (fauna) on continents such as Australia, India, Africa and South America were found to be similar, indicating that these areas were once joined.
- Geologists noted some similarities in the rock formations and mountain ranges. Such close correspondence was noted between north-west Europe and North America.
- A scientific study called **palaeomagnetism** has been used by scientists to determine the original positions of the poles in the past. This method uses the magnetic nature of rocks to determine the original position of continents. As a result, rocks in some coastal areas are of a similar original magnetic alignment for example, those of the east coast of South America and the west coast of Africa. This scientific piece of evidence using palaeomagnetism became the most reliable piece of evidence.

Two theories were put forward to explain why continents were drifting, namely, sea floor spreading and the expanding Earth. No concrete evidence could be given to support the two theories. Later, the theory of plate tectonics was put forward to explain, with full evidence, why the continents were drifting.

Plate tectonics theory

As time progressed, new scientific ideas emerged. The initial belief was that continents drifted. The early theories of continental drift failed to provide a satisfactory mechanism of how and why continents moved. However, new scientific evidence proved that continents are 'carried as passengers' on portions of the Earth called **plates**. As the plates move, so do the continents they are carrying along with these.

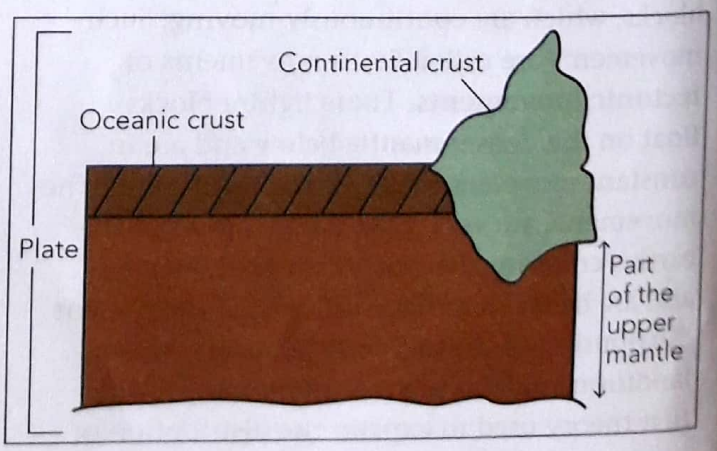


Figure 2.2 Plate movement

The block labelled 'plate' in Figure 2.2 consists of the oceanic crust, continental crust and some solid part of the upper mantle that floats above the partial molten sections of the upper mantle (called the asthenosphere).

Seven major plates have been identified: the African, Indian, South American, North American, Australian, Eurasian and Antarctic plates. The other minor plates include the Nazca and Arabian plates.

Why do the plates move?

In the centre of the earth (the core), rocks continue to be created and spread outwards or towards the centre. Convection currents are set up in the mantle where the new material created in the core is moved. This convection process resulted in the break-up of continents and their subsequent movements. Seas are created as continents drift apart. This process is termed **sea or ocean floor spreading** and causes the plates to move (Figure 2.3).

Plate margins

Plate margins represent the boundary between two plates. There are three types of plate boundaries: constructive/divergent, destructive/convergent and transform/conservative.

Divergent or constructive margin

In this case, the two plates are moving away from each other due to the convectional currents pulling the plates apart, as shown in Figure 2.4 below.

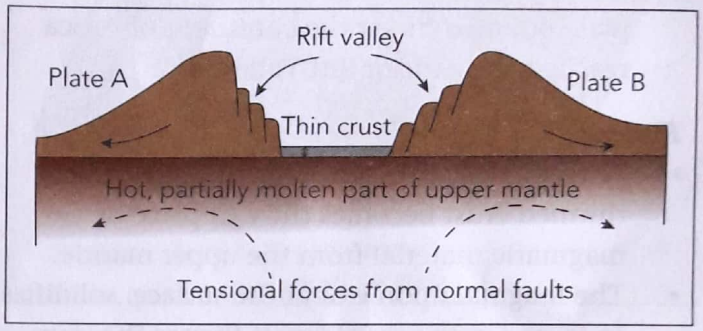


Figure 2.4 A divergent/constructive margin at its inception

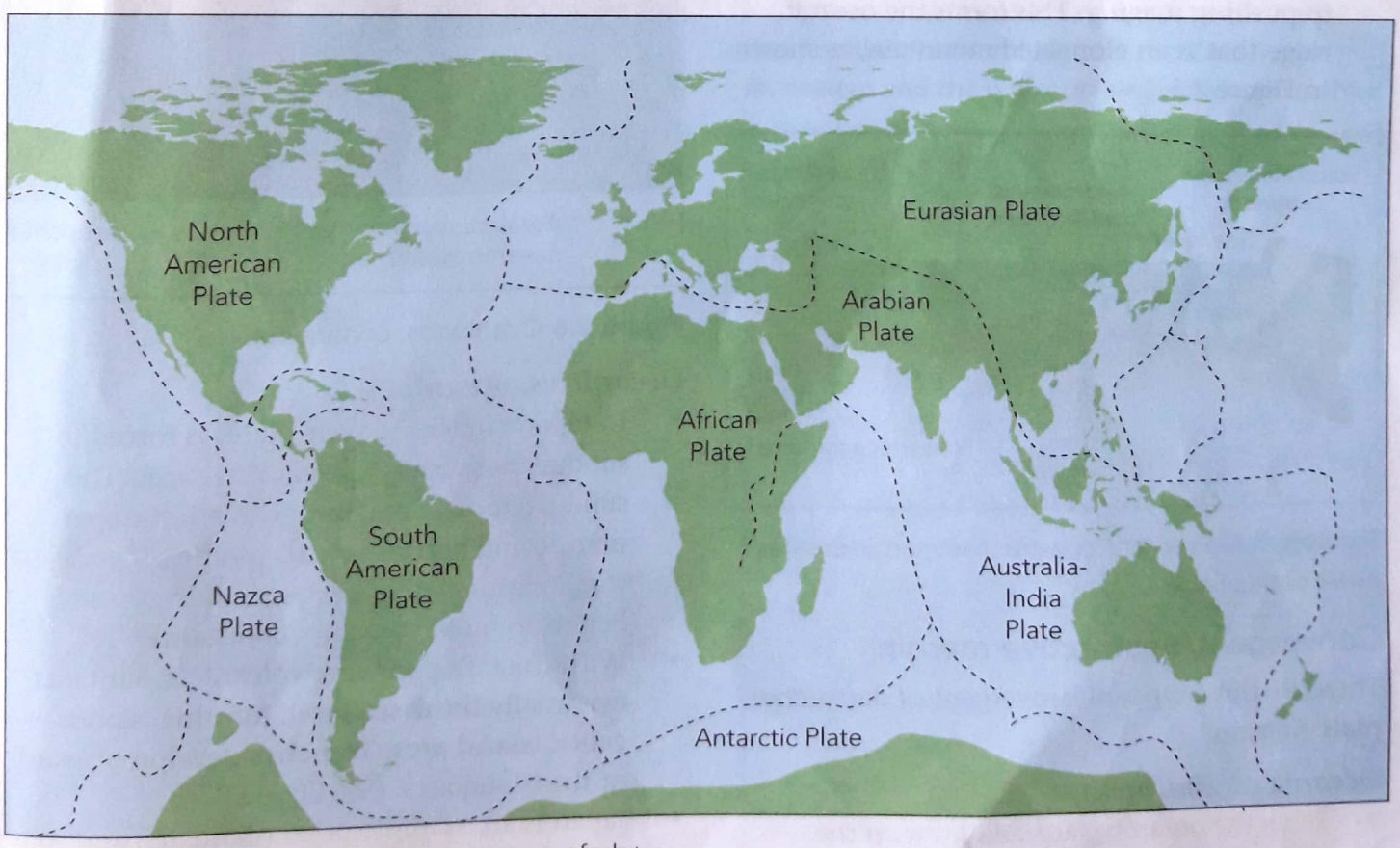


Figure 2.3 The distribution and movement of plates

Time 1

- At its inception, divergence of the two plates causes widespread fracturing of the crustal rocks due to **tensional forces** induced by the divergence.
- This inevitably creates rift valleys (valleys formed by rifting blocks).
- At the centre of the valley, the crust shows thinning and at its sides, the valley is marked by stepped faulting.
- It was during this stage that the divergent plate boundary over the continent of Africa reached the African Rift Valley.

Time 2

- With further divergence of the plates, the thinned crust becomes the exit place of magmatic material from the upper mantle.
- The magma, upon exit at the surface, solidifies to form a new oceanic crust (hence the term constructive).
- Meanwhile, the area directly below the central point of exit of the magma becomes raised due to pushing magma. This forms the oceanic ridge that is an elongated mountain, as shown in Figure 2.5.

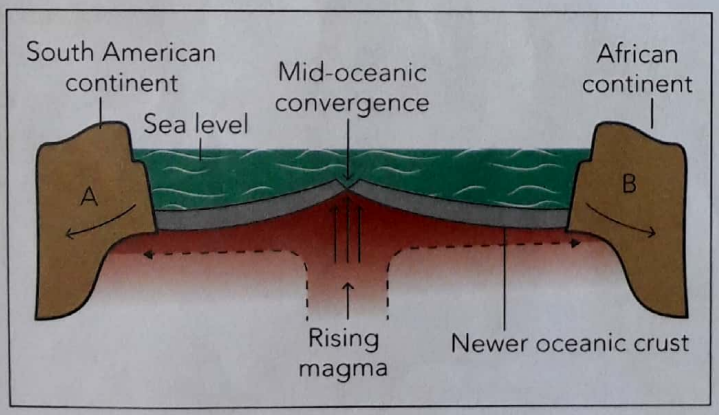


Figure 2.5 A divergent/constructive margin creates new oceanic ridge

Convergent/destructive margin

There are three types of convergent or destructive **plate margins**.

Oceanic vs. continental

- Here, the oceanic plate collides with the continental plate. Due to the fact that the oceanic plate is heavier, it is forced to subduct below the lighter continental crust. When it gets to the hot regions of the mantle, it partially melts, producing magma that rises up and intrudes the continental rocks or extrudes at the surface as **volcanoes**.
- Meanwhile, the sediments once aboard the sinking oceanic crust, do not subduct as well, but are compressed against the continental crust, forming high ranges of **fold mountains**. Examples are the Andes, the coastal ranges (North America) and the Sierra mountains along the coast of California.
- The subducting oceanic crust bends at the point of subduction, producing very deep ocean zones called **trenches**, for example, the Peru-Chile Trench. (See Figure 2.6.)

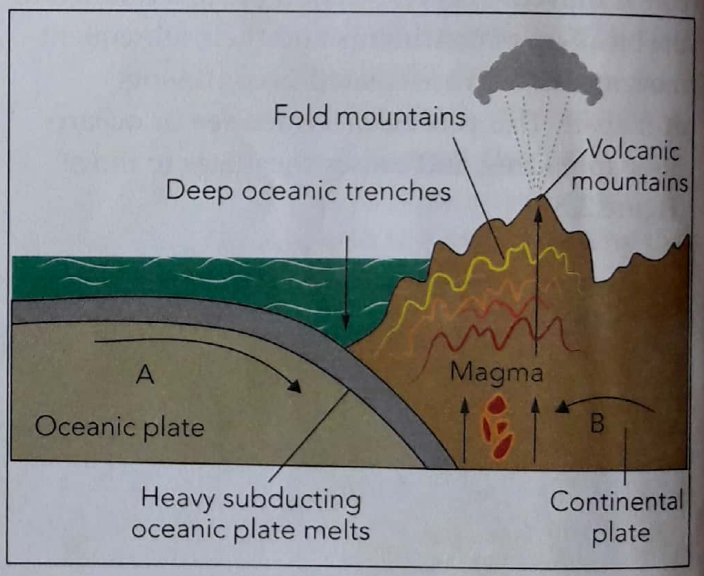


Figure 2.6 Oceanic vs. continental

Oceanic vs. oceanic

- Here, one of the oceanic plates is forced to subduct because of speed differences. The subducted plate encounters the hot upper mantle and partially melts, producing magma that extrudes the other oceanic crust and begins to build volcanic mountains.
- With time, the growing volcanic mountains eventually break sea level, forming islands called **island arcs**. **Trenches** develop seaward of the island arcs. (See Figure 2.7.)
- Japan is an example of an island arc, and so is New Zealand and the Tonga islands.

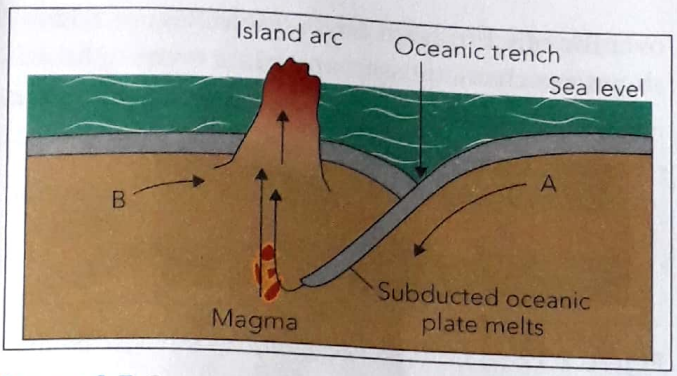


Figure 2.7 Oceanic vs. oceanic

Continental vs. continental

- This is initially an oceanic-continental **subduction zone**, shown in Figure 2.8.

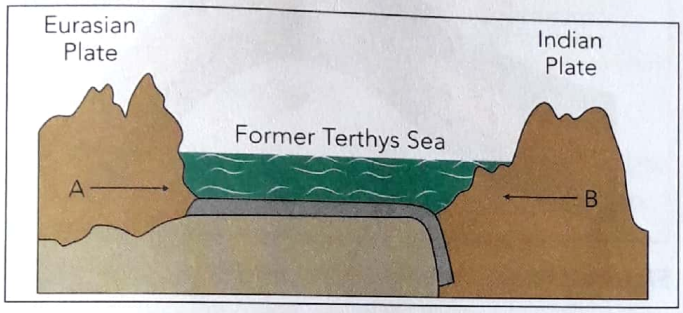


Figure 2.8 Oceanic-continental subduction zone

- The adjoining ocean's crust is slowly closed up by the advancing Eurasian and Indian plates. Meanwhile, sediments build up on the sea floor as shown in Figure 2.9.

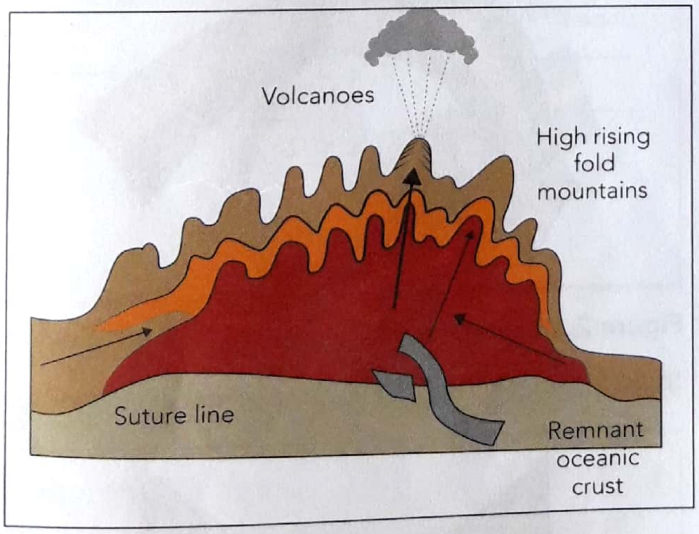


Figure 2.9 The build up of sediments

- Eventually, the advancing continental crusts collide, squeezing the sediments of the former sea to form high-rise fold mountains, for example, the Himalayan series, the Zagros, the Alps and the Atlas ranges.

Transform or conservative plate margins

- In this case, plates move horizontally, sliding against each other.
- There is neither creation nor destruction of the crust, hence the term conservative, meaning no change, as shown in Figure 2.10.

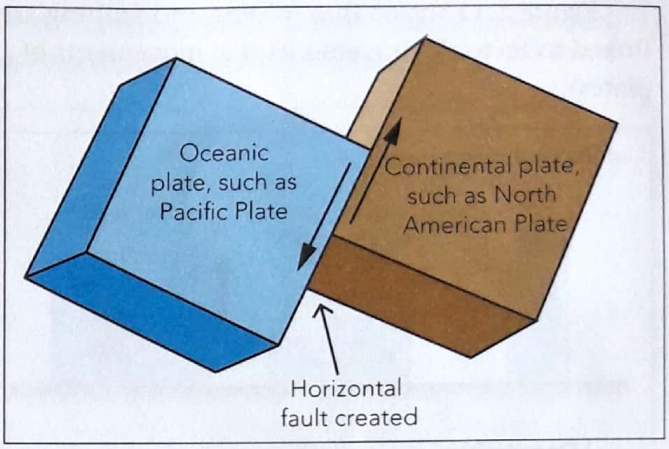


Figure 2.10 A transform plate margin

A good example of a **conservative plate margin** is found in north-western USA, along the San Andreas Fault. You should be able to go back to the map showing the plates and identify the direction of movement and the type of plate boundary involved.

Activity 1

Do the following tasks in groups of four.

1. Label two cards CONTINENTAL PLATES.
2. Label one card CONTINENTAL and the other OCEANIC.
3. Move the cards towards each other as at destructive plate margins. On blank cards, label all the resultant landforms. Name two examples of such plates.
4. Move the cards away from each other as at constructive plate margins. Again, label all resultant landforms on the blank cards. Name two examples of such plates.
5. Compare answers with other groups. The group with the largest number of landforms and correct names wins the game.
6. Explain why scientists believe that plate tectonic movement and climate change go hand in hand.

Folding and faulting

Tectonic forces result in Earth movements. The movements involve vertical or horizontal movements of the earth's crust. These movements result in land being uplifted (raised), depressed (lowered), folded (bent) or fractured or erupting.

Figure 2.11 shows that folding and faulting are linked to tectonic movements (i.e. movements of plates).

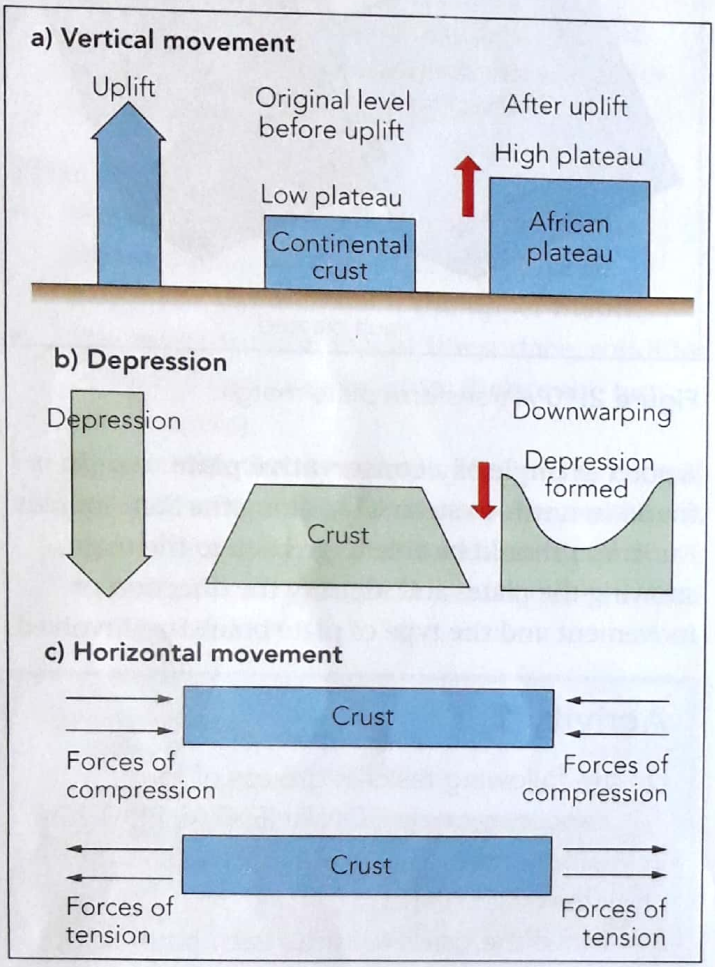


Figure 2.11 (a) Vertical movement, (b) depression and (c) horizontal movement

Types of folds

Folding is the bending of rock layers in the earth's crust. Folding results from **compressional forces** acting on the earth's crust. These forces act horizontally on a land mass and this results in the types of folds shown in Figure 2.12a to f. The nature of a fold depends on the amount of bending or folding. Imagine if you were to exert force on a piece of rubber. The rubber initially bends to form a simple fold, then an **asymmetrical fold**. With further force, one side of the rubber may be pushed over the other to form an **overfold**. Figure 2.12 shows the characteristics and main types of folds.

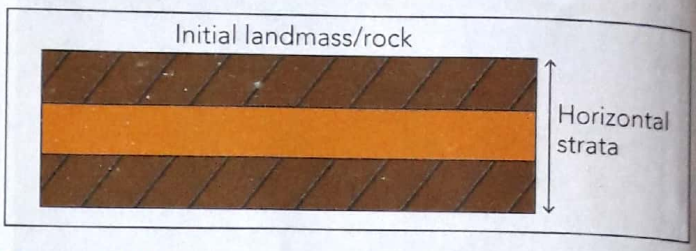


Figure 2.12 (a) Compressional forces on a landmass

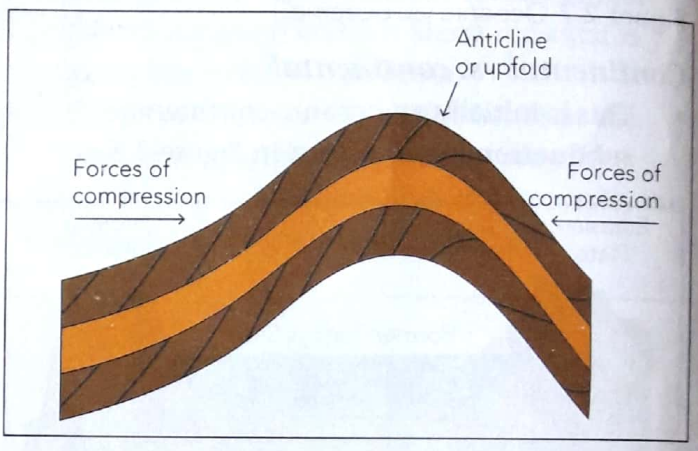


Figure 2.12 (b) A symmetrical fold

In a symmetrical fold, limbs (slopes) are of the same steepness and the fold is described as symmetrical. The limbs bend upwards, i.e. the fold is an upfold or **anticline**.

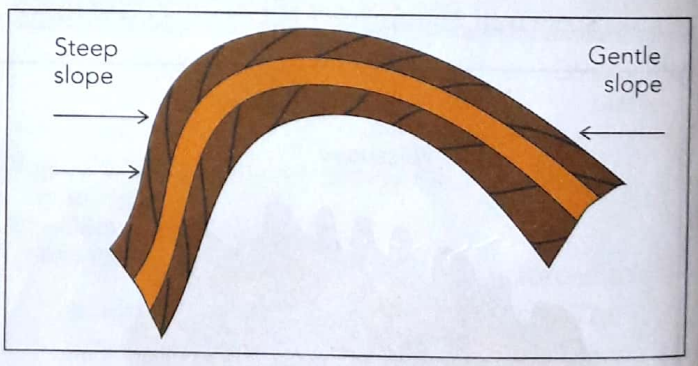


Figure 2.12 (c) An anticline

In an anticline, one slope is steeper than the other.

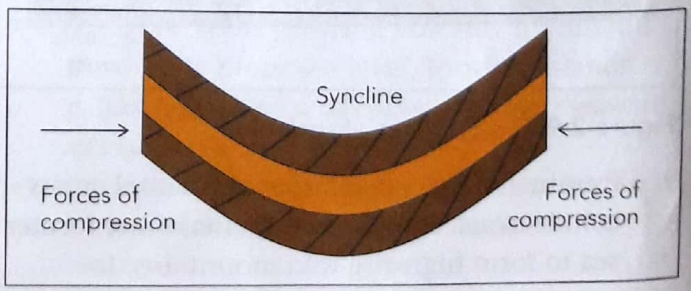


Figure 2.12 (d) A syncline

A **syncline** is a downfold because of the way in which the strata bend downwards. Horizontal strata are bent upwards.

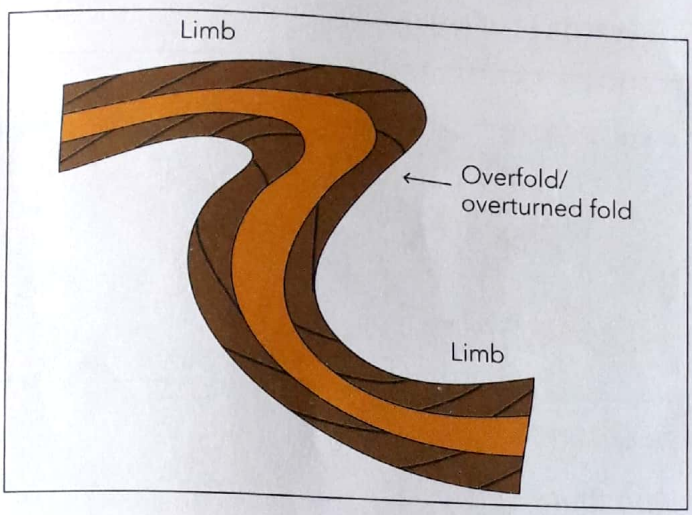


Figure 2.12 (e) An overfold

If compressional forces continue to be exerted on the overfold, one limb is thrust right over the other. An **overthrust fold** or **recumbent structure** results. If faulting then occurs over a plane, a nappe is formed.

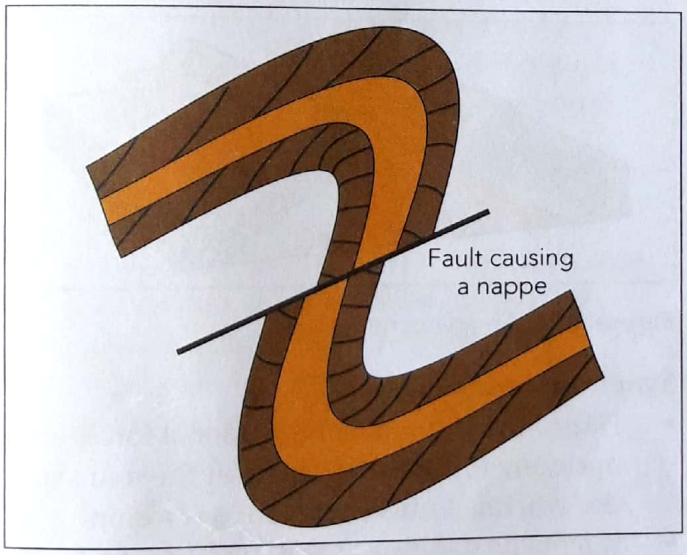


Figure 2.12 (f) Complex folding and its results

Landforms resulting from folding

Fold mountains

The most spectacular results of folding come in the form of fold mountains. The formation of fold mountains is referred to as **orogenesis**, originating from the Greek words *oros* meaning mountain and *genesis* meaning beginning or formation. As already noted, fold mountains result due to the convergence of plates at plate margins.

In Africa, most of the well-known mountain chains, such as the Cape folded ranges of South Africa, the Eastern Highlands (the Chimanimani) of Zimbabwe and the Atlas Mountains of North Africa, are classical examples of fold mountains (See Figure 2.13). Outside Africa, examples of fold mountains include the Himalayas, the Rockies of North America, the Andes of South America and the Appalachians of North America.

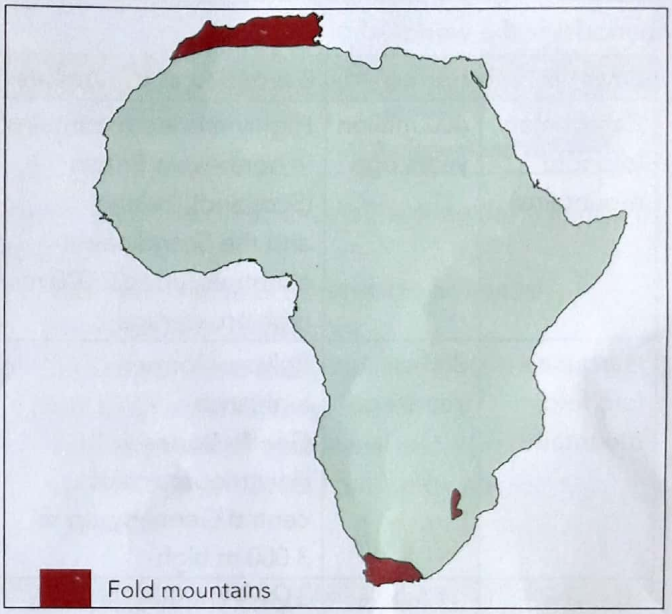


Figure 2.13 The distribution of major fold mountains in Africa

Fold mountains are classified into two major groups determined by their age as is seen in their elevation or altitude.

Old fold mountains

These are mountains that have been worn down by agents of denudation such as water and ice. Old fold mountains are therefore plateau-like in shape and, as a result, they are not very high. Fold mountains that were built during the Caledonian Orogeny (400 million years ago) and the Hercynian Orogeny belong to this category (see Table 2.1).

Young fold mountains

Young fold mountains form very impressive relief features. These fold mountains were built during the last orogeny called the Alpine Orogeny, 35 million years ago. They are characterised by their great heights and hugeness that makes them 'big mountains.' Unlike the old fold mountains

that are subdued or low in profile, young fold mountains are rugged and jagged ranges or ridges form. Examples of young fold mountains include the Alps, the Rockies, the Andes, the Himalayas and the Pyrenees.

A number of mountain-building periods that have occurred in the past, can be recognised in the world. These are shown in Table 2.1.

Table 2.1 Major orogenies (mountain-building periods) of the world

Orogeny	Period	Examples of mountains
Caledonian (old fold mountains)	400 million years ago	Highly eroded mountains in north-west Britain (Scotland), Ireland and the Scandinavian countries, up to 2 000 m high on average
Hercynian (old fold mountains)	300 million years ago	Relics of former highlands Gentle slopes Harz mountains of central Germany, up to 3 000 m high
Alpine (young fold mountains)	35 million years ago	Alps, Pyrennes, Rockies, Andes, Himalayas up to or over 6 000 m high.

Other features resulting from folding

Anticlinal mountains

- Initial landform produced by folding.
- Does not last for a long geological period by being quickly acted upon by denudation.

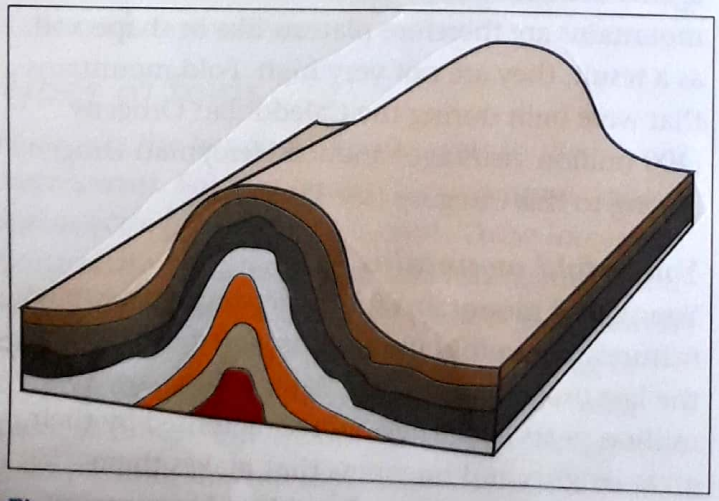


Figure 2.14 Anticlinal mountains

Synclinal valleys

- Initial landform produced by folding.
- The famous Mberengwa Greenstone Belt is an example of a synclinal valley.

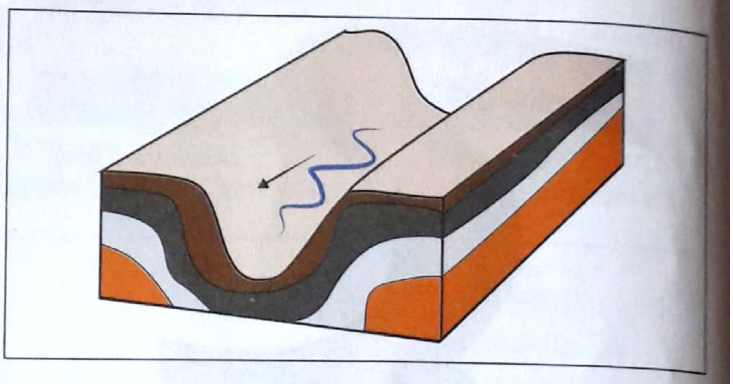


Figure 2.15 A synclinal valley

Anticlinal valleys

- Due to the fact that compressional forces are operating away from the fold axis, the anticline is quickly attacked by erosion.
- This forms an anticlinal valley on which unique trellis drainage may develop due to the exposure of tilted blocks.

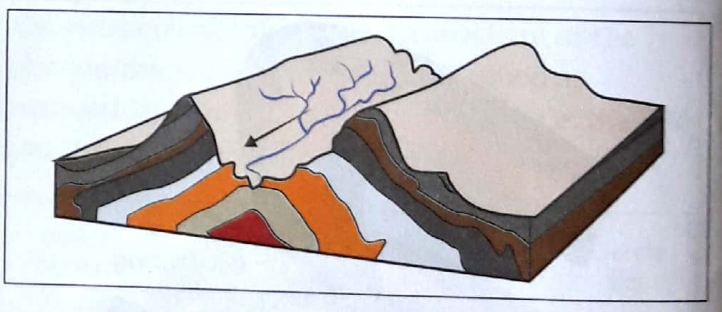


Figure 2.16 An aniticlinal valley

Synclinal mountains

- Due to the fact that compressional forces are operating towards the centre of the fold axis, the syncline is more resistant to erosion.
- It remains standing as the surrounding anticlines are eroded.

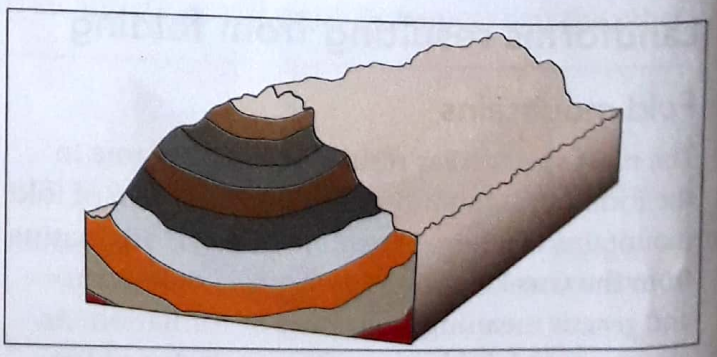


Figure 2.17 Synclinal mountains

Down-warping

Down-warping has resulted in basins being formed in some parts of Africa. The basins are simply shallow synclines due to lateral compressional forces. Examples include Lake Victoria and the Chad Basin.

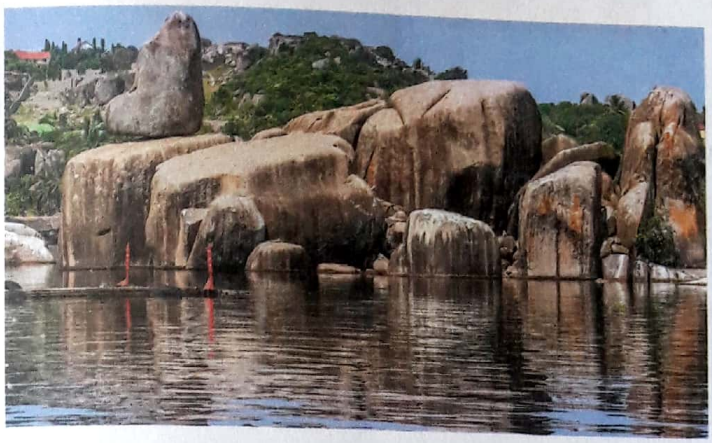
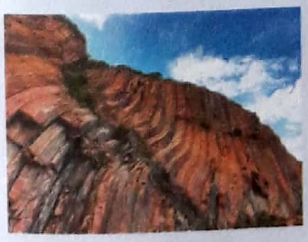


Figure 2.18 Lake Victoria formed in a basin as a result of down-warping.

Activity 2

1. In your atlas, look up the location of the following fold mountains: the Alps, Pyrenees, Rockies, Andes and Himalayas.
2. Name the Scandinavian countries where the Caledonian mountains are found.
3. List other Alpine fold mountains in Africa.
4. Describe the differences between old and young fold mountains. Hint: Think about age, appearance, common features, drainage, volcanic activity, location and so on.
5. Look at the two photographs in Figure 2.19.
   a) Make a sketch of each of the folds shown in the photographs.
   b) What type of fold do you think each one is?

A



B

Figure 2.19

Faulting

Faulting involves an upward or downward movement of a rock along a fault line. A **joint** differs from a **fault** in that a joint is simply a crack in a rock. There is no displacement of the rock along the fracture (See Figure 2.20).

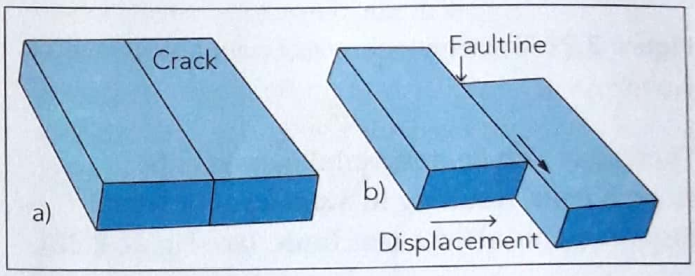
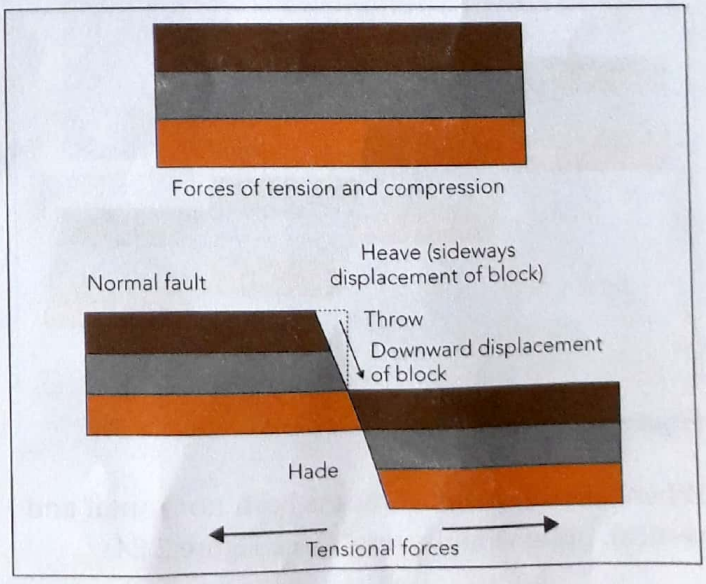


Figure 2.20 The occurrence of faulting: (a) A joint and (b) a fault

- In a fault, there is no vertical or lateral displacement of the rock.
- In a fault, there is displacement of rock along the crack or fault line.
- Faulting results from tensional and compressional forces that cause stresses in the rock.

Movements associated with faulting

- Vertical displacement of a block is referred to as the throw.
- Lateral displacement is the heave.
- The angle between the fault plane and the horizontal is the hade.
- Tensional forces result in **normal faults** and compressional forces result in **reverse faults** or thrust faults (See Figure 2.21).



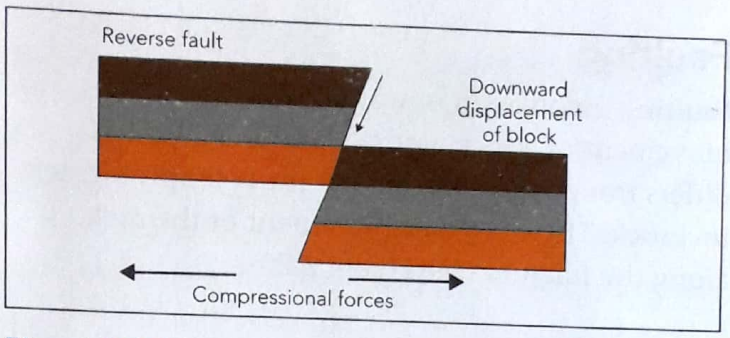


Figure 2.21 The development of normal and reverse faults

There may also be horizontal movements along a fault, resulting in a sideward or lateral displacement called a **tear fault**. (See Figure 2.22).

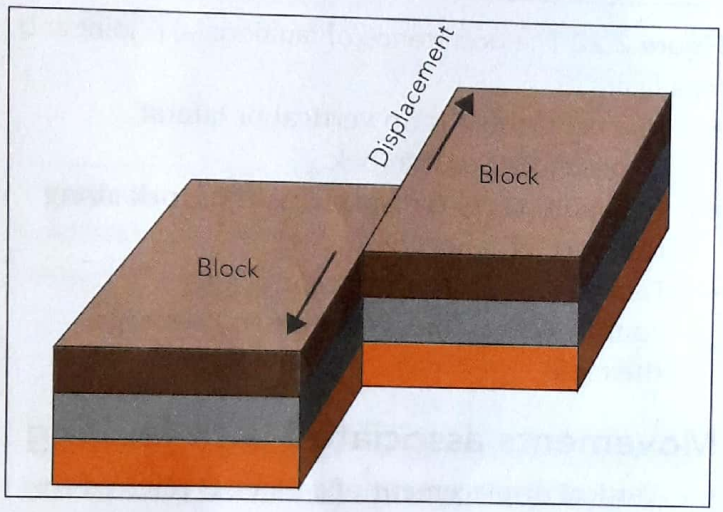


Figure 2.22 A tear fault

Faults may also be arranged in the form of steps resulting from tensional forces. Parts of the Great African Rift Valley and Rhone Rift Valley in Europe are characterised by this form of faulting (See Figure 2.23).

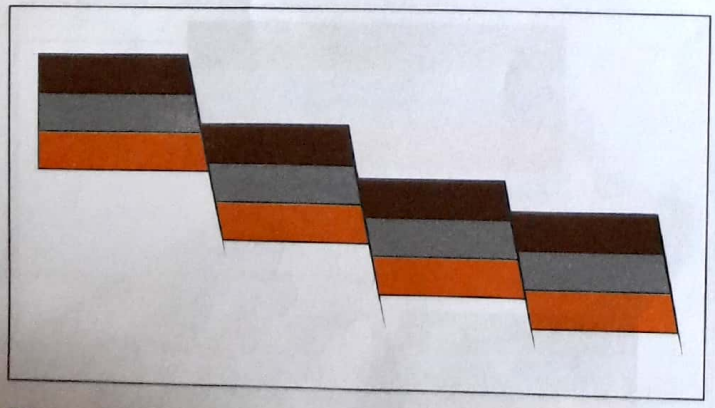


Figure 2.23 Step faults

Where displacement of rock is both horizontal and vertical, oblique faults result (See Figure 2.24).

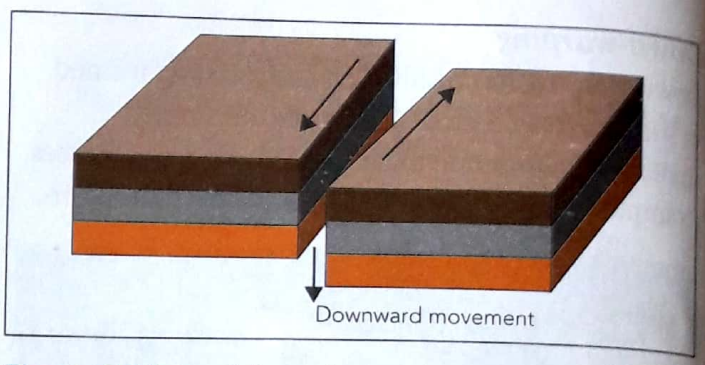


Figure 2.24 An oblique fault

Activity 3

Name the displacements and features marked a, b, c, d, e, and f on the block diagram.

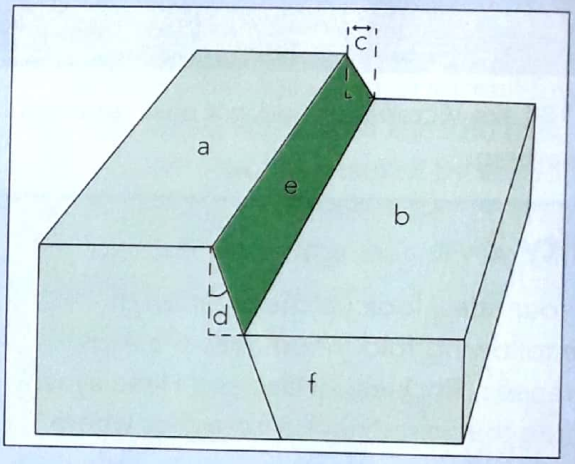


Figure 2.25 Characteristics of a fault block

Landforms resulting from faulting

Fault scarps

A **fault scarp** is the steep slope created on the face of a block when displacement occurs along a fault line. In Figure 2.26, it is indicated by an 'f'.

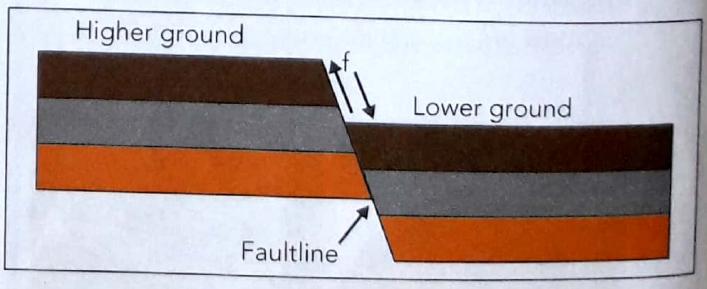


Figure 2.26 A fault scarp

A fault scarp is also simply referred to as a scarp, or it develops into an **escarpment**. A good example of an escarpment is the Zambezi Escarpment in northern Zimbabwe, which includes the famous Matusadonha and Mamvuradonha scarps.

A horst or block mountain

Normal faulting may occur, raising a central block and lowering the two adjacent blocks. The raised block is called a **horst** (mountain) or a **block mountain** (See Figure 2.27).

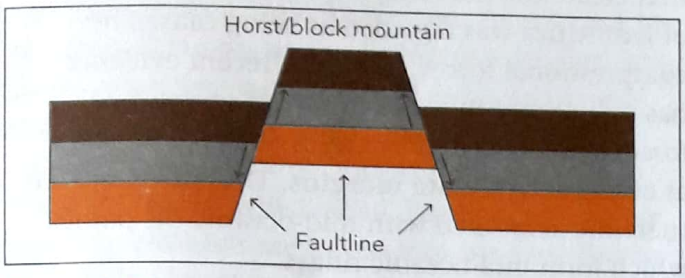


Figure 2.27 A horst/block mountain

Examples of horsts are the Ruwenzoni range of mountains in Uganda, the Kenya Highlands, the Great Kharas mountains of Namibia and the Chizarira range of mountains to the south of Lake Kariba in Zimbabwe. Horst features are also characterised by flat tops and these are the typical plateau landscapes of Africa.

A graben

A **graben** is the downthrow segment usually between the horst features. It results in the formation of rift valleys such as the Great East African Rift Valley. Grabens can be formed by tensional forces (See Figure 2.28) or by compressional forces (See Figure 2.29).

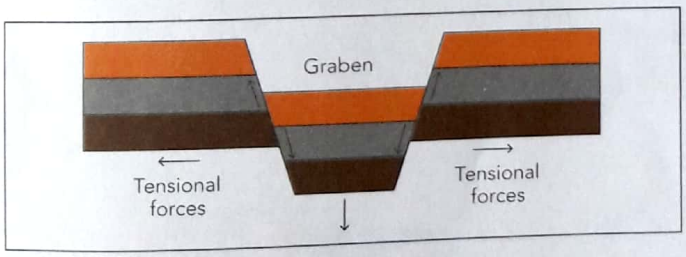


Figure 2.28 A graben

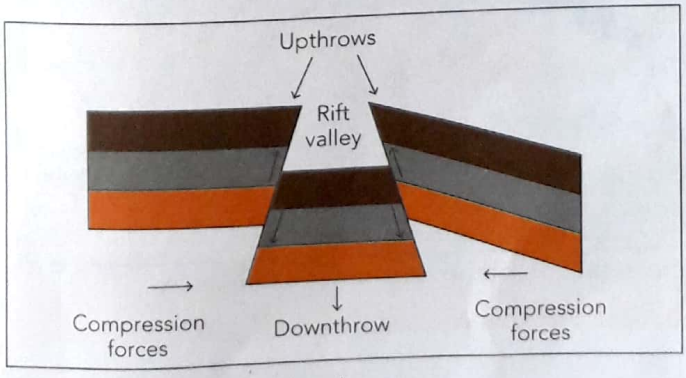


Figure 2.29 A graben landscape

Project

You will illustrate/demonstrate types of faults and resultant landforms. You will demonstrate the process of faulting and its common features by using blocks of wood such as those that are cut off from woodwork practicals.

Get two blocks of wood, each 15 cm in length, 10 cm in width and 10 cm in breadth, and cut them out along the lines as shown in Figures 2.30 and 2.31 below.

Block 1

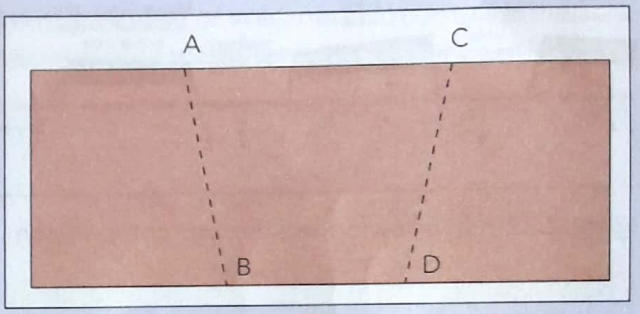


Figure 2.30 Demonstrating types of faults

Cut along A to B and C to D. Slide block ABCD up, and lower the blocks on the sides. What are the resultant faults on the slopes? Name the landform formed by the raised block.

Block 2

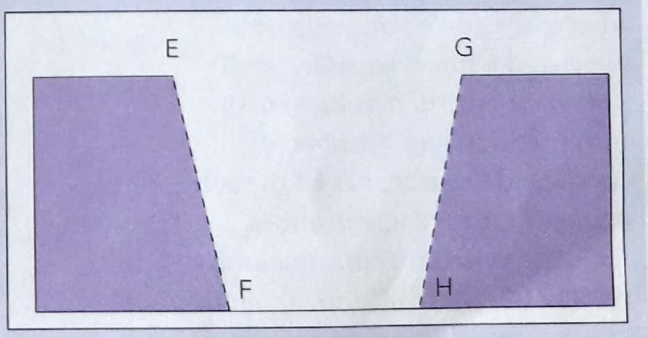


Figure 2.31 Resultant landforms from faults

This time, cut out the block along E to F and G to H. Lower block EFGH and name the faults along EF and GH. What are the resultant landforms?

Rift valley formation

Rift valley formation can be explained using the compression theory or tension theory.

The compression theory

In terms of this theory, the middle block is downthrown, resulting in a fault-bounded rift valley. A potential weakness of this theory is that the uplifted side blocks would be rising against the force of gravity and would form overhanging parts. Thus, the compression theory seems an unlikely cause of rift valleys.

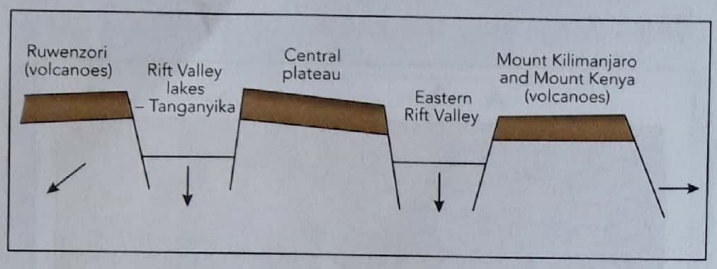


Figure 2.32 Rift valley formed through compression

The tension theory

In terms of this theory, the tensional forces are responsible for pulling apart blocks of rock and the middle block is downthrown to result in a rift valley.

These two theories differ in the type of forces that create the rift valleys. Initially, the Rift Valley of East Africa was regarded as being caused by compressional forces. However, recent evidence has discounted this idea in favour of tensional forces being initiated by the divergence of plates at **constructive plate margins**. The rift valleys are therefore associated with mid-oceanic rift points, which form mid-oceanic ridges.

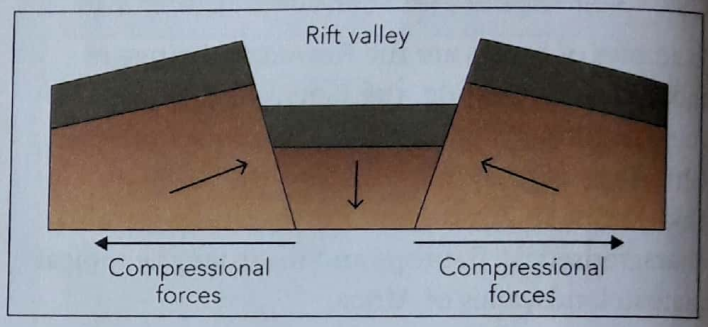


Figure 2.33 The Rift Valley of East Africa

Case study

The Great Rift Valley of Africa

The Rift Valley extends from Mozambique to the Jordan River – some 7 000 km in distance. It is on average 40–50 km wide. It is associated with steep sides (fault scarps), horsts such as Ruwenzori in the Democratic Republic of Congo and Uganda, rift lakes such as Lake Tanganyika, volcanoes like Kilimanjaro in Tanzania and a number of other volcanoes. Figure 2.34 is a cross-section of the rift valley from Ruwenzori, Mount Kilimanjaro and Mount Kenya. Honde Valley in Zimbabwe is a mini rift valley, which is an offset of the Great Rift Valley. The Zambezi Valley can be considered part of the Great Rift Valley system since it is bounded by faults.

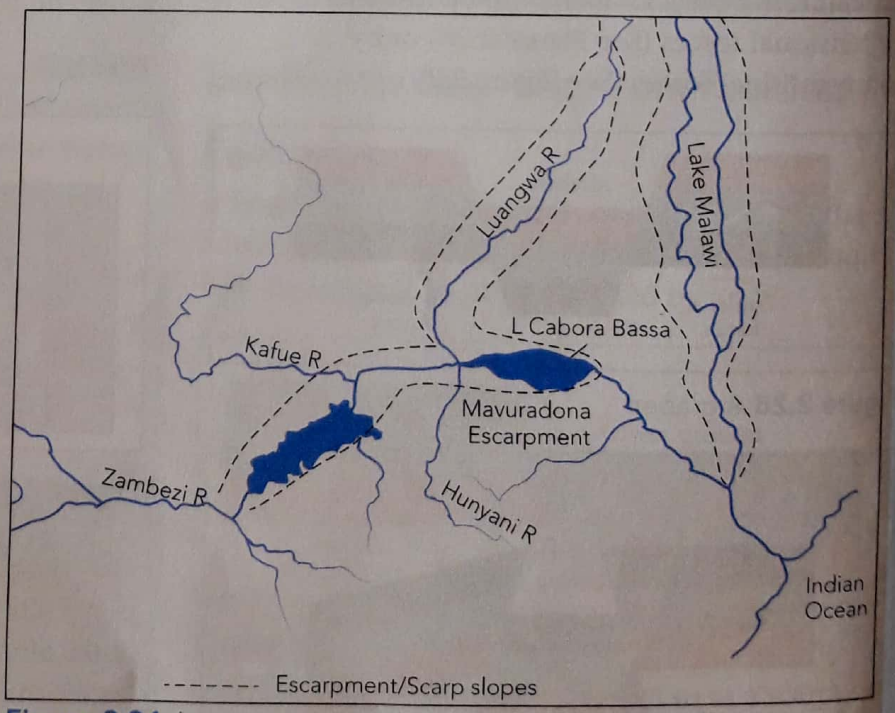


Figure 2.34 A cross-section of the East African Rift Valley

Volcanoes and earthquakes

As tectonic plates collide, slide past each other or pull apart from each other, stress builds up within them. With time, the stress becomes too much and the rocks in the lithosphere will break suddenly along a fault. This causes the shaking of the ground known as an **earthquake**. Molten lava, gases and other trapped materials find their way through the faults or cracks and this is referred to as **volcanic activity**. **Vulcanicity** refers to all the processes by which solid, liquid or gaseous, or **igneous** materials are forced into the earth's crust or ejected onto the surface. Intrusive vulcanicity is when the igneous material is moved inside the earth's crust. Extrusive vulcanicity is the ejection of igneous materials onto the earth's surface. Volcanology is the study of these ejection processes and volcanoes that result from the processes.

There is a close association between plate movements, on the one hand, and earthquakes and volcanoes on the other.

Volcanoes

Volcanic activity is mostly concentrated along plate boundaries such as mid-oceanic ridges, island arc areas, ocean deeps, faulting and folding regions. The world map in Figure 2.35 shows the distribution of volcanic activities and the boundaries of major tectonic plates.

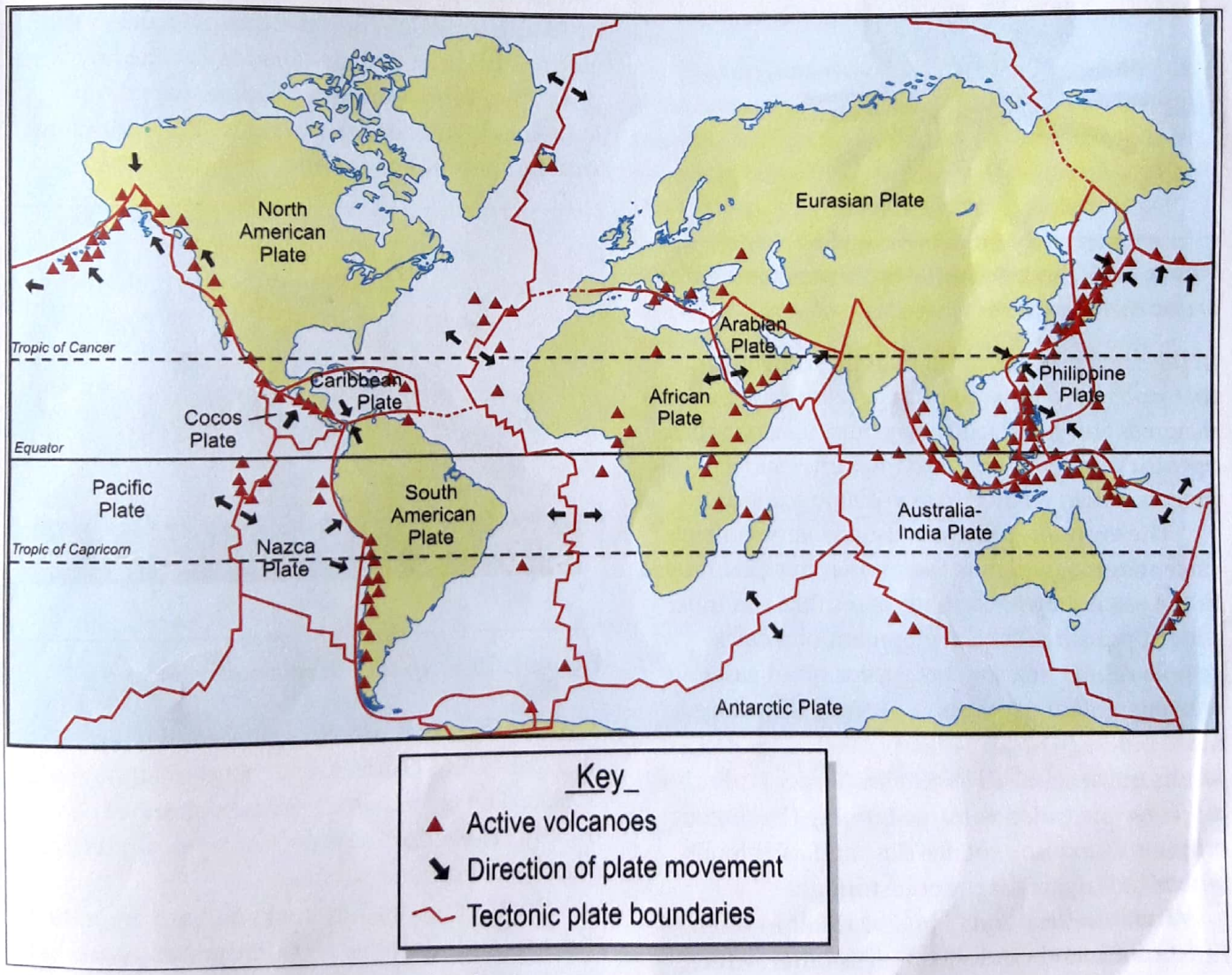


Figure 2.35 A map showing volcanic distribution

Volcanic eruption

The interior of the earth is made of a very hot mass of molten (liquid) and semi-molten rocks and gases, kept down by the pressure of the overlying rocks in the **lithosphere**. This situation can be likened to a pot placed on a fire with boiling soup covered by a lid. If a crack develops on the lid, steam, soup and other gases are released with force, as shown in Figure 2.36.

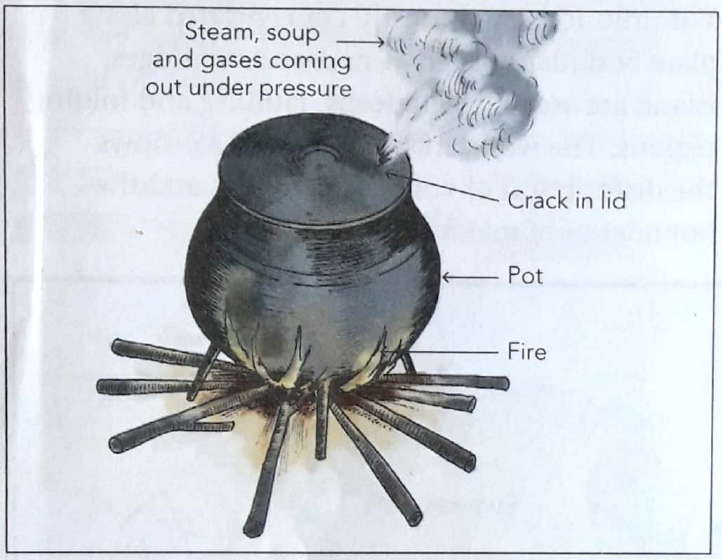


Figure 2.36 This pot illustrates the pressure exerted on the earth's surface.

In the same manner, if cracks in the form of faults that reach deep into the earth develop, gases, molten materials and some solids may burst up along these openings and pour out onto the earth's surface. This process is then referred to as volcanic eruption.

The eruption process is usually very violent, since **magma**, which is the molten material moved in the earth's crust, contains gases that are under a lot of pressure. The development of a crack or hole results in a sudden expansion of gases creating violent explosions. The gases produced, burn, producing a lot of heat. The violent process results in the throwing up of small rocks into the air. These are called volcanic bombs. The violent eruptions can also produce dust and ash clouds, which can trigger off thunderstorms.

The thunderstorms can also result in mud flows of **ash** and **cinder** known as **lahar**, which can be very destructive. Not all volcanic eruptions are violent, as some spew out material gradually, that is, they are **effusive**.

Figure 2.37 A volcanic eruption

As noted earlier, the molten material from the volcanic activity is called magma and the material comes out through an opening called a **vent** (hole) or **fissure** (crack). When the magma reaches the earth's surface, it is then called **lava**. The lava then piles up to form a mound or cone-shaped hill known as a **volcanic cone**. Figure 2.38 shows the structure of a volcanic cone.

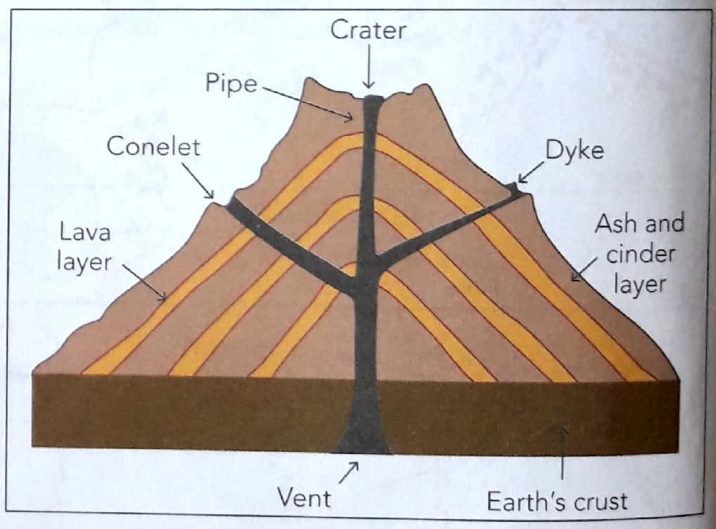


Figure 2.38 A typical volcanic cone structure

A volcanic cone is usually made up of layers of lava, ashes and **cinders**, which are small fragments of lava. The layers form because volcanoes do not usually erupt continuously, but lay down different materials at different times.

During an eruption, rocks and ash are initially thrown out to form a layer on the surface around the vent. This is then followed by lava, which spills over through the vent to cover the ashes and rock. Gradually, the lava at the top of the vent cools, and then solidifies and plugs up the vent as

the eruption stops. Pressure builds up beneath the plug and finally blows the plug to pieces, throwing out ash and cinders, which will then settle over the layer of lava. This process is followed by the blowing out of new lava, which will cover the second layer of ash and cinders.

The process continues until a mound or pile of alternating layers of lava and ash is formed, known as a **composite cone**. Some volcanic cones can be made up almost entirely of cinders and ash and others of pure lava. The top of the cone usually has a hole known as a **crater**. The crater can be filled with water to form a **crater lake**.

Activity 4

Study the maps, Figure 2.3 showing plate boundaries and Figure 2.35 showing the distribution of volcanoes.

1. Compare the distribution of plate margins and volcanoes shown on the two maps. Hint: Consider the close relationship between the two and refer to specific areas or zones. Some volcanoes occur in the middle of a plate, for example, the Hawaiian Islands and volcanoes in the DRC in Africa.
2. Draw a fully labelled diagram to show how volcanoes are associated with divergent plate margins. Use the example of a convergent plate margin given below as a guide. Remember to use a labelled diagram only.

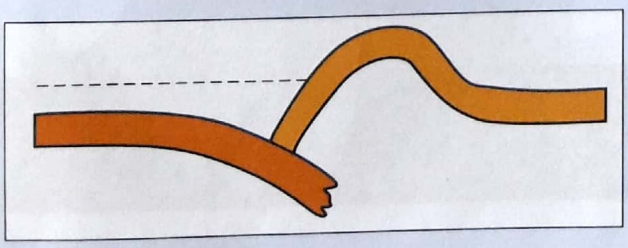


Figure 2.39 A convergent plate margin

3. With guidance from the map on plate boundaries, name the two convergent plates at which the following are found:
   a) Mount St Helens
   b) Himalaya Mountains.

Activity 5

From the information given so far, discuss in a group of about five, the possible effects of volcanic eruptions for people. Consider the effects that the erupted materials, for example, lava, gases and the accompanying rain, will have on people, infrastructure, crops and animals.

Classification of volcanoes

Volcanoes can be grouped according to the nature of the material being ejected or the shape of the volcanic cone.

Using the nature of the lava, we can come up with two types of lava, namely **acid lava** and **basic lava**.

Acid lava contains a high percentage of silica. It has a lower melting point of 700 °C and is highly viscous, that is, it is thick and sticky and tends to solidify quickly. The lava flows slowly and moves short distances, therefore producing steep-sided dome-shaped volcanic cones. Acid lava usually results in the formation of volcanic **plugs** or **spines**, which close the vent and help to build up pressure underneath, resulting in further violent eruptions. The volcanic plugs are usually exposed after the erosion of other materials making up the cone. Examples of volcanic plugs are Tororo Rock in Uganda and Wase Rock in Nigeria. Figure 2.40 shows the appearance of a typical volcanic plug.

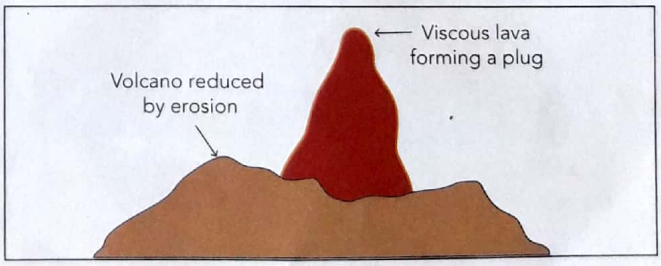


Figure 2.40 A Volcanic plug

Basic lava is rich in iron and magnesium and has a low silica content. It is highly fluid and can flow over long distances with speeds of up to 40 km/h. It has a higher melting point of 1 200 °C. Basic lava is associated with less violent eruptions, but very hot lava flows. Because of their fluid nature,

they produce gently sided and extensive features known as **basic lava shields.**

Using the shape of the volcanic cone, there are six main volcanic types: fissure, basic or shield, acid or dome, ash and cinder, composite cone and the caldera.

Fissure volcanoes

Figure 2.41 shows a volcano resulting from fissure eruption. Lava may be ejected through fissures, cracks or a vent. The fissures can extend for long distances, and because it is basic basaltic lava, it will accumulate over large distances to great heights to form lava plateaux. Good examples are the Al-Harujal-Aswad plateau of central Libya, the Drakensberg Mountains, the Ethiopian plateau, the Jos plateau in Nigeria, the Mafungabusi plateau north of Gokwe town in Zimbabwe and Nyamurore plateau in Nembudziya, Gokwe North, whose locations are given in Figure 2.42.

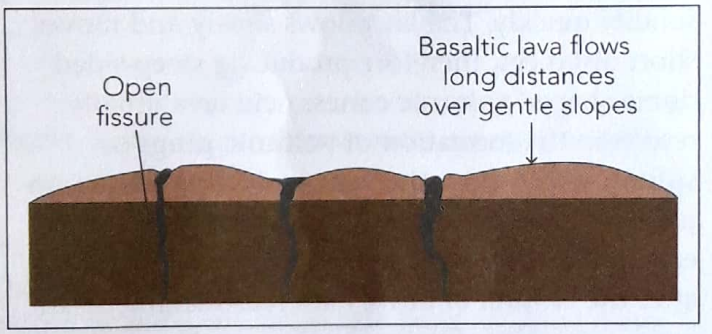


Figure 2.41 A fissure volcano

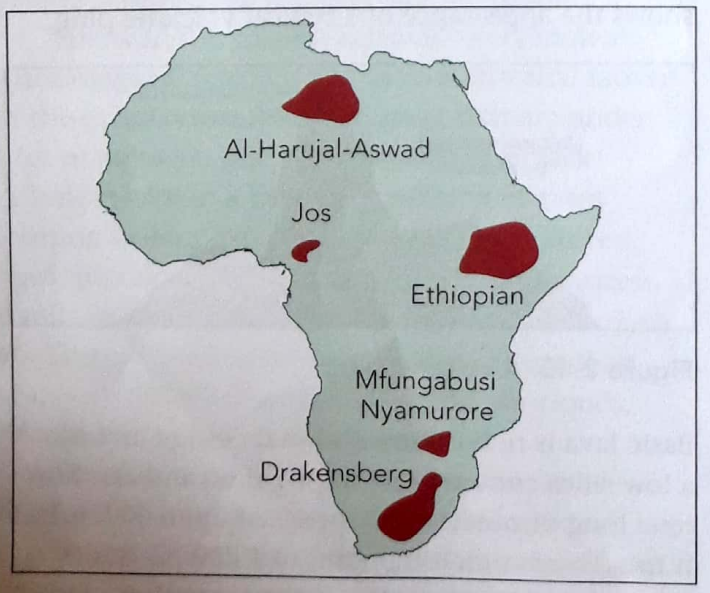


Figure 2.42 Some lava plateaux in Africa

Basic or shield volcanoes

The lava flows out of a central vent and can spread out to create gently sided cones made up of layers of lava. Figure 2.43 shows a basic or shield volcano. A good example is Mauna Loa on Hawaii. Nyamlagira in the DRC is a good example of a shield volcano in Africa.

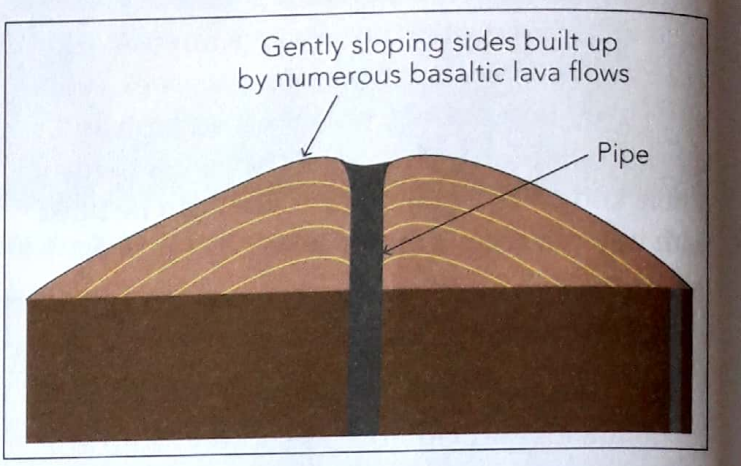


Figure 2.43 A basic or shield volcano

Acid or dome volcanoes

The lava quickly solidifies and as a result, produces steep-sided concise cones. Figure 2.44 shows an acid lava dome. The lava can solidify in the pipe to produce a spine as in Mount Pelee in the West Indies. As noted earlier, Tororo Rock and Wase Rock are good examples of volcanic plugs in Africa.

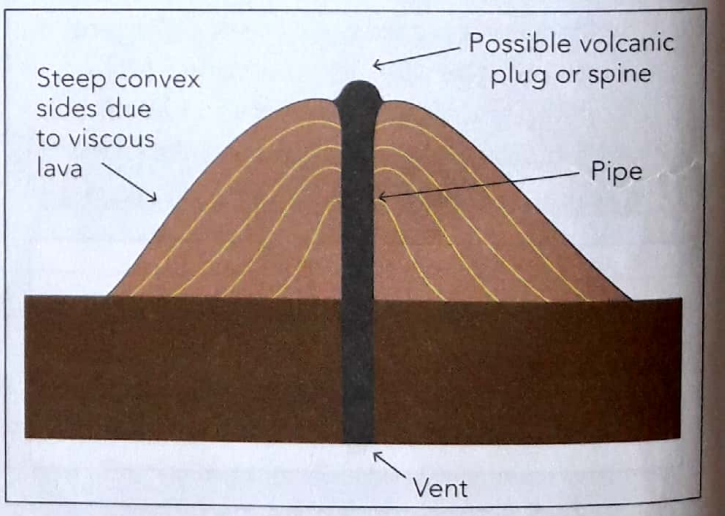


Figure 2.44 An acid or dome volcano

Ash and cinder volcanic cones

The ash and cinders produce a gently sided, slightly concave-shaped cone.

Figure 2.45 shows and ash and cinder cone.

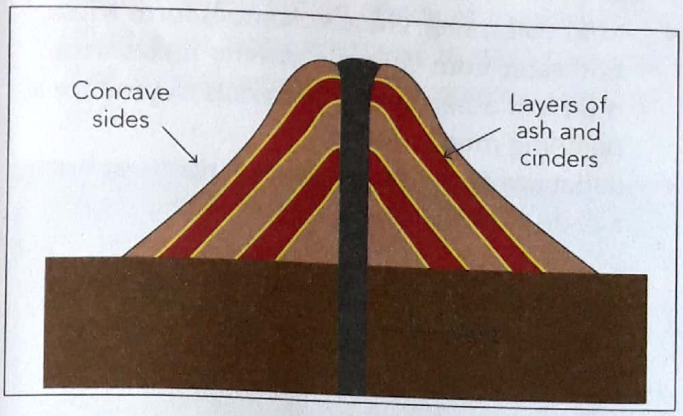


Figure 2.45 An ash and cinder cone

Composite volcanic cones

Most volcanic cones are of this type. It is a steep-sided cone made up of layers of lava and ash and may develop secondary pipes known as dykes and associated conelets or parasitic cones. Figure 2.46 shows a cross-section representation of a composite cone. Examples include Mount Kilimanjaro, the highest peak in Africa, Mount Kenya, Mount Elgon, Mount Cameron and Mount Etna in Italy.

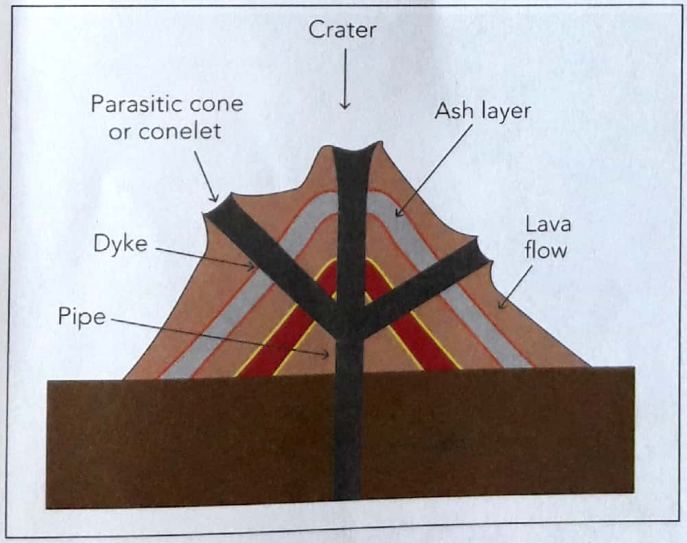


Figure 2.46 A composite cone

Calderas

These are volcanic cones with large craters. The large craters are usually filled with water to form caldera lakes. The calderas are formed in two main ways: either subsidence or violent eruption and disintegration.

Figure 2.47 illustrates the possible formation of calderas.

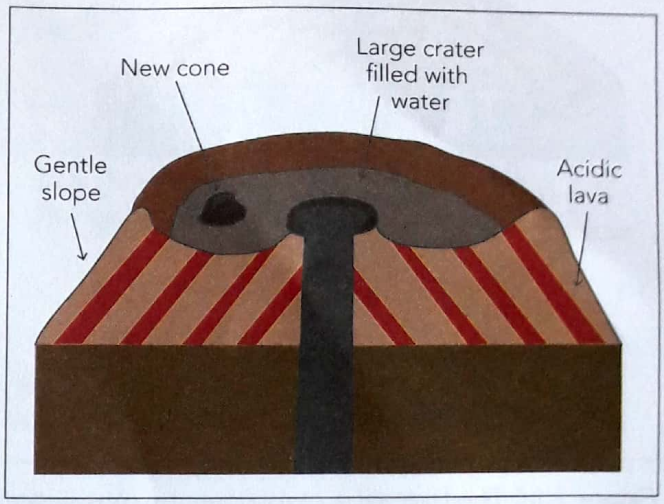


Figure 2.47 The possible formation of a caldera

Figure 2.48 shows the possible formation of a caldera due to a violent eruption and Figure 2.49 shows block formation of a caldera due to subsidence. Examples are Longonot near Nairobi and the Ngorongoro crater in Kenya. In Kenya, there are also a number of steam jets and springs. Lake Bosumtwi in Kumasi area of West Africa and Lake Shala in Ethiopia are also good examples of calderas. These are only examples of volcanic features in Africa but they are also found in other parts of the world.

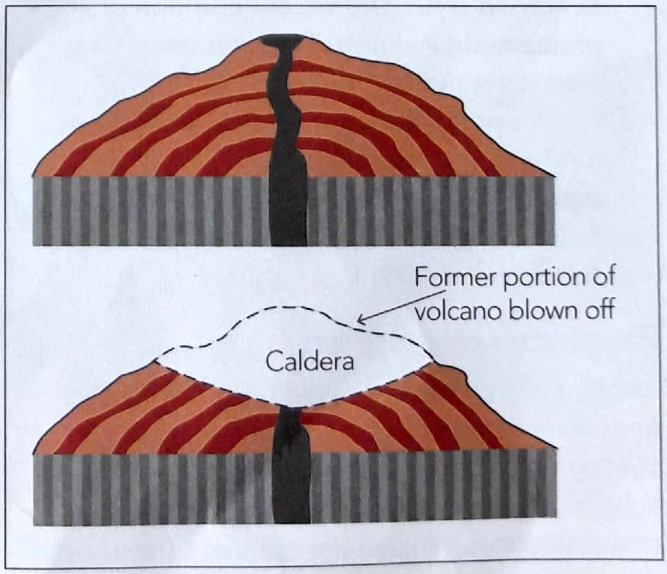


Figure 2.49 The formation of a caldera by violent eruption

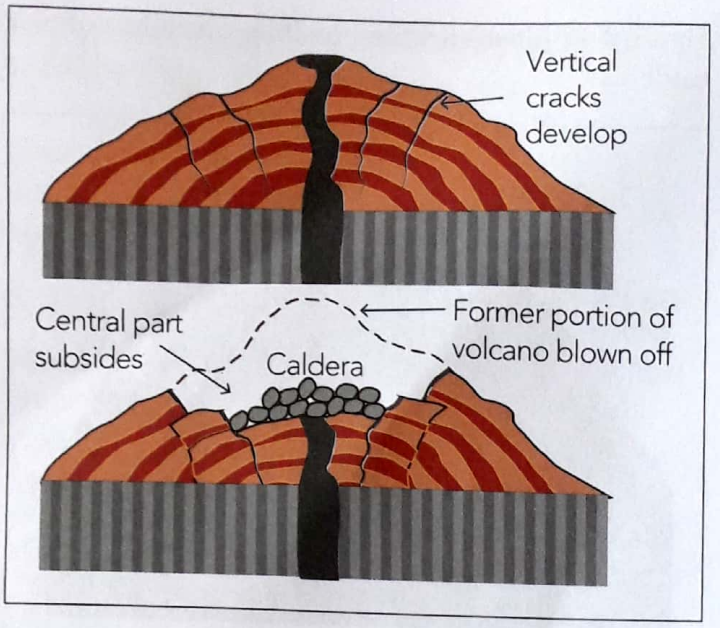


Figure 2.50 The formation of a caldera by subsidence

Eruption style

Volcanoes can also be classified according to the eruption style. This classification is based on the degree of violence of the explosion. The classification is as follows:

- Icelandic style: Lava flows gently from a fissure.
- Hawaiian style: Lava is emitted gently, but from a number of vents.
- Strombolian style: Lava emission is violent due to viscous lava.
- Vulcanian style: The eruptions consist of gases, ash and cinders. They are violent.
- Versuvian style: The violent eruption of gases produces dark clouds. These eruptions take place after periods of inactivity.
- Plinian style: These explosions produce the most violent eruption of gases made of fine ash.
- Pelean style: A strong lateral blast of gases occurs due to solidified lava.

Frequency of eruption

Another way of classifying volcanoes is on the frequency of the eruptions. There are **active** volcanoes, which can erupt any time. **Dormant** volcanoes have erupted in recent times, while **extinct volcanoes** have not erupted in historic times.

Other minor extrusive volcanic features

- Mild volcanoes: These volcanoes form when hot water from volcanic activity mixes with mud and other surface materials to produce a bubbling mud volcano.
- Solfatara: This volcanic feature does not have a cone but might have a crater, which could be as wide as 2 km. A solfatara is created when gases, especially sulfurous, are released from the earth's crust. Solfataras got their name from a small volcano known as Solfatara outside Naples in Italy.
- Fumaroles: These volcanic features are formed by superheated water turning into steam as it cools on its ejection from the ground.
- Geysers: These are formed when water in the earth's crust is heated by hot volcanic rocks to produce steam. The production of steam forms some cavities or openings and then creates pressure, resulting in steam and water exploding onto the surface. Geysers form natural fountains of hot water. A good example of a geyser is Old Faithful in the Yellowstone National Park in the USA.

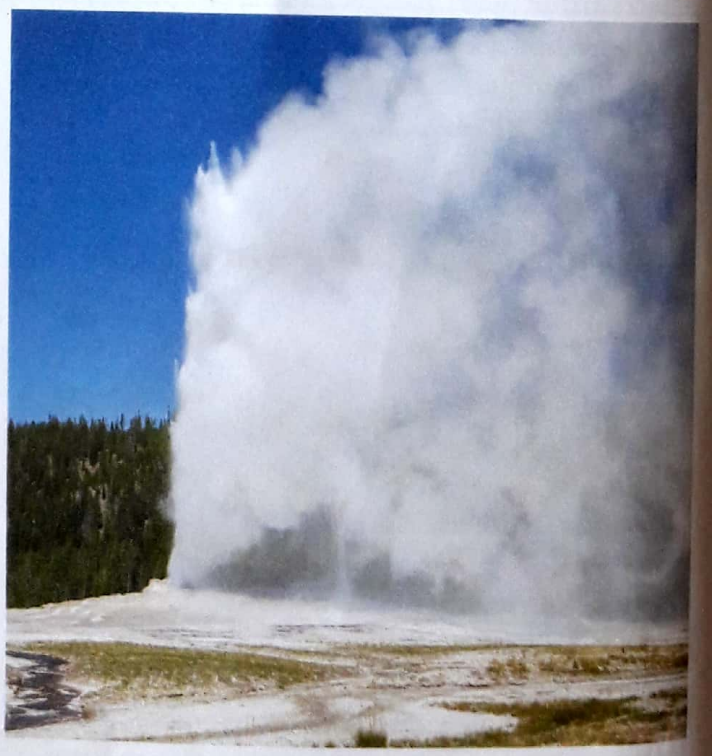


Figure 2.51 Old Faithful geyser in Yellow Stone National Park

- Hot springs: These are formed by superheated water flowing out quietly from the ground. In Zimbabwe, these are found in the Nyanyadzi hot springs area and in Binga in the Zambezi Valley.

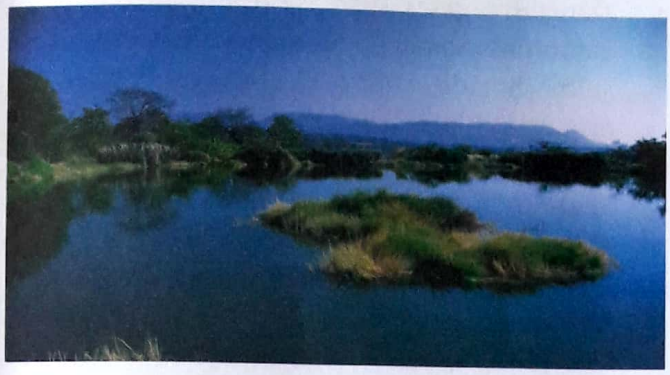


Figure 2.52 Nyanyadzi hot springs in Zimbabwe

Activity 6

1. Draw a well-labelled diagram to show a composite cone.
2. Describe briefly how calderas are possibly formed.
3. Check your answers against the account given earlier.

DID YOU KNOW?

Washing with hot spring or natural geyser water cures some skin diseases. Indigenous knowledge or belief has it that such water has 'lucky' or 'spiritual holiness' associated with it. Many people have gone to Binga in search of hot spring water or baths.

Intrusive igneous features

All volcanic activities that take place on the earth's surface are referred to as **extrusive volcanic** forms. In real life, very little magma reaches the earth's surface since most of it is intruded into and solidifies within the crust, forming **intrusive igneous** landforms. The importance of these intruded magma features is only seen after the features have been exposed to the earth's surface by erosion.

The intrusive features are classified according to their shape, the mode of formation as the magma moves along lines of weakness in the rocks and how they look when exposed by agents of erosion. Refer to Figure 2.53.

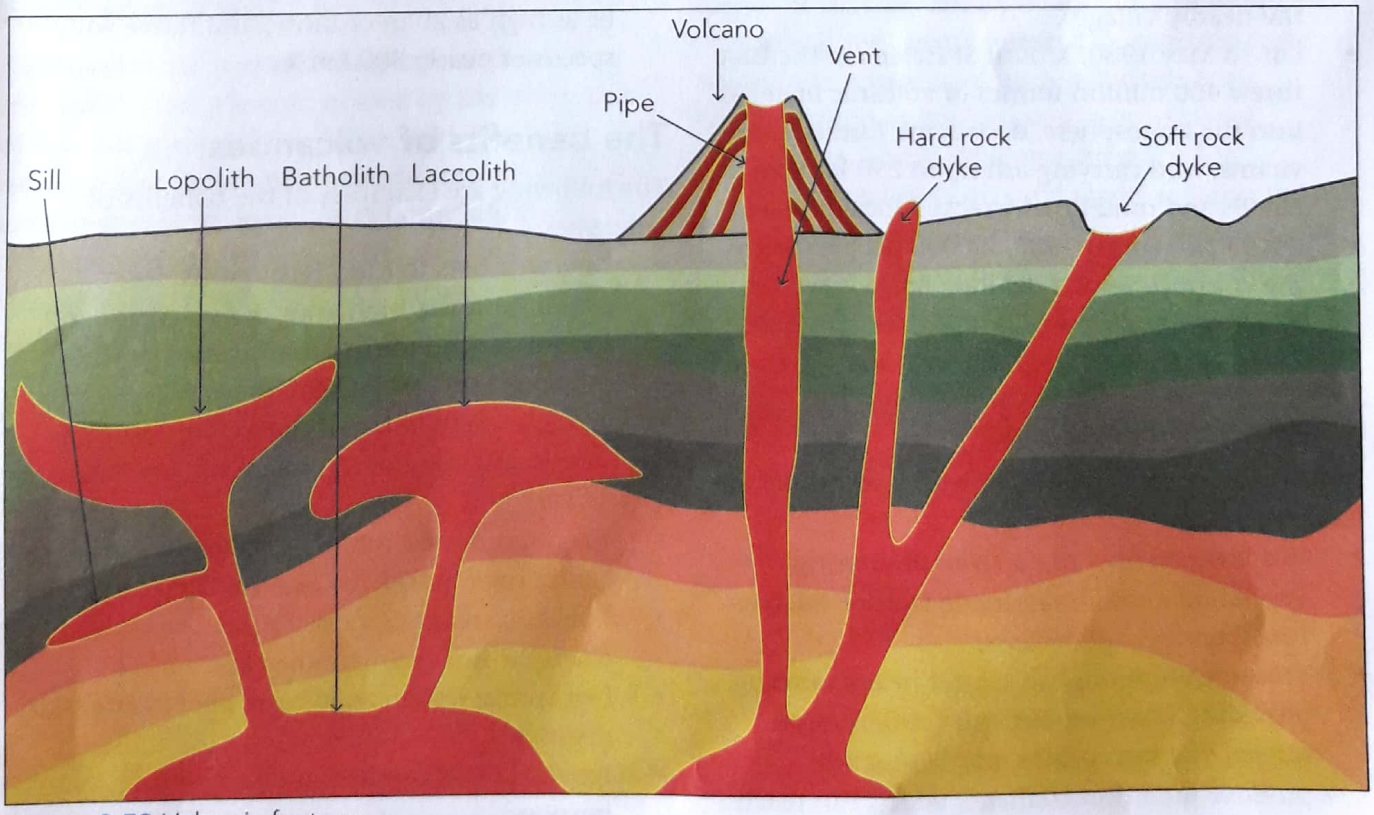


Figure 2.53 Volcanic features

- Batholith: A large mass of magma, which accumulates in the earth's crust. When exposed by erosion, these batholiths form large granite uplands.
- Sill: This feature is formed when magma intrudes along bedding planes or joints in sedimentary rocks. In tilted rock strata, the sill can form escarpments if exposed by erosion.
- Dyke: When magma cuts across bedding planes, it forms dykes. Dykes may be exposed by erosion. If the dykes are made of hard rock, they form ridges and if they are made of soft rock, depressions may be formed.
- Laccolith: When magma intrudes along a bedding plane, it arches up or it piles up to form dome-shaped laccoliths.
- Lopolith: If magma is forced to move along a bedding plane, it forms a crescent-shaped or saucer-like landform called a lopolith. The Great Dyke of Zimbabwe is a good example of a lopolith.

Cases of volcanic eruptions

- On 21 August 1986, a cloud of dense gas was emitted from Lake Nyos in Cameroon, causing death by asphyxiation of over 1 700 people in the nearby villages.
- On 18 May 1980, Mount St Helens in the USA threw 400 million tonnes of volcanic material into the atmosphere, destroying forests in the vicinity and carrying ash up to 250 km away. Floods and mud flows wrecked local homes.
- On 13 November 1985, 23 000 people died as the volcano Nevada del Ruiz Bolga, gave rise to a huge mud flow of hot ash, ice and water called lahar.

Volcanoes as hazards

The following are examples of where volcanoes are hazards:

- Hot lava can flow like a river, destroying vegetation and human-made features such as roads, bridges and houses.
- Volcanic eruptions can trigger heavy rains by providing water vapour and condensation nuclei. The heavy rains and falling ash produce mud flows (lahars), which can reach speeds of 90 km/h and these can wipe out villages and towns.
- Small hot rocks and dust can be thrown up as high as 1 km and destroy vegetation, kill people or bury settlements.
- Dangerous gases, such as carbon dioxide, carbon monoxide, hydrogen sulfide and sulfur dioxide, can be released into the atmosphere and this can seriously affect the health of people and animals and even destroy vegetation. A good example is that of a huge volume of carbon dioxide released by Lake Nyos in Cameroon, West Africa, in August 1986.
- Volcanic eruptions can produce huge clouds of very hot gases with temperatures of up to 1 000 °C, mixed with volcanic dust, which move down slopes at speeds of 100 km/h and destroy everything in the way.
- Landslides can be triggered by volcanic activity, resulting in the destruction of human life and physical features.
- Volcanic activity can trigger **tsunamis**, as in the case of the eruption of Krakatoa in south-east Asia in 1883, when 30 000 people drowned. Tsunamis are large waves that can be as high as 20 m or more, and move with speeds of nearly 800 km/h.

The benefits of volcanoes

The following are examples of the benefits of volcanoes:

- Lava weathers to form fertile soils, for example, in the highlands of east Africa and Indonesia, and fertile basaltic clays of the south-east lowveld in Zimbabwe.
- Volcanic activity is associated with precious stones and minerals, for example, in South Africa.
- The superheated water can be used to produce geothermal power, for example, in Iceland.
- Volcanic areas are tourist attractions, for example, hot springs and geysers.
- Hot spring water is said to be able to cure skin diseases.
- Igneous rocks can be used for building purposes.

Activity 7

Divide yourselves into two groups and debate the topic 'Volcanoes are more of a benefit than a hazard.' Toss a coin. 'Heads' will be for the topic and 'Tails' against the topic.

DID YOU KNOW?

The word 'tsunami' is derived from two Japanese words and it simply means 'harbour waves'. The majority of tsunamis result from shallow focus earthquakes that occur under the sea floor. They can be caused by violent volcanic eruptions. In deep water, tsunamis travel at considerable speeds of up to 700 km/h. When a tsunami enters shallow water, it increases in height. Waves of up to 30 m high are created, and these cause great damage to buildings and other infrastructure. The most damaging tsunamis occur in the Pacific Ocean. Tsunamis can carry away light structures, tear apart buildings, and wash away vegetation and soils.

Earthquakes

Earthquakes are sudden vibrations or tremors in the earth's crust that are caused by the movement of tectonic plates as they slide, fold, break or simply move due to internal pressure. Earthquakes are found mainly along plate boundaries such as mid-oceanic ridges, volcanic arcs, deep sea trenches and transform faults. Figure 2.54 shows the global distribution of earthquake activity.

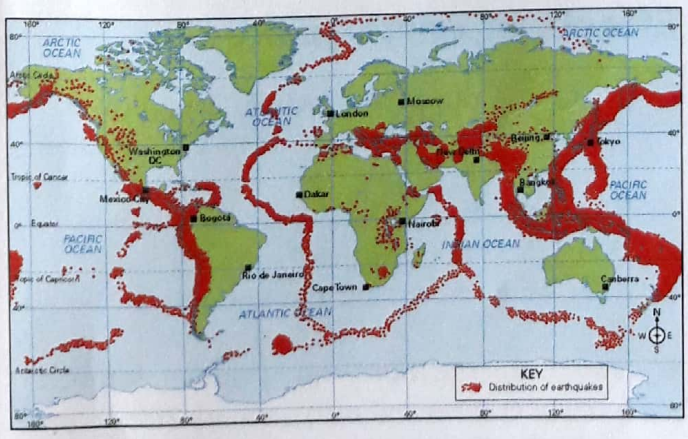


Figure 2.54 The distribution of global earthquake activity and major plate boundaries

Earthquakes are basically shock waves that are transmitted from a focus, which can lie anywhere from the surface to 300 km beneath the earth's crust. Earthquakes cause the most damage when their focus is close to the surface. The point on the earth's surface above a focus is labelled the **epicentre** and it shows the characteristic features and origin of an earthquake.

DID YOU KNOW?

Earthquake shock waves can be grouped into two: **body waves**, which move through the crust and **surface waves**, which travel through the surface rocks. Body waves can further be divided into **primary** and **secondary** waves. Surface waves can also be divided into Love (L) waves and Rayleigh (R) waves. Surface waves are the most destructive.

Measurement of earthquakes

Earthquakes are measured with a **seismometer**, which records the amplitude of the **seismic waves**. The two basic measurements for earthquakes are **magnitude** and **intensity**. **Magnitude** is the degree of shaking caused by earthquake waves and intensity is the energy released in an earthquake. Magnitude is measured using a Richter Scale, which is often quoted in press reports about earthquakes. The scale ranges from 0 – 8,9.

The **intensity** of an earthquake is measured by the modified Mercalli Scale. This is a fixed scale of 0–12, where 0 means it was not felt at all and 12 was total destruction, as shown in Table 2.2.

Table 2.2 The Mercalli Scale

Number	Intensity	Effects
1	Instrumental	Animals sense tremors; tremors recorded on seismograph
2	Weak	Noticed by people resting
3	Slight	Tremors similar to truck vibrations
4	Moderate	Felt indoors; parked cars shake
5	Fairly strong	Tremors felt generally and waken sleepers

Number	Intensity	Effects
6	Strong	Trees are shaken; furniture falls over
7	Very strong	Plaster falls and walls crack
8	Destructive	Weak walls, columns and chimneys fall
9	Ruinous	Some houses collapse; ground cracks
10	Disastrous	Destruction of many buildings; railway lines bend
11	Very disastrous	Floods, landslides; few buildings left standing
12	Catastrophic	Ground forms waves; overall destruction

The distribution of earthquakes in Zimbabwe

The major occurrences of earthquakes in Zimbabwe are found in the Kariba area along the Zambezi Valley, as is seen in Figure 2.55.

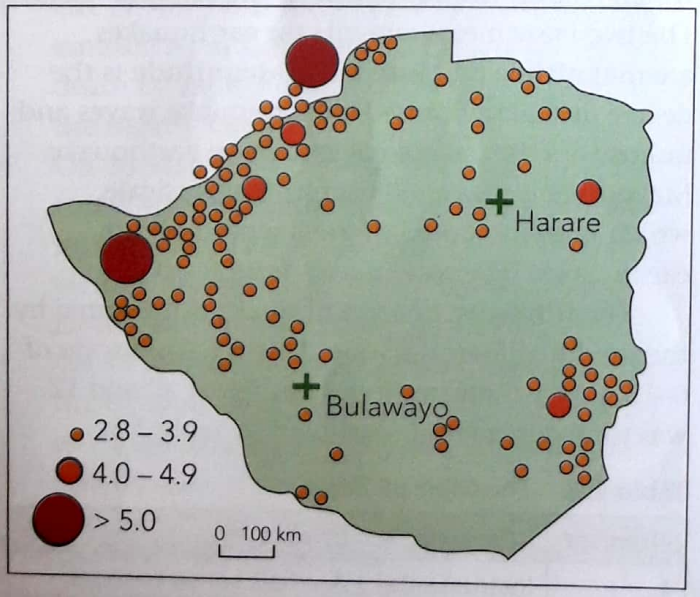


Figure 2.55 The distribution and size of earthquakes in Zimbabwe

Most of these earthquakes are associated with the infilling of Lake Kariba, as well as with changes in the level of the water in Lake Kariba.

The other significant concentration of earthquakes is found in the south-east of the country around the Save Valley and Chipinge area.

What to do to be prepared before a volcanic eruption or an earthquake

Follow these guidelines to prepare for a volcanic eruption or earthquake:

- Make sure you have a fire extinguisher, a first aid kit, a battery-powered radio, a flashlight and extra batteries at home.
- Learn first aid.
- Learn how to turn off the gas, water and electricity.
- Make a plan for where to meet your family after a disaster.
- Do not leave heavy objects on shelves (they will fall during a volcanic eruption or quake).
- Anchor heavy furniture, cupboards and appliances to the walls or floor.
- Learn the volcano or earthquake plan at your school or workplace.

What to do during a volcanic eruption

Follow these guidelines if a volcano erupts near where you live:

- Leave the area immediately. If you are warned to leave because a volcano is about to erupt, do so.
- If you are inside, close all windows and doors. Place damp towels at places where gas can come in.
- Bring animals into closed shelters.
- If you are outside, look for shelter in a car or building.
- If you are near a stream or river, move to higher ground to avoid being caught by rising water or mudflows.

Effects of earthquakes

The effects of earthquakes include the following:

- They cause vertical or lateral displacement of the crust.
- They cause landslides and the opening up of deep cracks on the earth's surface.
- They cause the raising and lowering of the sea floor.
- They cause the formation of tsunamis. In late December 2004 and early January 2005, some of the deadliest tsunamis, triggered by deep-

seated tectonic plate adjustments, killed about 20 000 people in Indonesia and south-east Asia. The effects were felt in far off places such as the east African and South African coasts, Australia, India and areas bordering the Indian Ocean.

The impact of an earthquake varies greatly. However, the effects are felt more in developing countries than in developed countries, and more in poor, rural areas than in urban areas, for the following reasons:

- Many villages are built in precarious physical locations such as mountain slopes.
- Poor communication systems result in many deaths.
- There is rarely, if ever, any contingency plan for dealing with the immediate physical effects of earthquakes.
- The provision of water and sanitation is usually poor and easily affected, resulting in a high risk of post-event disease and infection.
- Local medical and welfare facilities are usually poor and they are unable to respond to any emergenies.
- The houses are built of poor materials, which easily disintegrate during earthquakes.
- The location of buildings and settlements are not planned and they are easily affected by floods from burst dams.
- Aid supplies are often slow in reaching the affected areas because of their remote nature and poor communication.

Effects on Climate

The global climate cycle is disturbed by changes in the location of water bodies that help to regulate heat and moisture on Earth. Plate tectonics can cause a change in the ocean currents, which in turn generates more heat.

Tectonic plate shifts that cause volcanic eruptions also increase the amount of carbon dioxide and sulfur dioxide in the atmosphere. This is what leads to a rise in the temperature levels globally. Some studies have suggested that the increased heat leads to a shift in the tectonic plates. This has led to the conclusion that plate tectonic movement and change in climate go hand in hand.

Activity 8: Case study

Read the report about the biggest earthquake in Southern Africa. Answer the questions that follow.:

The biggest southern African earthquake

The biggest southern African earthquake in decades struck the Save Valley in Mozambique at 12:19 am yesterday, shaking much of Zimbabwe and Mozambique, and parts of north-east South Africa.

The quake – measuring 7,5 on the Richter scale – was centred on the north bank of the Save River, very close to a national park in a sparsely settled area.

Injuries and damage were minimal with initial reports indicating that just two people had died in a small settlement a few kilometres from the epicentre, although more casualities are expected once information has been received from all homesteads and villages near the epicentre.

Espungabera in Mozambique, and Chipinge and Chimanimani in Zimbabwe – the nearest towns to the epicentre – were badly shaken but damage was negligible.

Beira, the nearest city, about 225 km away, was shaken but again with no significant damage. The Save flows through the lower arm of the Great Rift Valley at the point where the earthquake struck. While this valley is notorious for frequent low-level tremors, major earthquakes are very rare.

Yesterday's Save quake was totally unexpected by experts, who have described it as a once-in-a-century event.

The earthquake was very close to the surface, with the epicentre being just 11 km below ground level, according to information gathered by southern African seismographs and published by the US Geological survey, which archives material on all earthquakes and tremors around the world.

The officer-in-charge of Zimbabwe's Goetz Observatory in Bulawayo, Mr Lovemore Masawi, yesterday said the 7,5 magnitude was the biggest recorded by his observatory, the National Seismology Centre.

Over the past 35 years, there have only been two other quakes of 7 Richter or more in southern Africa, both near the Equator. Tanzania recorded a 7 Richter quake in September 1992, near the eastern shore of Lake Tanganyika and the DRC was hit by a 7,2 Richter quake in December 2005 in the Lualaba Valley.

The largest earthquake centered in Zimbabwe was on 23 September 1963 in the Kariba area with a magnitude on the Richter scale of 6,1. This was the biggest in a series of quakes and tremors induced by the huge weight of water placed very suddenly in geological time-scales on the surface of the earth as the dam filled.

Although the tremors were felt throughout Zimbabwe, reports coming from Plumtree, Hwange and Gokwe, as well as near towns and cities, indicate that there had been no damage.

[Source: The Herald 24 February 2006 abridged]

Questions

1. What was the epicentre and seismic focus or origin of the biggest southern African earthquake?
2. Why was this earthquake associated with little damage?
3. Draw a map of the East African Rift Valley and show the location of the epicentre of this earthquake.
4. Why are earthquakes associated with faulting?
5. Study the hints on page 38 about what to do before, during and after an earthquake. Say which one applies to your situation.

Project

As a group of five, choose one of the following topics:

a) African earthquakes
b) Volcanic eruptions
c) Tsunamis (tidal waves)

1. For your chosen topic, make a time line of the major disasters associated with it in the last two to three years. Ensure that your timeline has these columns: date starting with the earliest to the most recent, the place of occurrence and brief notes on effects and casualties.
2. Prepare a bulletin board display of your findings. Include a world map or a map of Africa locating the disasters.

Mitigating vulcanicity and earthquakes

What to do during an earthquake

Follow these guidelines if an earthquake happens:

- Stay calm. If you are inside, stay inside. If you are outside, stay outside.
- If you are inside, stand against a wall near the centre of the building, stand in a doorway, or crawl under heavy furniture (a desk or table). Stay away from windows and outside doors.
- If you are outside, stay in the open away from power lines or anything that might fall. Stay away from buildings (things might fall off the building or the building could fall on you).
- Do not use matches, candles or any type of flame. Broken gas lines and fire do not mix.

What to do after an earthquake

Follow these guidelines for what to do after an earthquake:

- Check yourself and others for injuries. Provide first aid to anyone who needs it.
- Check water, gas and electricity lines for damage. If any are damaged, shut off the valves. Check for the smell of gas. If you smell it, open all the windows and doors, leave immediately and report it to the authorities (use someone else's phone).
- Turn on the radio. Do not use the phone unless it is an emergency.
- Stay out of damaged buildings.
- Be careful around broken glass and debris. Wear boots or sturdy shoes to avoid cutting your feet.
- After a volcano erupts, stay indoors and away from volcanic ash falls. Protect your face and eyes by wearing a mask and goggles if you need to clean up ash.

Summary

- Continents drift or move relative to one another, though initially the concept of continental drift could not be explained. Plate tectonic theory explains the mechanism of continental break up, subsequent movements and ocean floor spreading. Continents broke up from a supercontinent called Pangea, made up of Laurasia in the north and Gondwanaland in the south.
- The plate tectonics theory proved, through sea floor spreading, that continents are carried as passengers on rafts called plates.
- Where plates diverge, constructive plate margins, associated with landforms such as mid-oceanic ridges and rift valleys, form. Where plates converge, destructive plate margins are formed at subduction zones. Landforms include fold mountains, trenches, island arcs and geosynclines of compressed sediments. Conservative margins are associated with tear faults.
- Tectonic movements are Earth movements and cause folding and faulting. Folding results in landforms such as fold mountains, synclinal valleys, plateaux and down-warping.
- Faulting results from tensional and compressional forces. Tensional forces cause normal faults and compressional forces result in reverse faults. Faulting results in escarpments or fault scarps, horst/block mountains and graben features. Rift valleys can be explained by the compression and tension theories.
- The main structural features of the earth are ancient shields, plateau blocks, old fold mountains, young fold mountains and sedimentary plains.
- Both volcanoes and earthquakes are created by the movement of plates and occur mostly at plate boundaries.
- Volcanoes and earthquakes are mainly due to the faulting and folding of the crust as it moves.
- Volcanoes produce a variety of landforms, which can be grouped according to extrusive and intrusive features.
- Intrusive features are noticed mainly after they are exposed by erosion.
- Volcanoes are classified according to the nature of the lava, the cone shape, the style of the eruption and the frequency.
- Volcanic activity brings both benefits and hazards to human beings.
- Earthquakes destroy buildings and other features through shock waves, the most destructive being surface waves.
- Earthquake measurement is usually done by measuring its magnitude using a Richter Scale or its intensity using the Mercalli Scale.
- Earthquakes cause vertical and lateral displacements of the crust, resulting in landslides and tsunamis that cause the destruction of structures and loss of human life.

Glossary

ancient shield – a basement complex of undulating terrain made up of igneous and metamorphic rocks
anticline – upfold, strata bends upwards
asymmetrical fold – a fold with one limb steeper than the other
cinders – small fragments of hot lava
compressional forces – forces acting towards each other
conservative plate margin – a zone where plates slide past each other
constructive plate margin – a zone where plates diverge
continental drift – movement of continents
destructive plate margin – a zone where plates collide
earthquake intensity – the degree of shaking caused by earthquake waves, which is measured on the Mercalli scale
earthquake magnitude – the degree of energy released in an earthquake, which is measured on the Richter scale
epicentre – the point on the earth's surface vertically above the focus of the earthquake
fault – a fracture in a rock with a displacement of rock
fault scarp – the steeper slope of an escarpment
fissure – a crack through which magma and other volcanic material may be ejected onto the surface
Gondwanaland – a supercontinent in the Southern Hemisphere
graben – the depressed part between two horsts
horst – a block mountain resulting from uplift
joint – a crack in a rock
lahar – a mud flow of volcanic ash lubricated by water from a lake, snowmelt or heavy rain
Laurasia – a supercontinent in Europe
lava – magma thrown out onto the earth's surface
lithosphere – the rigid outermost layer of the earth
magma – molten rock material from the interior of the earth
normal fault – a fault resulting from tensional forces
overfold – a fold where one side is pushed over the other
overthrust fold – one limb pushed right over the other
palaeomagnetism – the use of magnetism to determine the original position of poles
Pangea – a supercontinent made up of Gondwanaland and Laurasia
plate tectonics – the movements of rafts carrying continents
reverse fault – a fault resulting from compressional forces
sea floor spreading – the movement of materials in the mantle by convection currents creating seas or oceans and also moving continents
subduction zone – a zone where oceanic plate sinks below the continental crust and is destroyed
syncline – downfold, strata bent downwards
tear fault – a fault where plates slide past one another
tensional forces – forces pulling apart
tsunami – large ocean waves produced by earthquakes or volcanic eruptions

Topic test

1. The movement of plates is caused by:
   A convectional currents
   B subduction
   C folding
   D volcanoes.
2. Which of the following describes a place where an oceanic and continental plate meet?
   A a constructive plate margin
   B a destructive plate margin
   C the palaeomagnetism
   D lithosphere
3. The areas are shaded on the world map below are:
   A ancient shields
   B block mountains
   C fold mountains
   D lava plateaux.

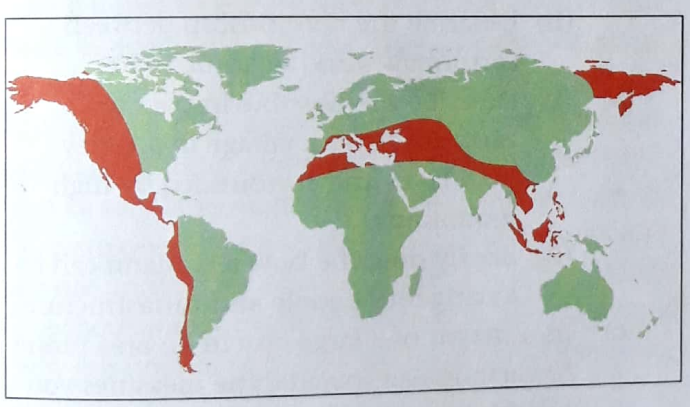


Figure 2.54 A world map

4. a) What is continental drift, and how does it differ from plate tectonics theory?
   b) Describe and explain the landforms associated with the following plate margins (use large clear diagrams in your answer):
      (i) Constructive plate margins
      (ii) Destructive plate margins
5. a) Using clear diagrams, describe the main types of **(i)** folds **(ii)** faults.
   b) Describe and explain, using relevant examples, the main types of landforms that result from folding and faulting.
   c) Discuss the value of fold mountains to people.
6. Figure 2.55 below shows a cross-section of an active volcano. The feature labelled X is a:

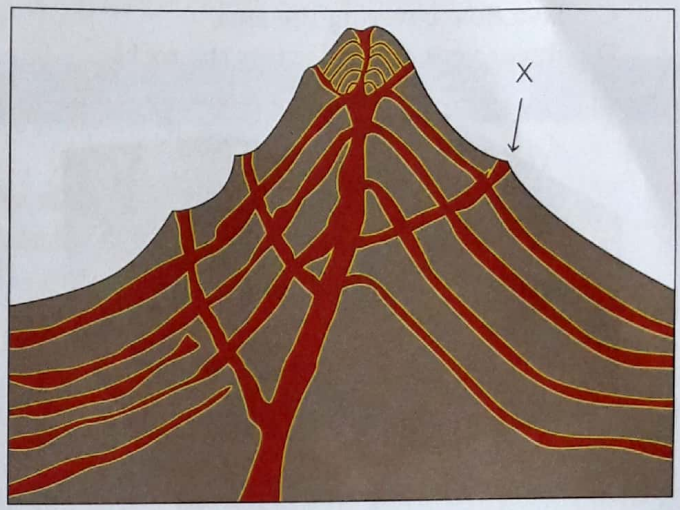


Figure 2.55 A cross-section of an active volcano

   A conelet
   B dyke
   C crater
   D vent.
7. Figure 2.56 shows the origin of an earthquake and possible areas of destruction. In which of places, A, B, C or D, would you expect to have the most destructive effect?

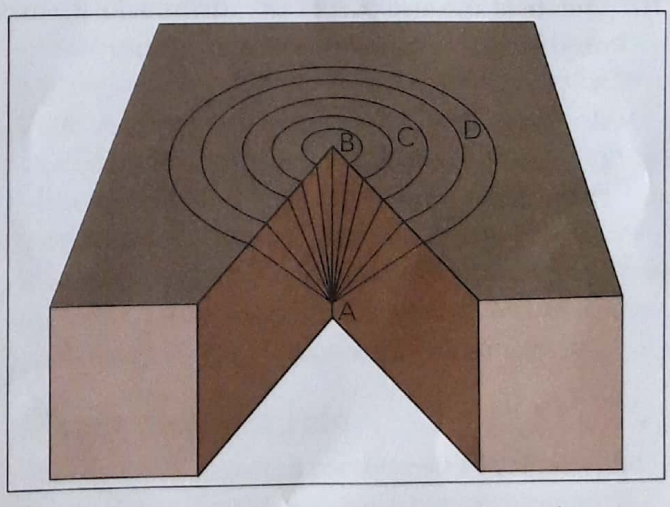


Figure 2.56 The origin of the earthquake and possible areas of destruction

8. Figure 2.57 shows rock strata affected by intrusive volcanic activity. The feature marked Y is a:
   - A dyke less resistant to erosion
   - B sill less resistant to erosion
   - C lava flow covering the area
   - D linear vent cutting across the rocks.

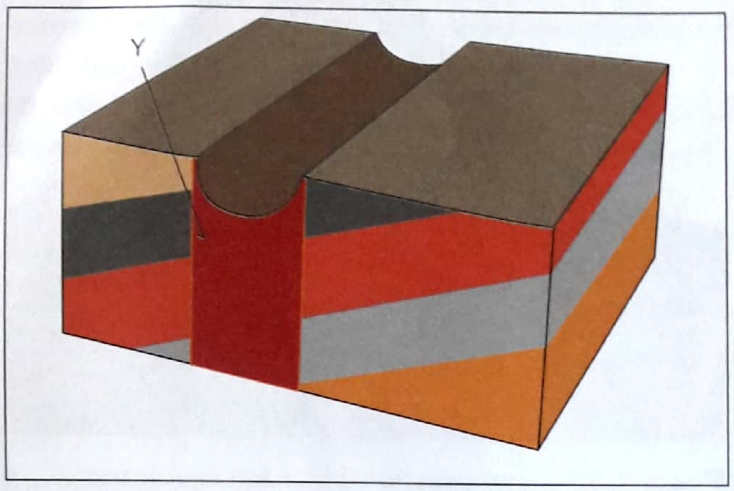


Figure 2.57 Rock strata affected by intrusive volcanic activity

9. Which type of volcanic feature is the Ngorongoro crater in Kenya?
   - A Volcanic plug
   - B Volcanic cone
   - C Collapsed caldera
   - D Mud volcano

10. The most intense part of the earthquake occurs on the earth's surface and is called the:
   - A focus
   - B epicentre
   - C seismic centre
   - D surface wave.

11. a) Distinguish between magma and lava.
   b) (i) With the aid of diagrams, describe the formation of a caldera.
   (ii) Why are volcanic eruptions a danger to people?
   c) What measures would you take to reduce the effects of a volcanic eruption in an area of active volcanoes?

12. a) (i) Name four features of intrusive vulcanicity.
   (ii) For any two of the features you named in part (i), draw a diagram to illustrate each of them and explain how they are formed.
   b) (i) Give reasons why people like to stay in volcanic areas.
   (ii) In what way can volcanic areas be considered hazardous to people?

13. a) (i) What is a focus in the study of earthquakes?
   (ii) Describe the relationship between earthquakes and tectonic plates.
   b) (i) Describe the possible impact of an earthquake on a village in a valley with lakes and surrounded by high mountains.
   (ii) Briefly describe how a tsunami can be a danger to people and infrastructure.
   c) As a mayor of a large city in an area prone to earthquakes, outline the measures you would recommend to reduce the effects of an earthquake.

Topic 3 Ecosystems

Objectives

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

- explain the biogeochemical cycles (nutrient cycle, nitrogen cycle, carbon cycle)
- outline the importance of biogeochemical cycles in the ecosystem
- explain the importance of wetlands
- outline the benefits of wetlands
- identify methods of conversation
- explain the methods of restoring ecosystems
- outline the benefits of restoring ecosystems
- explain the importance of ecosystems.

An ecosystem includes all living things and all non-living things in a given area. The living components, such as plants and animals, interact with each other and with the non-living components, such as sun, soil and air. An ecosystem can be very small, such as a puddle of water or the ground under a rock, or it can be very large, such as an ocean. In an ecosystem, all components have a role to play, and they depend on one another for survival. In this topic, we will find out about energy cycles in ecosystems and understand why it is important to take care of our environment.

Biogeochemical cycles

Energy enters the ecosystem from the sun. Plants convert this energy into chemical energy, which animals consume and use. These nutrient and chemical elements move through the ecosystem in biogeochemical cycles, where they are re-used repeatedly. We will look at two nutrient cycles: the nitrogen and carbon cycles.

Nutrient cycles

All living things need nutrients to grow and reproduce. The nutrient cycle is the continuous movement of nutrients between the living and non-living components of an ecosystem. It is vital for the well-being of soils that nutrients be replenished. Fertile soils are vital for plant growth. Plants are the producers in an ecosystem. All animals depend on plants, either directly (herbivores) or indirectly (carnivores and omnivores). When animals eat plants or other animals, they take in the nutrients from those organisms and use them for life processes. When plants and animals die, they return nutrients to the environment.

Bacteria and fungi break down dead vegetation and animals through decay and decomposition. Earthworms and other small animals in the soil also help to mix mineral and organic matter, distributing it through the soil for plant roots to access. Plants can then absorb these nutrients for their own growth and the cycle starts again. The overall process can be broken down into:
photosynthesis → feeding → decomposition
Nutrient cycles are important because they allow the environment to re-use existing nutrients. There are many nutrients in an ecosystem. We will look at two cycles: the nitrogen and carbon cycles.

The nitrogen cycle

Nitrogen is an essential component of proteins and amino acids. It is also a component of chlorophyll, which plants need to trap the sun's energy for photosynthesis. Approximately 78% of the air in our atmosphere is made up of nitrogen gas (N_2). However, most plants and animals cannot use nitrogen gas. Organisms need nitrogen in a form that they can use, namely, as ammonia (NH_3) or nitrate (NO_3). Nitrate is

a particularly important form of nitrogen, as it is the form most commonly used by plants.

Some bacteria have the ability to fix nitrogen from the air into a form that is useable for organisms. Most of these bacteria live freely in the environment, while some share symbiotic relationships with plant roots. It is the symbiotic bacteria that are responsible for fixing enough nitrogen to be significant in nitrogen production. Since these organisms have been fixing nitrogen for many years in the past, there is now a reservoir of ammonia and nitrates in most ecosystems. In aquatic ecosystems, however, nitrogen is limited and has not accumulated in the same way that it has in terrestrial habitats. To overcome this, certain types of algae work together with bacteria to fix nitrogen from the environment for organisms to use.

Lightning storms create a lot of energy that helps oxygen to bond with nitrogen, creating nitrates that plants can use. Large amount of nitrogen are also added to the environment through fertilisers that are applied to agricultural developments. As a result, human activity now plays an important role in the nitrogen cycle.

Nitrogen-containing compounds, like proteins in plant and animal bodies, are decomposed quickly by bacteria and fungi. These micro-organisms break down the dead plant and animal matter and return their nutrients (including nitrogen) to the air and the soil. Plants then use the nutrients in the soil for their own growth, starting the cycle over again. When micro-organisms release nitrogen back into the air, the process is called denitrification.

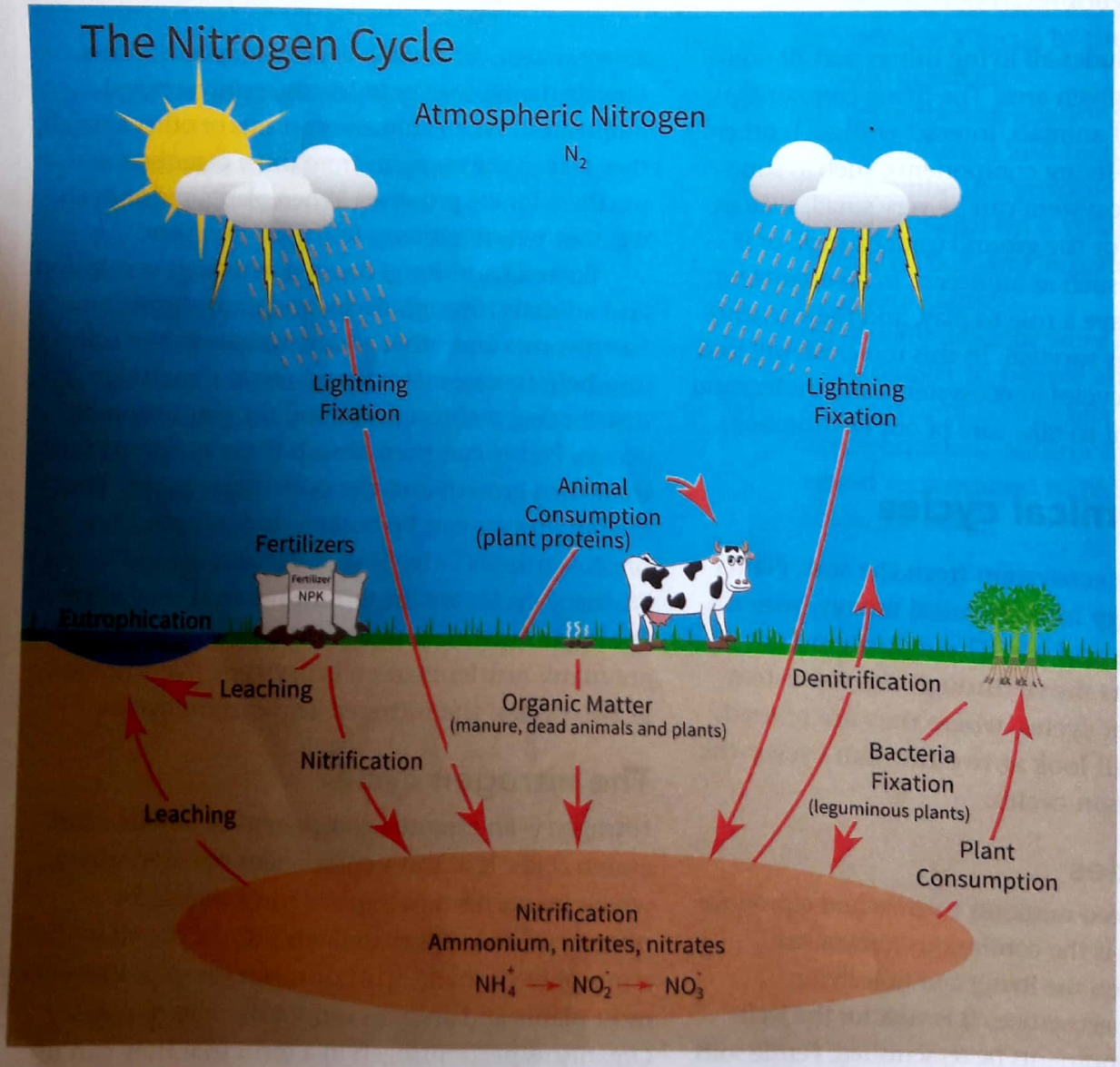


Figure 3.1 The nitrogen cycle

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The carbon cycle

Carbon is a part of all living things and organic molecules. Similar to the way in which micro-organisms fix nitrogen into useable forms in the nitrogen cycle, plants are responsible for making useable carbon. This is done through photosynthesis. Plant roots absorb water and nutrients from the soil. Plants absorb atmospheric carbon dioxide through their leaves. Using energy from sunlight and carbon dioxide, plants can make glucose. Glucose is a source of energy, which the plant uses to grow. The carbon is then passed to animals as they eat the plants (herbivores) or other animals (carnivores). Animals then release carbon back into the environment in two ways: through decomposition and through respiration. When plants and animals die, they decompose and the chemical elements, such as carbon, in their bodies are released back into the environment. When animals respire (breathe), they take in oxygen and release carbon dioxide, providing plants with more of the building blocks they need to produce glucose through photosynthesis. Plants can also release carbon dioxide as a waste product from their own respiration processes. In this way, carbon is re-used over and over again.

If plants or animals die and their remains are too far underground, the carbon they possess is not re-used immediately in the environment. Instead, it can lead to the formation of fossil fuels, like coal and oil. When fossil fuels are burned, they release carbon back into the atmosphere. However, carbon dioxide is a greenhouse gas, and too much of it in the atmosphere contributes to global warming.

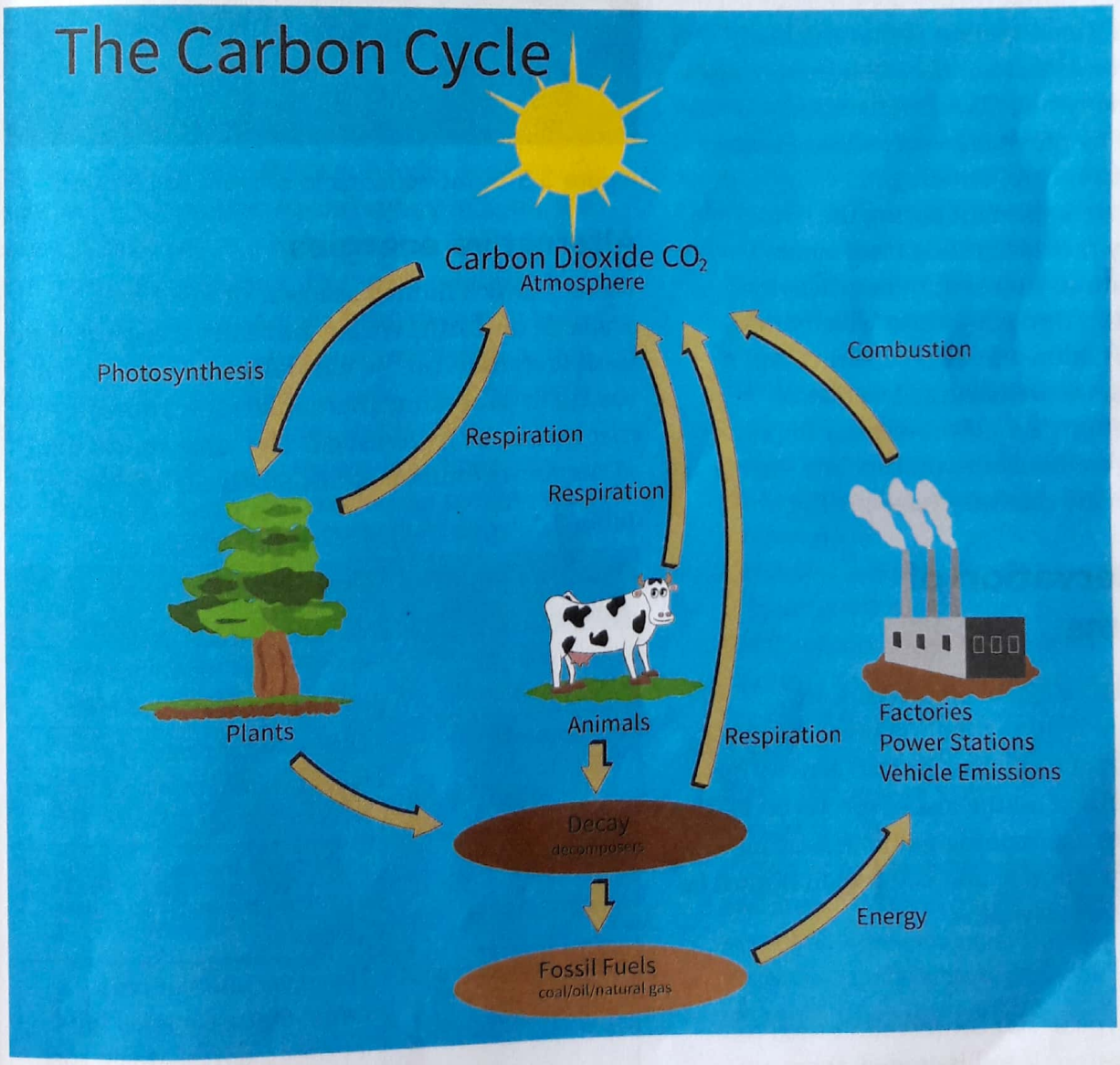


Figure 3.2 The carbon cycle

Wetlands

Wetlands are marshy areas with water that is either static or gently flowing. In southern Africa, they are known as dambos or vleis, and they cover over 1.3 million hectares in Zimbabwe.

Wetlands are important during the dry seasons as they provide grazing for animals and for cultivation. However, human activities, such as pollution through industrial activities, fishing, deforestation and dam construction, are threatening the well-being of wetlands.

The importance and benefits of wetlands

Wetlands are among the most productive ecosystems on Earth, owing to the large amounts of nutrients they contain. They are home to a wide variety of water-tolerant plants and many invertebrates, birds and animals. Besides serving as a habitat for many organisms, wetlands play a vital ecological role by providing water storage basins that can help to control flooding.

Wetlands are important during the dry seasons as they provide grazing for animals and for cultivation. However, human activities, such as pollution through industrial activities, fishing, deforestation and dam construction, are threatening the well-being of wetlands. Government efforts are now underway to protect the remaining wetlands and prevent any further loss of biodiversity that they have to offer.

The conservation of ecosystems

The current rates of loss of biodiversity are alarmingly high. While extinction often happens naturally as part of evolution, human activity has had a serious impact on the loss of species on Earth. Everything from maintaining soil to legislating against unlawful hunting and deforestation must be done to conserve ecosystems.

Terracing

Terracing is a type of soil conservation used to prevent soil erosion. If soil is eroded, there are not enough nutrients present for plants to grow effectively. Fewer plants mean fewer crops and less food for people and grazing animals.

In hilly areas, terracing provides level surfaces on which plants can grow. This also makes it possible to grow many different types of plants and crops along the terraces. Normally, in the absence of terraces, nutrient-rich topsoil would be washed or blown away down the hillside. Terracing helps to prevent this soil erosion, allowing the soil to retain more of its nutrients.

Figure 3.3 Terracing helps to prevent soil erosion

Alternative energies

There is only a limited amount of fossil fuel available on Earth. We are currently using up more fossil fuels than can be naturally replenished. This has led to us seeking alternative fuels and energies that we can be replenished. The table shows some of the most common forms of alternative energy

Table 3.1 Types of alternative energies

Type of alternative energy	Description
Wind energy	Electricity is made from wind using large wind turbines.
Hydro-electricity	Energy is captured from falling water, rotating turbines to create electricity.
Solar energy	Light from the sun is captured using solar panels to make electricity.
Biofuel and ethanol	These are alternatives to petrol that are made from leftover plant materials, such as sugar cane

By using alternative energies, we save more of the earth's natural resources and conserve life on Earth.

Destocking

Destocking is the removal of animals from an area of land so the soil and vegetation can replenish itself. Grazing and animals' hooves can lead to soil erosion by removing and destroying the plants in an area of ground. By moving the animals out of an area, the land can be rehabilitated and the soil can become more fertile with time and care.

Indigenous knowledge systems

By indigenous knowledge systems (IKSs), we mean the understanding that people have about the land on which they have lived for many years. While global developments and scientific analyses are useful, they must be combined by knowledge from people who understand the rich history of the land they occupy.

For Zimbabweans living in rural areas, indigenous knowledge is used to make decisions about everyday life. This knowledge is often specific to a certain area and trying to apply the same knowledge to a different area might not always work effectively. In the past, indigenous knowledge was transferred from person to person within an area. With modern technologies, it is becoming easier to write and record indigenous knowledge so that it is not lost forever.

Some examples of indigenous knowledge are:

- Rain dancing and music under specific trees, such as mibvumira and misasa. Certain trees can also be set aside as rain sanctuaries where they serve as homes for the rain spirits.
- Burial places, where the ancestral spirits of clans now reside. Using these places for anything other than paying respect is considered desecration.
- Sacred water bodies and animals must be respected. In order to do this, conservationists must work together with local people to understand the indigenous knowledge systems before taking any action.

Restoring ecosystems

With effort, it is possible to restore an ecosystem that has been placed under strain from human or animal activities. Restoring ecosystems can only benefit people and the environment. If we do not restore ecosystems and continue consuming without consequence, we will not have enough food or clean water for everyone.

One of the most fundamental ways to restore an ecosystem is to improve the quality of its soil. This usually involves reversing the effects of soil erosion.

Gully reclamation

A gully is a small valley or channel that has been formed from soil being washed away. This happens in areas where there is a lot of rainfall but few plants or vegetation to keep the soil from being washed away. Gully reclamation is the process of fixing the damage that has been done through excessive washing away of the soil. There are several gully reclamation techniques, some focussing on fixing the damage caused through heavy rains, others on preventing it.

- Filling the gully with soil. If the gully is shallow and the soil has been washed away to a nearby place, that same soil can be moved and filled into the gully. Rocks and plants are then added to the area to prevent the soil from being washed away again. This technique is done during the dry season, giving the soil time to settle.
- Diversion barriers. Sometimes water overflows into areas where it should not be, leading to the formation of gullies. Establishing proper channels for the water to run along where it is supposed to be is a good preventative measure. Adding bales of hay to areas of flooding can direct the flow of water away from where it should not be.
- Proper drainage. Some areas become flooded and have their soil washed away because of poor drainage. Drains and proper channels for water to run along can be built to ensure valuable soil is not washed away.

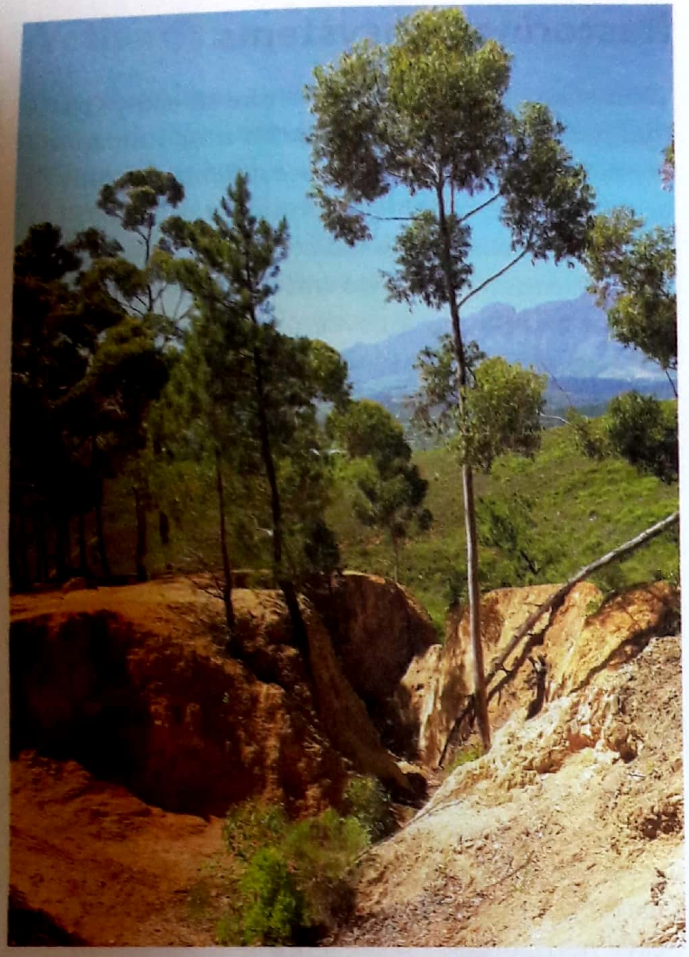


Figure 3.4 An example of a gully

Grass planting

Planting grass is a very good technique for restoring the soil quality in an ecosystem. Grass roots help to bind the soil and keep it together so it is not eroded away. The grass itself is good for reducing splash damage from rain and provides food for animals. Grass also protects the underlying soil from animals' hooves.

Tree planting

Similar to planting grass, planting trees also helps to restore an ecosystem. The roots of the trees help hold soil together and the leaves prevent splash damage. Trees provide habitats for various insects and animals. They also produce more fresh air through photosynthesis. In sustainably managed forests or plantations, we can responsibly make timber products and paper without harming the environment.

The benefits of ecosystems

Humans rely on ecosystems to provide many of the things we need to survive. A healthy ecosystem will lead to healthy habitats for us to live in, with enough food and water for everyone living there. Some of the benefits are:

- Timber. Wood is used to make furniture, paper and to create warmth through fires. It takes trees several years to grow big enough to provide mature wood. If we cut down trees faster than we can replace them, there will not be enough wood to meet our needs and we will have damaged the environment.
- Carbon sinks. A carbon sink is any environment that can absorb carbon dioxide. As you already know, carbon dioxide is a greenhouse gas that can lead to the planet becoming too hot. Through photosynthesis, plants reduce the amount of carbon dioxide in the air. A healthy ecosystem with lots of plants is a good carbon sink, absorbing carbon dioxide and using it for plants to make their own food and grow.
- Oxygen. As we just learnt, plants take carbon dioxide from the air and use it for photosynthesis. A waste product from this process is oxygen, which many organisms, such as humans, need to breathe. Healthy ecosystems with lots of plants help provide us with clean air.
- Fruits and honey. Flowering plants produce pollen and nectar. Bees are attracted to the flowers for their nectar, which they take back to their hives to make honey, which people can harvest to make many valuable products. Most often, bees also transfer pollen from the male part to the female part of either the same flower or a different one. When flowers are pollinated, they produce seed-bearing fruit. These fruits are often edible for people and can provide a valuable source of nutrients.
- Reducing soil erosion. The leaves and roots of plants in a well-preserved ecosystem help to reduce soil erosion in a habitat. Reducing soil erosion keeps the soil nutrients where the plants are growing, instead of washing them away.

- Humus. A healthy ecosystem will have many living things in it: plants, insects and animals. Eventually these will die. Plant leaves will fall to the ground and insects and animals will die. This leads to decomposition, where the nutrients in the plant materials or animal bodies are returned to the soil. Humus is the substance that forms from the complex decomposition of organisms in an ecosystem. It is vital for the fertility of soil.
- Medicines. Many plants in ecosystems have medicinal value. These natural remedies are often used in conjunction with indigenous knowledge to cure ailments. For example, aloe leaves contain fluids that are used to treat a number of skin conditions.
- Increasing precipitation: Plants release water vapour through transpiration. This water vapour enters the ecosystem and contributes to the formation of precipitation. More plants will lead to more rain, which helps people and ecosystems to thrive.

Activity 1

Read through the following report and then answer the questions that follow:

Wetlands in Harare under threat

More than half of Harare is built on wetlands. The large shortage of housing in the capital city has led to the construction of houses on wetlands in Harare. This has led to contamination of underground water. People build septic tanks that seep into underground water. If more houses are built on the wetlands, the water could become unsafe for drinking.

Mrs Pahwaringira, the Institute of Water and Sanitation's Capacity Development Officer, said that by 2025 there will be a water scarcity in Zimbabwe because of poor management of our ecosystems.

Monavale Vlei is one of the wetlands of Harare that has been turned into residential stands. Houses built on wetlands are prone to flooding and collapsing.

A case study of Shurugwi District showed that wetlands occupied 56.6% of the area in 1980.By 2003, this had declined to 43.4%. The destruction of wetlands leads to imbalances in ecosystems. Wetlands act as a natural sponge. They soak up the rain and then slowly release this water in drier seasons. They also prevent flooding in rainy seasons. Development on wetlands increases surface runoff, which results in increased risk of floods.

Wetlands filter water thereby improving the water quality. Clearing wetlands for housing developments causes water pollution. In addition, wetlands act as temporary storage basins, which reduces erosion. Wetlands also provide a habitat for many species of plants and animals. The construction of houses on wetlands thus decreases biodiversity.

1. Why are wetlands being used for housing developments?
2. Draw a mind map to show the effects of construction on the wetlands.
3. By what percentage did the area occupied by wetlands decrease between 1980 and 2003?
4. Why is it important to conserve wetlands?

THE HEAD
P.O BOX 25
BEATRICE

Summary

- Nutrient cycles help to re-use nutrients in an ecosystem.
- In the nitrogen cycle, micro-organisms fix atmospheric nitrogen into a form that plants can use, allowing it to enter the nutrient cycle.
- In the carbon cycle, plants use sunlight and carbon dioxide to make glucose, which the plant uses to grow.
- Wetlands are full of life and serve many important ecological functions, such as helping to control flooding.
- There are many ways to conserve an ecosystem and to prevent soil erosion, such as terracing, using alternative energies, destocking and implementing conservation legislation.
- Ecosystems offer many benefits, such as providing timber, establishing carbon sinks, producing oxygen through photosynthesis, providing fruits and honey for human consumption, reducing soil erosion, forming humus to enrich the soil, providing natural medicines and increasing precipitation.

Glossary

biogeochemical cycle – the process in which chemicals are cycled through the ecosystem by passing through living and non-living elements of the ecosystem
denitrification – the process by which micro-organisms release nitrogen back into the air
glucose – a simple sugar made during photosynthesis
fossil fuels – fuels deep in the earth that are made from plant and animal materials
wetland – land made up of marshes or swamps, saturated with water.

Topic test

1. In the nitrogen cycle, plants cannot use nitrogen in the following form:
   A Ammonia
   B Nitrate
   C Nitrogen gas
   D Nitrite
2. In the carbon cycle, the main process for capturing usable carbon is:
   A Photosynthesis
   B Transpiration
   C Precipitation
   D Soil erosion
3. Which of the following is not an important benefit of wetlands?
   A a habitat for many organisms
   B assisting in the formation of fossil fuels
   C helping to control flooding
   D providing grazing for animals
4. When speaking of conserving ecosystems, terracing refers to:
   A a soil conservation technique where flat surfaces are made in hilly areas
   B making laws to protect the environment from human activities
   C a technique for fixing gullies after they have formed
   D putting up fences to keep out animals to prevent soil erosion
5. Which of the following is not a restoration technique in ecosystems?
   A gully reclamation
   B planting grass
   C planting trees
   D deforestation
6. Are the following statements true or false? If false, explain why.
   a) When micro-organisms release nitrogen back into the atmosphere, it is called atmospheric nitrogen fixation.
   b) Carbon dioxide is a greenhouse gas that contributes to global warming.
   c) Fossil fuels are an alternative energy.
   d) Gullies are a result of soil erosion when water washes away soil and forms valleys.
   e) A carbon sink is the amount of carbon human activities release into the atmosphere.
7. Draw and label the:
   a) nitrogen cycle
   b) carbon cycle.
8. Draw a table to list and describe four alternative energies.

Type of alternative energy	Description

9. List and briefly explain three ways to restore an ecosystem.
10. Describe any three benefits of ecosystems.

Topic 4

Natural resources

Objectives

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

- describe resources conservation measures
- identify ways of conserving resources
- describe wildlife management
- identify the advantages of wildlife management
- distinguish between problem animals and dangerous animals
- identify the causes of human-wildlife conflict
- suggest solutions to human-wildlife conflict
- give reasons for the establishment of the CAMPFIRE
- discuss the benefits of the CAMPFIRE
- discuss the sustainability of CAMPFIRE.

The conservation and management of resources

Natural resources like minerals are finite, that is, they can be used up or exhausted. They must therefore be consumed with care. As people use them today, we must remember that future generations also need them for various uses.

Conserving natural resources

Natural resources are conserved through the following ways:

Education

Environmental education is essential as it aims to make people aware of the importance of resources. Many organisations can assist in educating people. The main environmental organisations in Zimbabwe are the Department of Natural Resources (under the Ministry of Environment and Tourism), the universities and colleges, non-governmental organisations (NGOs) such as the Africa Resources Trust, Environment Africa, Environmental Development Activities (ENDA) and the recently formed Environmental Management Authority (EMA).

Legislation

Laws can be used to control the use of resources. Control may be on stream-bank cultivation, the disposal of waste, the cutting down of trees and the burning of grass. Those people or organisations misusing resources can be penalised by way of fines or arrest. Municipalities use bylaws to conserve the natural resources. The country's Environmental Management Act is used to manage the use of national resources.

The substitution of minerals

Some minerals have been substituted for others, for example, copper has been replaced by aluminum in electronics, and optics and metals by plastics such as polyvinyl chloride (PVC).

Technology

There should be improved mining **technology** to exploit even low grade ores.

Waste disposal

Better disposal of waste through recycling, incineration or burning and sanitary land filling should be encouraged. The waste should be handled at the production point and not at the

end point, for example, by using technology to limit its production or by recycling it immediately, rather than treating the waste after production.

Conserving soil

The soil is an important natural resource, which has been subjected to **erosion** and, like any other resource, needs to be well conserved and managed for continued agricultural production. It is important to highlight the causes, effects and possible solutions to soil erosion as it relates to agriculture. The map in Figure 4.1 shows the state of soil conservation and erosion in Zimbabwe.

The causes of erosion can be summarised as:

Human-related factors

Human-induced factors include:

- population pressure
- the extension of farming land
- overgrazing
- the high demand for fuelwood

These factors lead to the following:

- extensive **deforestation**
- poor conservation practices
- poor methods of farming
- the unequal distribution and use of land among the various groups
- over-cultivation.

Physical factors

Physical factors causing soil erosion include the following:

- easily eroded soils such as the sodic and granite-derived soils
- steep slopes
- bare rock surfaces which promote runoff
- low vegetation cover
- pressure on the land from wildlife
- the intensity of rainfall.

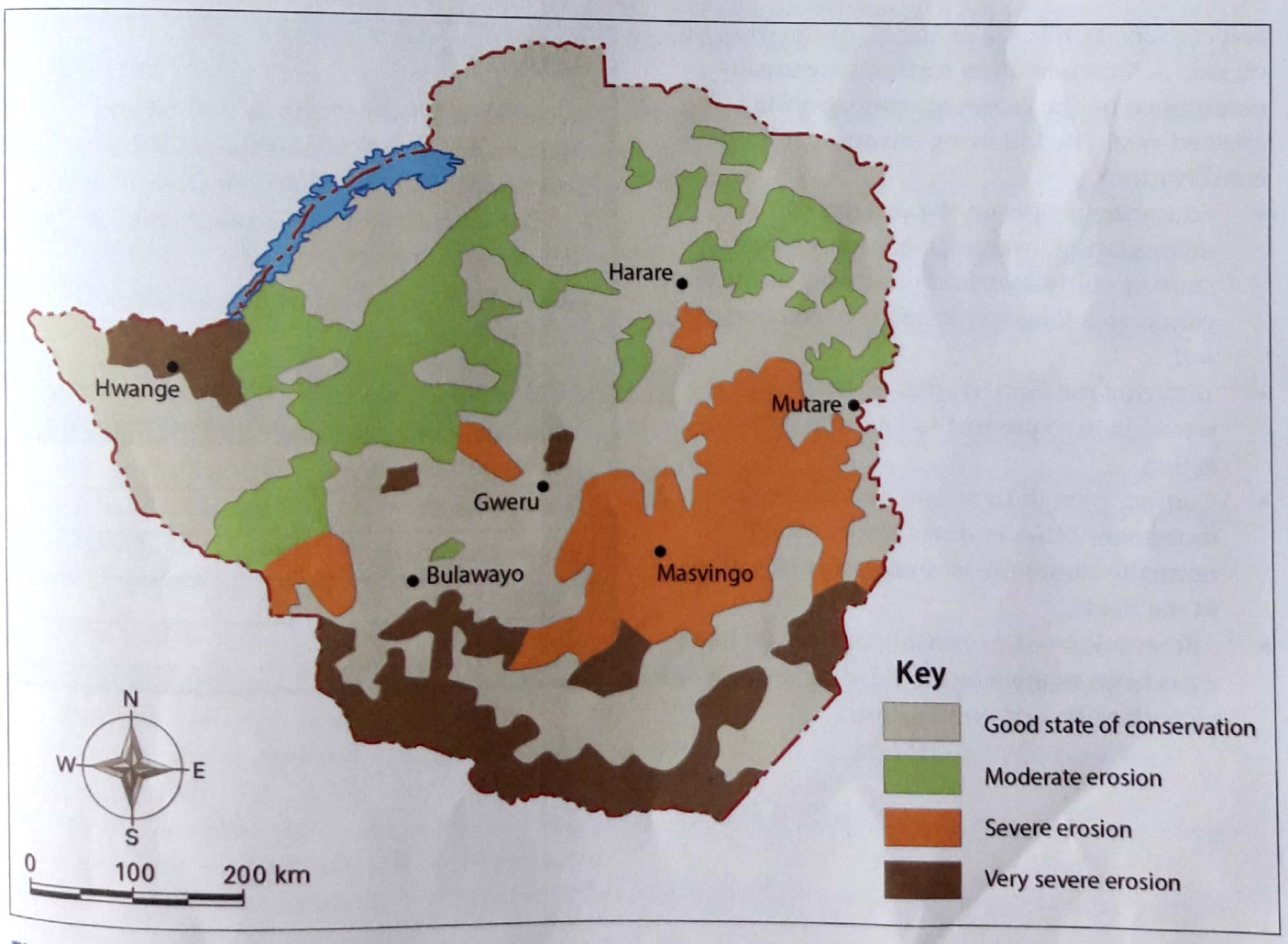


Figure 4.1 The state of soil conservation and erosion in Zimbabwe

Erosion affects agricultural activities in the following ways:

- the siltation of rivers and dams leads to the shortage of water for irrigation and for domestic use by people and livestock
- the development of gullies reduces available farmland and makes areas inaccessible
- the removal of soil nutrients occurs because the fertile top soil is lost
- the high frequency of flooding destroys crops and fields because of reduced river depth through siltation
- the money and energy are spent in trying to maintain and restore soil fertility and soil cover lost through erosion, thereby increasing costs
- the restricted crop root develops as a result of shallow soils
- the low-water-holding capacity of soil becomes evident.

Soil conservation is the saving of, or the wise use of, soil. Soil conservation methods are usually determined by the causes of erosion in the affected area. The following measures promote conservation:

- Educating people on the dangers of deforestation, overgrazing, monoculture, shifting cultivation and ploughing down slope would go a long way in the conservation of soil.
- Terracing the land in areas of steep slopes would help to prevent soil erosion by water action.
- Contour ploughing would reduce the fast movement of water down slope, which normally causes the washing away of topsoil in the fields.
- Afforestation or the growing of trees on bare areas helps to prevent the washing away of soil by both water and wind action.
- Controlled grazing and rotational grazing would limit pressure on grazing land and prevent the destruction of vegetation.
- Destocking or the reduction of domestic animals would reduce overgrazing.
- Practising mixed farming and crop rotation helps to avoid monoculture.
- Gulley prevention through use of stones and concrete walls to protect land, would stop the gulleys from developing.
- Preventing veld fires and the unnecessary burning of vegetation would reduce soil loss through water and wind action.
- Creating windbreaks on the farm, growing vegetation, building concrete or stone walls in areas prone to wind would help prevent erosion.
- Ploughing at least 30 metres away from the riverbanks would help prevent stream bank cultivation.

Activity 1

Study Table 4.1 which shows the soil and moisture conservation practices in Kandeya Communal Lands in the Mount Darwin district.

1. Draw a pie chart or bar graph to show the information in the table.

Table 4.1 Soil and moisture conservation practices in Kandeya

Practice	Number of farmers using the practice
Contour ridges	71
Gully protection	4
Winter ploughing	53
Planting holes	46
Crop rotation	73

Activity 2: Case study

Read the case study and answer the questions that follow:

Environmental youth group launched

Environment Africa has launched the Victoria Falls Environmental Action Society, a 15-member youth group composed of school-leavers who plan to lobby decision-makers to involve young people in environmental decision-making.

The Victoria Falls coordinator for Environment Africa, Ms Skululekile Ncube, said the society has so far embarked on a number of projects such as the cleaning of the Masue River, which cuts across the Victoria Falls/Bulawayo highway at the 5 km peg from Victoria Falls.

The river is located next to the dumpsite and sewage ponds.

'All these are deemed to be the possible sources of its pollution. Some companies also dump their waste into this river,' said Ms Ncube.

The group has adopted a 2-km stretch of this river and they clean it up once every two months.

She said UNESCO declared the year 2003 as the international year for fresh water and in response to this declaration, the youth adopted this project.

The group is also embarking on the planting of the vetiver grass with the aim of controlling soil erosion in the town.

'The soils that make this resort town are the deep red Kalahari sands, which are very loose and prone to erosion. Of late, Victoria Falls has witnessed the rapid development of gullies and it is in an effort to help other stakeholders reduce the rate of soil erosion that the group members came up with this idea,' said Ms Ncube.

Vetiver grass is deep-rooted, drought resistant, unpalatable to animals and helps stabilise soil by binding it together. Vetiver can withstand harsh climatic conditions.

The group collects it from Lukosi area on the outskirts of Hwange and plants it at the car wash in Victoria Falls.

The group is also embarking on the propagation and planting of moringa trees, in partnership with the Ministry of Health and Child Welfare.

'The propagation of the Moringa tree, which is very nutritious, is aimed at benefitting those of ill health, orphans and malnourished children,' she said.

Ms Ncube said that through the extension of this partnership, the youth group decided to plant this tree at the old-age home so that the aged can also benefit in boosting their immune system.

The youth are also embarking on other activities such as the preparation and commemoration of national and international events such as Clean-up, World Day, World Environment Day and National Tree Planting Day.

[Source: The Herald, 23 February 2004]

Questions

1. List four activities the environmental group has embarked on to manage and conserve the environment and its resources.
2. Describe how the group's activities are linked to or guided by similar activities from outside Victoria Falls.
3. With reference to the group's activities, explain the idea that 'enviromnental issues focus on wider issues than just cleaning up the environment.'
4. Do you have such groups at your school? What would be the aims of your group and how would you attempt to achieve them?

The conservation of fish

Fishing plays an important role in the economy of Zimbabwe. It is a source of food that is rich in nutrients such as protein. In addition, the fat in fish provides energy for the human body and they contain many essential minerals such as iodine, iron, calcium and magnesium. A number of by-products are also obtained from fish waste as well, notably oils, glues and fish meals. The fishing industry also provides employment to people involved in the processing of the catch, in cutting, cleaning, salting, smoking, pickling, drying and canning the fish.

Fishing at Kariba

The main fishing area in Zimbabwe is Lake Kariba. Here commercial fishing is undertaken on a large-scale and a small-scale basis. Of the over 130 fish species in Zimbabwe, the most common types are kapenta, bream, mudsucker, tiger fish and barbell. Over 50 varieties of fish breed in the waters of Lake Kariba. Some of these include bream, chessa, nkupe, Cornish jack, bottlenose, kapenta, vundu and tigerfish (See Figure 4.2.)

Kapenta fishing at Kariba

Kapenta were introduced into the lake in 1967 at Sinazangwe on the Zambian side of the lake, by the Zambian Government. In 1973, a commercial fishing enterprise was formed. Fish here were caught initially using the purse seine and square lift net techniques. With further developments in fishing technology, the dip net method is mostly used because more fish are caught. This is a method whereby dip nets are suspended from a boom on the rigs. These nets are fitted to metal rings that are 6–7 m in diameter. The nets are conical in shape and are 10 or 12 m long. When fishing starts at night, the nets and underwater lights are lowered into the water and the overhead lights are switched on to attract the kapenta. The overhead lights are then switched off after 30 minutes to concentrate the shoal around the underwater light above the net. The net is lifted at least three or four times at night to drag the catch out.

The caught kapenta fish are put in baskets and their freshness is maintained using coarse salt. Some fish are dried in the sun and these can be easily transported to areas that have no refrigeration.

Types of fish caught in Zimbabwe

The poem below highlights the diversity of fish in Zimbabwe:

Zimbabwe boasts of a diveristy of fish
In the waters of the country,
Lake Kariba alone is flooded with many kinds of fish
From tigerfish to bream.

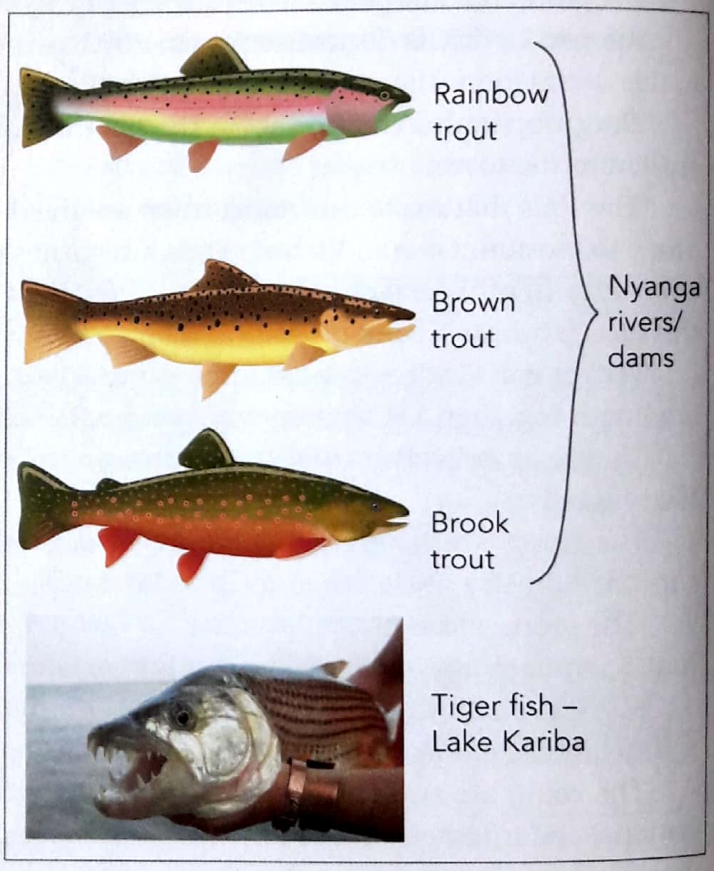


Figure 4.2 Some types of fish caught in Zimbabwe

Problems of fishing in Zimbabwe

Some of the problems associated with fishing in Zimbabwe are listed below:

- Waterweed has colonised most inland fisheries, for example, Lake Chivero; the reduced oxygen levels in the water (eutrophication) has led to fish dying due to blocked light and altered water temperatures.
- The poor management of fisheries has resulted in over-fishing.

- Fish are being poached.
- Inappropriate fishing technology is being used, for example, fish poisoning which pollutes the water.
- There is a shortage of capital to buy modern boats and fishing equipment.
- There is a lack of proper storage facilities, especially refrigerated vessels and rooms.
- Pollution from industrial waste is being deposited into rivers and lakes.

Possible solutions

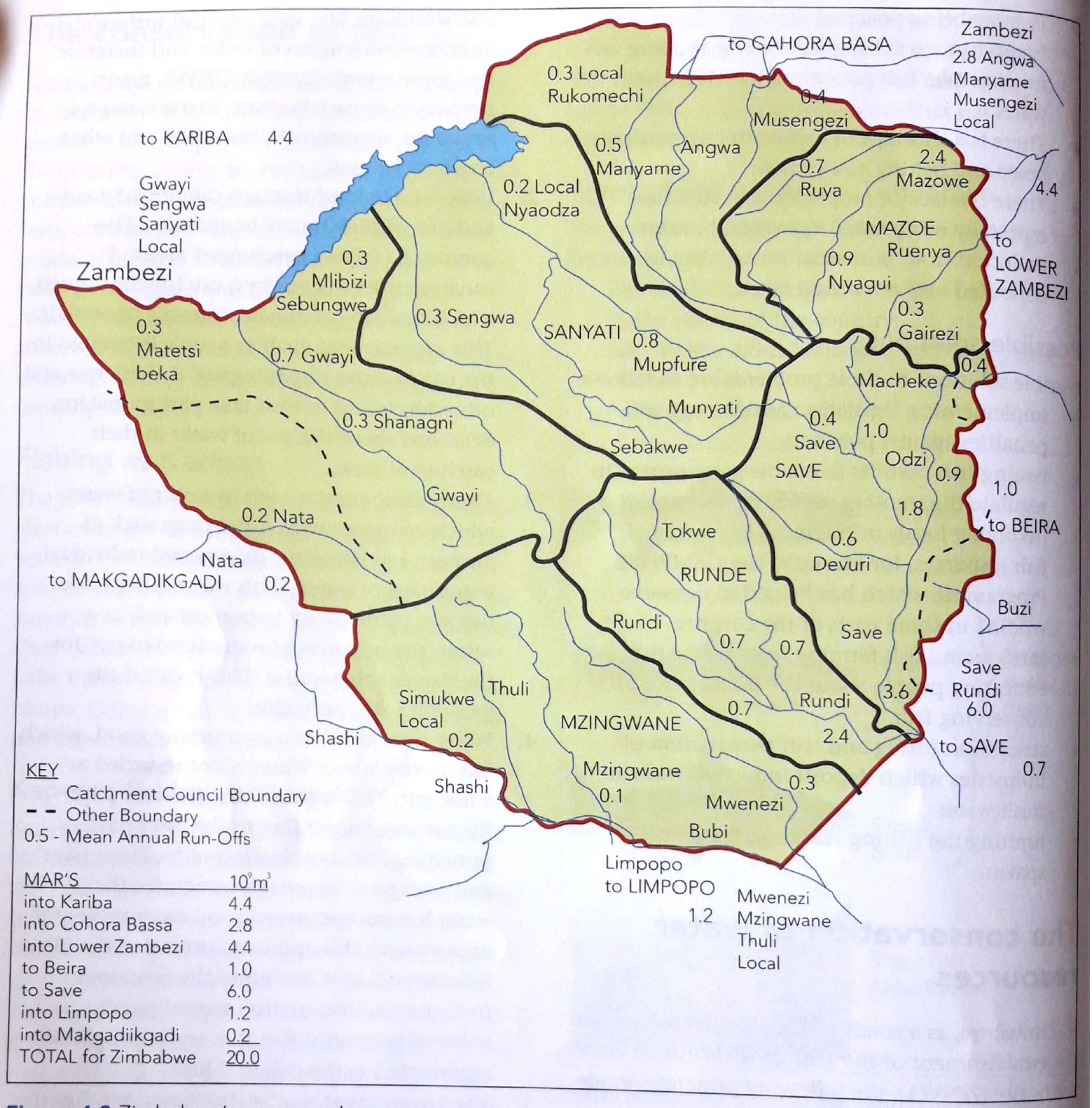
Possible solutions to these problems are as follows:

- implementing legislation and issuing stiff penalties against poachers
- issuing fish permits to enable government to regulate the number of fishing companies
- involving locals in the management of fish resources, for example, the CAMPFIRE Programme which has helped to conserve wildlife in some parts of the country
- introducing fish farming to conserve fish
- educating people about the importance of conserving fish
- strict monitoring and stiff penalisation of industries which deposit industrial waste in fresh water
- limiting the fishing season to allow fish to spawn.

The conservation of water resources

In Zimbabwe, as a result of the 1998 Water Act and the establishment of the Zimbabwe National Water Authority (ZINWA), the following principles guide the use and management of water resources:

1. Users have to obtain permits for activities relating to the commercial use of water (apart from domestic uses such as drinking, cooking and washing). The state owns all surface and underground sources of water, and therefore the government, through ZINWA, grants permits to those who want to use water for irrigation, recreational, industrial and other commercial uses.
2. Water is managed through catchment areas and not administrative boundaries. The country has seven **catchment areas**. A catchment area is run by a catchment council, which has sub-catchment councils beneath it. This arrangement enables people interested in the use of water to participate at these two and other levels and to thus take part in making decisions about the use of water in their catchment areas.
3. The environment is seen as a user of water which competes with other users such as farmers, industrialists, miners and individual consumers of water. High water quality has become increasingly important and, as a result, the polluters of water have to pay for the damage they cause. This is called the 'polluter pays' principle.
4. Water is regarded as a commercial good, which has money value. Water is not regarded as a free gift. This requires that the user pays for the water according to the 'user pays' principle. The combination of 'polluter pays' and 'user pays' approach recognises that water has both economic and environmental importance. This approach is termed the 'Blue Revolution,' as it combines the economic (red) use and the environmental (green) value of water and also that water is generally represented as the colour 'blue'.
5. The government, under the Water Act, has the duty to ensure that water prices charged to individual consumers are affordable.



MAR'S	$10^9 m^3$
into Kariba	4.4
into Cohora Bassa	2.8
into Lower Zambezi	4.4
to Beira	1.0
to Save	6.0
into Limpopo	1.2
into Makgadiikgadi	0.2
TOTAL for Zimbabwe	20.0

Figure 4.3 Zimbabwe's water catchment areas

Activity 3

1. There are various ways of conserving water resources. At a local level, these measures include:
   - preventing water pipe leakage by doing repairs and not leaving taps on
   - sharing bath water
   - watering plants with used water
   - harvesting rainwater through the use of tanks.

   List 10 other actions you can take to conserve water.

2. On a large scale, water is conserved through:
   - building dams
   - digging wells and boreholes
   - instituting water conservation education and awareness campaigns
   - adopting farming systems, such as hole planting, mulching and ploughing, that conserve moisture.

Do research and make notes on each of the approaches above, using the following table:

Table 4.2 Water conservation

Method and examples	Advantages	Disadvantages
Dams		
Boreholes		
Wells		
Mulching		
Winter ploughing		
Awareness campaigns, etc		

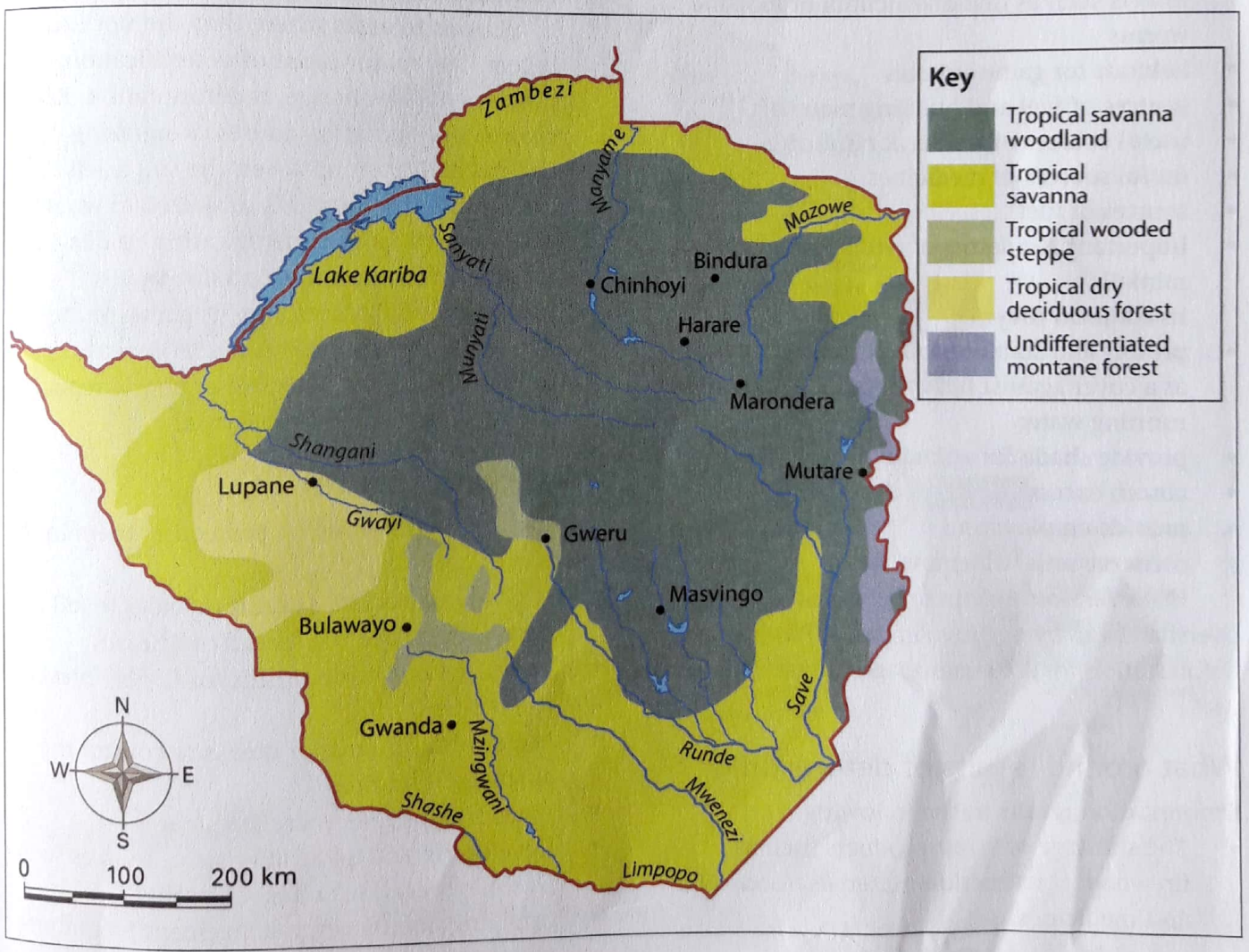


Figure 4.4 The distribution of forests in Zimbabwe

The conservation of forests

Forestry may be regarded as a relatively small sector of the economy of any country, but its products are extremely useful to humankind. The things we obtain from forests include resources such as wood fuel for our homes and industries, wood for furniture making, building material, paper used in schools and elsewhere.

Figure 4.4 shows the distribution of forests in Zimbabwe.

The importance of forests

Forests and forest plantations are important in a number of ways. They are:

- scenic attractions which are ideal for tourism (aesthetic value)
- sources of food such as fruits, edible roots and insects such as madora/mcimbi or mopane worms
- habitats for game animals
- sources of fuel and building materials
- useful sources of timber for industries
- useful sources of medicines
- sources of fuel
- important regulators of temperature and rainfall.

In addition they:

- protect and stabilise soils because they act as a cover against heavy rainfall, winds and running water
- provide shade for animals
- absorb excessive carbon dioxide
- provide employment
- conserve soils, water and trees.

However, some of these benefits are being overshadowed by negative impacts that include deforestation for settlement, agriculture and other uses.

What are the results of deforestation?

Deforestation results in the following:

- The shortage of forest products such as firewood, construction materials, foodstuffs and medicines.
- Women spend a great deal of time fetching firewood at the expense of other household chores.
- A loss of biodiversity, that is, reduced variety of wild animals and plant species.
- Increased incidents of landslides and soil erosion because the topsoil is now uncovered and can be easily moved by running water or wind.
- Rainfall is reduced and droughts become common because the evapo-transpiration rates are also reduced.
- Trees are vital absorbers of carbon dioxide; they are referred to as carbon sinks. If the carbon dioxide is not absorbed, the atmosphere will have high temperatures and will therefore be unpleasant to live in. Plants will not survive due to this greenhouse effect.
- Desertification is the spread of desert conditions to areas where they did not exist before. The major cause of desertification, besides climate change, is deforestation. Rapid growth of population causes overgrazing and overcultivation. When the soil is left uncovered, the topsoil is subjected to wind and water erosion. Desertification results in reduced food production due to less productive soil. Increasing global warming, due to desertification, results in increasing drought incidents. This subsequently reduces the capacity for food production.

Protecting forests

Forests can be conserved by protecting them in the following ways:

- spraying insecticides and fungicides to kill pests and reduce the spread of diseases
- using lookout mechanisms for fires to prevent forest fires
- building fire guards or breaks to control the spread of veld fires
- educating people to use forests wisely
- developing and using alternative sources such as solar energy, which is renewable
- applying good forest management techniques to stop overuse of forests.

Activity 4

1. A number of problems are associated with the commercial exploitation of forests. What are these problems? Discuss these with a partner.
   Here are **some** clues:
   - fungi, insects, strong winds, fires, the axe
   - transport, diseases affecting people
   - scattered trees, humid and hot conditions
   - soil erosion, equipment, the impact on ecosystems, the loss of biodiversity
   - disrupting local people's lives, the loss of agricultural land, resettlement, the depletion of forests
   - bulky trees, problems with environmentalists
   - forest penetration, reduced rainfall amounts.
2. How would you solve the problems you mentioned above? With the same partner, discuss your solutions.

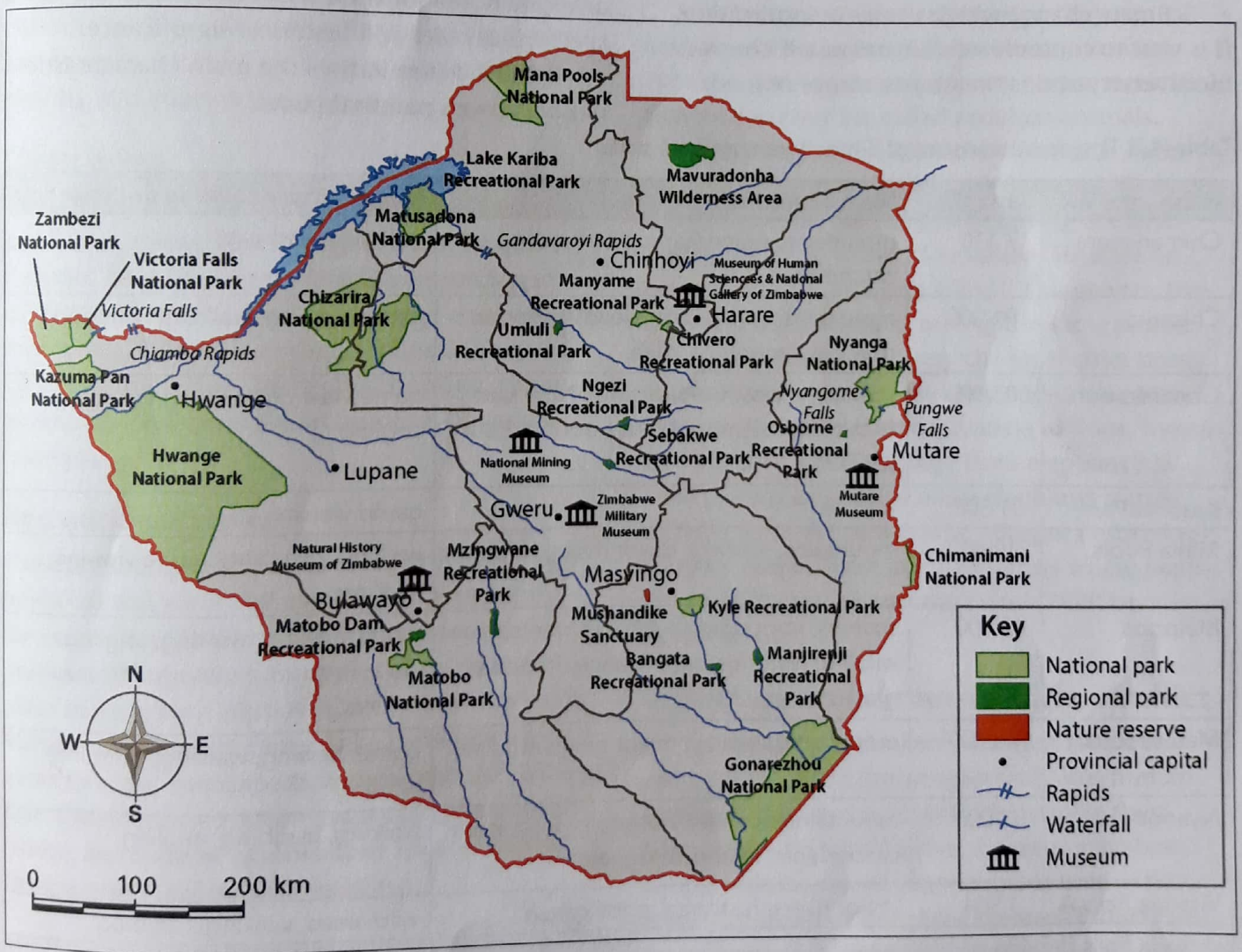


Figure 4.5 The Parks and Wildlife Estates of Zimbabwe

Wildlife management

Wildlife refers to plants and animals found in the wild and which are not domesticated. Wildlife faces increasing threats from the growing population. The loss of wildlife may be very rapid if unchecked and is estimated at almost one species per day. The major causes of wildlife losses are:

- poaching due to uncontrolled hunting and trapping
- the uncontrolled collection of rare species of plants and animals
- tree cutting which reduces the habitats for animals
- the spraying of crops with pesticides which endangers other species
- climate change which causes desertification.

It is vital to conserve wildlife because it ensures **biodiversity** and is therefore a source of food, medicines and many other products we need. Conservation also ensures that endangered species are safeguarded.

Types of wildlife management

The Parks and Wildlife Estates cover almost 5 million hectares, which is almost 12,7% of the country. Six categories of land use have been identified. These are national parks, botanical reserves, botanical gardens, sanctuaries, safari areas and recreational parks. Let us look at the characteristics of each of these areas.

National parks

There are 11 national parks in Zimbabwe, which cover 2 703 900 ha (6,8% of the country). These areas are noted for their wild animals, scenic views, spectacular relief and historical significance.

Table 4.3 summarises the main characteristics of Zimbabwe's national parks.

Table 4.3 The characteristics of Zimbabwe's national parks

Name of park	Area (ha)	Main attributes	Main visitor activities or attraction
Chimanimani	17 110	mountains, scenery, important river catchments	walking, climbing
Chizarira	191 000	mountains, spectacular views, important river catchments, wildlife	game viewing, walking, climbing
Gonarezhou	505 000	scenery, major rivers, wildlife. Now part of the Great Limpopo Transfrontier Park (GLTFP)	game viewing, walking, climbing, angling
Kazuma Pan	31 300	wildlife	game viewing
Mana Pools	219 600	mountains, scenery, major rivers, wildlife	walking, climbing, game viewing, angling
Matopos	42 400	scenery, important river catchments, wildlife, historical significance (Rhodes' grave)	game viewing, walking, angling
Matusadona	140 700	mountains, scenery, major rivers, wildlife	game viewing, walking, climbing, angling
Nyanga	33 000	mountains, scenery, waterfalls, important catchments, historical significance	walking, climbing, angling
Victoria Falls A	1 904	major rivers, historical significance	wild areas, walking, climbing
Victoria Falls B	436	waterfall	scenery
Hwange	1 465 100	spectacular wildlife	game viewing, walking
Zambezi	56 010	scenery, major rivers, wildlife	game viewing, walking, climbing, angling

Botanical reserves, botanical gardens and sanctuaries

Botanical reserves are important for the protection of individual species of plants and animals. Botanical gardens are especially managed to preserve indigenous species. Examples include Bunga Reserve for mountain forests (Chimanimani Forest), Chisekera for mangrove ferns, and Sebakwe I, II, III for Acacia Karoo, Great Dyke flora and Mountain Acacia respectively.

Sanctuaries are areas where animals are protected. These include Chimanimani Eland that is 1 800 ha in area for the protection of eland. Mbadze Pan has an area of 40 ha and is a bird sanctuary on an oxbow lake of Shangani River. Nyamanetsi Sanctuary is 2 480 ha and is characterised by Great Dyke flora, and Tshabalala Sanctuary is 1 100 ha in size and is used for game viewing and educational purposes.

Safari areas

These areas are set aside for recreational hunting and the cropping of wild populations. Examples include Zhete (hunting, crocodile research and university research), Dande (hunting and outdoor recreation), Doma (hunting), Malipati (limited safari hunting), Sapi (individual hunting, canoe safaris) and Tuli (individual hunting, botanical reserves).

Recreational parks

These are found where natural features have been preserved and protected to maintain biological diversity. They develop close to dams for the purposes of recreation. Examples of recreational parks include the Chinhoyi Caves where the main features are dolomite caves, Lake Kariba for angling, game viewing, water sports and commercial fishing, Lake Chivero for outdoor recreation, commercial fishing and fisheries and Sebakwe for commercial fishing, some angling and yachting.

Activity 5

Debate this statement: 'Tourism helps with wildlife management.'

Human and wildlife conflict

Human-wildlife conflict refers to the interaction between wild animals and people and the negative impact on people or their resources or wild animals or their habitat. As human populations expand and natural habitats shrink, people and animals are increasingly coming into conflict over living space and food.

In most parts of Africa, wildlife is under increasing pressure from poachers and hunting, as well as from grazing, agriculture, mining and expansion for settlement. The most endangered animals include the elephant and the rhino. Other animals under threat include the impala, rabbits, zebra, the sable, the cheetah and the leopard.

Some animals are dangerous as they can kill humans. Other animals do not harm humans, but they damage crops, property and sometimes livestock so they are called problem-animals.

According to the Zimbabwe National Parks and Wildlife Authority, 27 people were killed by wild animals across Zimbabwe during the first quarter of 2015, while 15 sustained injuries. In revenge attacks, villagers killed 12 elephants, five lions and 10 crocodiles, during the same period.

In one communal area, the local chief states that people in his area had lost 640 cattle, 420 goats, as well as pigs and chickens to lions, hyenas and baboons. Crop damage from elephant has been particularly severe since elephants started moving from the park to the villages, destroying people's crops. There are many areas where people have not harvested anything since 2009 because of the elephants.

Solutions to human-wildlife conflict

An important aspect of any solution is that it must benefit both the animals and local human communities, and must actively involve these communities. In Zimbabwe, a community-based wildlife management programme is used, which is the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE). Wildlife is managed by the people in the locality where it occurs. The proceeds from the management programme are used by the community to build

schools, clinics, roads, boreholes, hospitals, and so on. The community thus benefits in terms of money and therefore feels obliged to use their local resources in a sustainable manner.

CAMPFIRE

Zimbabwe's Communal Areas Management Program for Indigenous Resources (CAMPFIRE) is highly regarded in the conservation community. CAMPFIRE was initiated in 1988 to ensure that local communities benefited from hunting safari concessions operating in their area. It was designed to give control of wildlife management to rural communities so that they would invest in wildlife and habitat conservation.

Villagers work with government agencies to develop sustainable wildlife management programmes for their areas. Profits from the project are used for communal benefit or distributed to individual households at the discretion of the community.

The benefits of CAMPFIRE

CAMPFIRE contributes to job creation, empowerment and the diversification of livelihoods for rural communities. Some communities benefit from infrastructure such as clinics, schools, grinding mills, boreholes and roads.

The CAMPFIRE concept has helped eradicate extreme poverty and hunger by facilitating the creation of an enabling environment for pro-poor economic growth; creating employment opportunities; reducing dependence on rain-fed agriculture and increasing agricultural productivity. It has also developed projects that enhance food and nutrition security. The CAMPFIRE programme generates three primary benefits:

- It improves the livelihoods of rural people.
- It empowers rural communities to manage themselves, imparting the sense of self-confidence and self-dependence that has long been denied to them, at the same time removing this burden from government.
- It provides an incentive for rural communities to conserve wildlife.

The sustainability of CAMPFIRE

Between 1989 and 2004, the programme raised about US$30 million, which was channeled back into the communities. More recently, CAMPFIRE's impact on national income is at least US$10 million annually. If the multiplier on tourism activities is included, CAMPFIRE is worth US$20–25 million to Zimbabwe's economic income each year. Periodic contributions have also come from USAID, FAO, the Safari Club International Foundation and the Kellogg Foundation.

To date, 58 out of 60 administrative districts are part of the CAMPFIRE programme covering an equivalent area of 40–50,000km^2. The CAMPFIRE Association is a registered welfare organisation established in 1992 to lead the CAMPFIRE programme. The primary role of the association is to promote the management of wildlife and other natural resources for the benefit of producer communities.

Summary

- National resources need to be conserved so that they do not get exhausted and can be used by future generations. This can be done by educating people about the proper use of the environment. Legislation or laws can be used to guide people on the use of natural resources. In Zimbabwe the Environmental Management Act oversees the management of resources.
- Fish are important as a source of food, containing vital minerals such as calcium, iodine, magnesium, copper, iron and phosphorus.
- The main fishing ground in Zimbabwe is Lake Kariba where commercial fishing takes place. There are 130 fish species in Zimbabwe with kapenta, bream, mudsucker, tiger fish and barbel being the most common.

Glossary

environmental education – organised efforts that aim to teach people about environmental issues
erosion – the process of eroding or being eroded by wind, water, or other natural agents.
deforestation – the act of cutting down or burning forests and converting these areas into cleared land, or land for alternative use
biodiversity – the variety of plant and animal life in a given area

Topic test

1. Natural resources:
   - **A** can be used up
   - **B** recycle themselves continually
   - **C** have to do with money
   - **D** are the problem of the government
2. Erosion is caused by:
   - **A** too much rain
   - **B** too little rain
   - **C** a number of human-related and physical factors
   - **D** pollination
3. Name three human-related factors that can lead to erosion.
4. Name three physical factors that can lead to erosion.
5. The main fishing area in Zimbabwe is:
   - **A** Sinazangwe
   - **B** Lake Kariba
   - **C** Lake Chivero
   - **D** Mana Pools
6. Define deforestion in your own words.
7. Identify the problems caused by deforestation in Zimbabwe.
8. Identify three reasons why humans and wildlife come into conflict.
9. Name three possible ways of solving problems associated with human-wildlife conflict.
10. Based on what you have read about CAMPFIRE, provide motivation as to why the organsiation has been successful.

Topic 5 Energy and power

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Objectives

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

- explain how energy sources can be conserved
- analyse types of energy used and the conservation measures undertaken in your local area.

We need energy to do tasks such as ploughing soil, cooking food, travelling long distances, and constructing roads and buildings. There are different ways of producing the energy we need. In this topic, we examine different sources of energy and ways of conserving energy.

What is an energy source?

An energy source is material that is burnt to produce energy. Examples are oil, paraffin, coal, natural gas, wood, animal waste and uranium. Other examples are things such as the wind, tides, waves, geothermal power, solar power, biomass energy and animals that are used in a system to make energy.

What are the different sources of energy?

We can group the sources of energy into ten major groups, some of which will be covered in the sections that follow:

1. Solar energy is energy from the sun.
2. Wind energy is where wind power turns turbines that, in turn, power generators to produce electricity or mechanical machinery.
3. Geothermal power is energy that is produced from the hot rocks beneath the Earth. These rocks heat up the water that produces steam, which is used to turn turbines.
4. Hydrogen energy is the use of hydrogen gas from water as a fuel to power ships, vehicles, homes industries and rockets.
5. Tidal power is energy derived from the rise and fall of tides, mainly in coastal areas.
6. Wave energy is energy produced by the waves in the oceans and harnessed along coastal regions.
7. Hydro-electric energy is energy produced by the power of water. The water turns generators to produce electricity.
8. Biomass energy is energy produced by burning or using materials such as wood, charcoal, bagasse and animal waste, from plants and animals. This energy is used as fuel.
9. Nuclear power is energy produced by using uranium as a source of fuel to power generators.
10. Fossil fuel energy is energy produced by burning fossil fuels such as coal, oil and natural gas.

What is energy conservation?

Energy conservation refers to reducing or going without an energy service to help save energy or to help save the energy source. Energy conservation entails anything from turning off lights or shutting down appliances such as computers once a user is finished for the day, to driving less and cycling more in an effort to reduce the amount of fuel used.

Energy use can also be reduced by using energy efficiently. For instance, the tsotso stove produces more energy despite using a reduced amount of fuel source. An example of energy conservation in cold environments is when homeowners replace single-pane windows in their homes with energy-efficient double-glazed windows. The double-glazed windows prevent warm air from escaping in winter and cool air from leaking out during summer, thus reducing the use of electrical or gas heating and cooling systems.

Ways of conserving energy

We can save energy in many ways. Energy conservation does not necessarily require drastic steps. We can all reduce energy consumption by making small changes to daily habits, such as using public transportation or more efficient household appliances.

Some of the ways of conserving energy are as follows:

Buying modern products

Replacing old light bulbs with newer compact fluorescent bulbs can help conserve energy. Another way is to replace old appliances such refrigerators or washing machines with new high-efficiency models.

Adjusting appliance temperatures

Heating and cooling take a lot of energy, so turning down the heat for water heaters, dishwashers and washing machines by a few degrees helps a great deal.

Using alternative methods of transport

Driving a car consumes a large amount of energy, so switching to walking, biking or taking public transport can cut down on energy use. If you have to drive, it is best to try and share your journey with someone going in the same direction or using hybrid cars that use electricity and hydrogen gas.

Making home heating and cooling more efficient

Homeowners are aware that heating in cold weather and cooling in summer can be very expensive. Taking steps to improve home insulation and lowering home heating and cooling helps towards energy conservation.

Advocating for an environmental policy

All energy conservation measures are vital in our challenge to combat global warming. Voting and taking action to ensure lawmakers enact good energy policies is one way of ensuring that everyone is made aware of the need to conserve energy. Students, for example, can help with energy conservation by joining tree-planting and recycling clubs.

Activity 1

Write down recommendations you would make to your local authority to promote energy conservation in your area.

How public transport helps conserve energy

The use of public transport reduces the amount of gases and oils used. It also decreases carbon emissions and reduces traffic congestion. A light passenger vehicle can transport five passengers. However, a full 75-seater bus can carry the same number of people as 13-five seater cars.

Public transport includes city buses, trams, mini buses, passenger trains, underground trains, ferries, coaches, airlines, high-speed rail trains and intercity trains.

Research by the state of Delaware's Division of Waste and Hazardous Substances determined the following, with regard to commuting:

- A bus with a few passengers is more fuel-efficient than the average single-occupant car.
- The fuel efficiency of a fully occupied train car is 15 times greater than that of the average single-occupant car.
- In terms of energy consumption per passenger mile, a bus is more efficient.
- Buses use 8.7% less energy per passenger mile than a typical car.
- Commuter trains use 23.7% less energy per passenger mile than a typical car.

Activity 2

Create a poster for your local community showing the advantages of using public transport.

Renewable energy sources

Renewable sources of energy, such as energy from the sun (solar energy), the wind and hydrogen, are seen by many experts as the energy forms of the future. In addition to these renewable forms, it should be noted that tidal power and geothermal

power contribute to the energy needs in some parts of the globe.

Wind energy

Wind energy is generated through windmill blades that are turned by wind. The rotating wind blades are linked to turbines, which produce electricity. The windmills are also used to pump water for livestock and even for crop irrigation. Figure 5.1 shows a windmill.

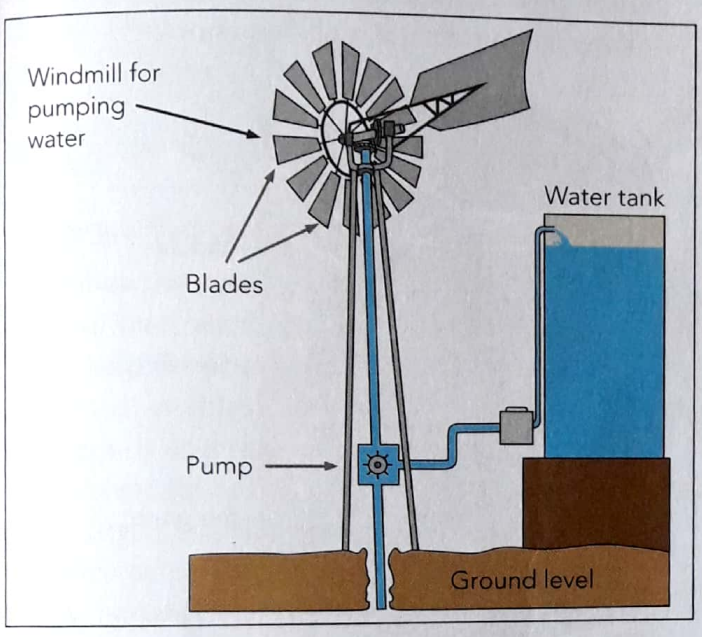


Figure 5.1 A windmill for pumping water

In developed countries such as the UK, the Netherlands and Germany, wind farms are common features. In Zimbabwe, wind speeds of 2 to 3 metres per second are too low to produce wind power successfully. To be effective, wind speeds must range between 3 to 6 metres per second. Table 5.1 summarises the advantages and disadvantages of wind energy.

Table 5.1 Advantages and disadvantages of wind energy

Advantages	Disadvantages
• It is a renewable and a clean energy source. • It is relatively cheap to maintain and run windmills.	• Wind farms are seen as ugly and spoil the natural scenery. • It can only be used in areas where great wind speeds are experienced. • It is a localised source of energy.

Biomass fuels

Biomass energy sources are derived from plants and animals. They include forms such as fuelwood, charcoal, plant residues such as bagasse and animal waste such as cow dung.

Fuelwood or firewood

Firewood is the most widely used source of energy in Zimbabwe, especially in communal and resettlement areas. The uses of fuelwood include:

- domestic uses such as cooking, heating and fish or meat smoking
- agricultural uses such as drying coffee, tea and tobacco crops
- brickmaking and limemaking.

The reasons why fuelwood supplies over 50% of the country's total energy needs, making up 6 million tonnes of wood per year, are that:

- it is reliable and affordable for low-income households
- it is an indigenous (local) source of energy which requires no foreign currency to import
- making charcoal and selling it is a source of income for many households.

The widespread use of firewood in urban and rural areas has many problems, such as the following:

- Deforestation increases. In turn, problems of erosion and siltation also increase.
- People need to travel long distances to get firewood. This is usually the work of women in rural areas. The long distances travelled mean that a lot of time is spent on this task and other jobs needing attention are left undone.
- Shortages of firewood are increasing, with the result that other less efficient and health-threatening alternatives are used. These may include the use of maize stalks and cow dung.
- Conflicts over firewood often arise when communal farmers 'poach' firewood from nearby commercial farming areas.

Solutions have been put in place to reduce the negative effects of deforestation and the fuelwood shortage. The following are some of the solutions:

- Carry out afforestation and reforestation programmes.

- Educate people about the importance of trees.
- Use alternative energy such as gas.
- Encourage the community to participate in national events, such as National Tree Planting Day.

Biogas

Biogas is a form of energy derived from biological waste, that is dead plants and animal waste. Decaying biomass materials, including sewage, can be a source of energy. A biodigester enables the solid biomass to be digested by bacteria to produce methane, which can then be used in a gas stove. Many institutions, including schools, have biodigesters and use biogas cookers to prepare meals.

Although the technology for the use of biogas is still to spread to many parts of the country, the major advantage of biogas is that it uses waste. It is also a renewable source of energy. The major disadvantage in the use of biogas is that methane (which is a greenhouse gas) is let into the atmosphere leading to temperature increases.

Ethanol is derived from sugar molasses. At Triangle, an ethanol plant produces this fuel. Ethanol is mixed with petrol to form blend petrol, which is 85% petrol, 14% ethanol and 1% benzole. Biofuel is also produced in the Middle Save – Chisunbanje area.

Other plant and animal waste

Crop residues such as maize stalks and animal waste such as dung, can be burnt to provide heat in the same way as firewood is used. Bagasse from sugar cane is used in the lowveld plantations to power thermal stations. Go back to the cartoon in Figure 3.1 and state the extent to which the situation shown is true in Zimbabwe.

Activity 3

1. Work in a group to make a list of the advantages and disadvantages of using cow dung and crop residues as forms of fuel.
2. Read the information about tsotso stoves and then answer the questions.

The tsotso stove is a fuel-efficient stove made from metal. It is a steel cylinder with a fire grate and a removable bottom grid made from wire. The cylinder has two handles. They are a cheap and efficient way of cooking and heating as you only need a few twigs to make a fire. This helps to conserve wood and prevents deforestation. They also reduce the time that people need to gather firewood. Tsotso stoves help to protect families from respiratory diseases, because they make less smoke.

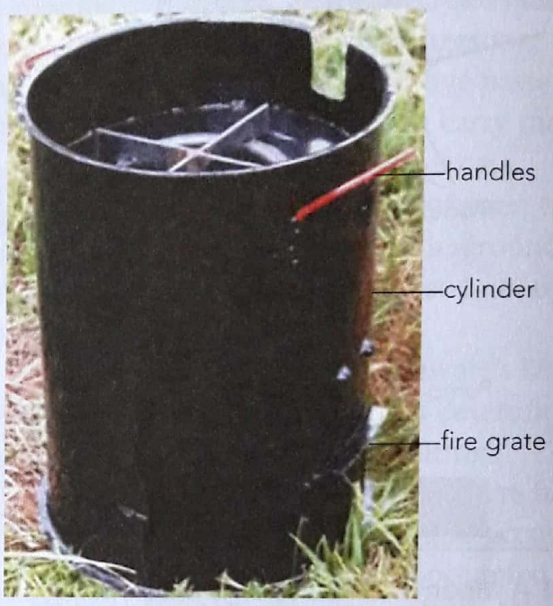


Figure 5.2 A tsotso stove

a) Describe a tsotso stove.
b) How do they help to conserve forests?
c) What are the advantages of using a tsotso stove?

Hydroelectric power (HEP)

Hydroelectric power (HEP) is energy produced by falling water such as behind a dam wall or in a waterfall. Figure 5.2 shows a hydroelectric power station using dam water. The inclined tunnel called the **headrace** or **penstock** is built through the dam wall. This enables the water to fall down forcefully. The falling water acts in the same way as high steam pressure does in a thermal power station. The water turns the turbine, which turns the generator to produce electricity. The electricity is then carried from the substation through cables to consumers.

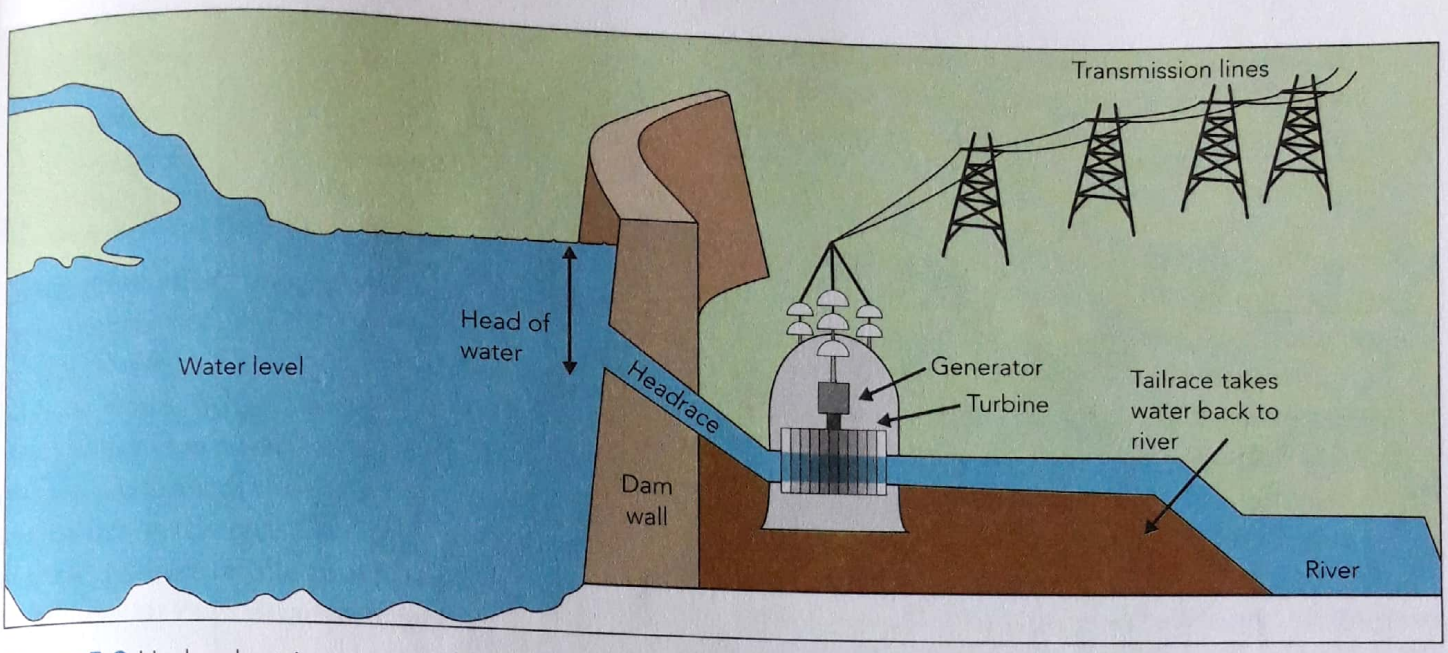


Figure 5.3 Hydroelectric power station

The following conditions are necessary for the siting of hydroelectric power stations:

- A large **head of water** (as shown in Figure 5.2), which enables the water to flow swiftly. A high dam or waterfall meets this condition.
- A plentiful or continuous supply of water from a large dam, natural lake or a perennial river such as the Congo River.
- A narrow, deep gorge across, which a dam wall can be built. Such a gorge enables large amounts of water to be stored and the dam wall to be built across a short distance, thereby reducing the costs of building.
- The availability of a large market for the use of electricity. For example, when Kariba Dam was completed in 1960, it supplied power mainly to urban areas in Zimbabwe and the Copperbelt area in Zambia.
- A large amount of capital for the initial cost of building and the maintenance of the power plant.
- The area in which the dam is built should be of hard rock to form a firm foundation for the dam water. There is a need for forested catchments or slipstream areas in order for the dam to be as free as possible from erosion, such as through cultivation, as this leads to the siltation of the dam.

The Zambezi hydroelectric power stations

The Kariba Dam, built between 1956 and 1959 opened in 1960, was one of the largest human-made lakes at the time. The Kariba Dam can hold up to 180 000 000 cubic metres of water, of which 40 million cubic metres is useful for power production.

At Kariba, the north and south bank power stations, serve Zambia and Zimbabwe respectively. Each power station has a capacity of over 600 MW. The factors that led to the opening of the Kariba power station include the following:

- the Kariba gorge
- the market for electricity in Zimbabwe and Zambia. Most markets were within 300 km for easy transmission of hydroelectric power without too much loss
- a large volume of water was available, which ensured a continuous supply
- the geology of the area is generally made up of solid rock, providing a firm foundation.

The Kariba power station also led to the opening up of the Zambezi Valley, which was largely inaccessible and disease-prone. Other activities and developments such as the establishment of Kariba town as a fishing industry and tourist resort accompanied the construction of the Kariba hydro-electric power station.

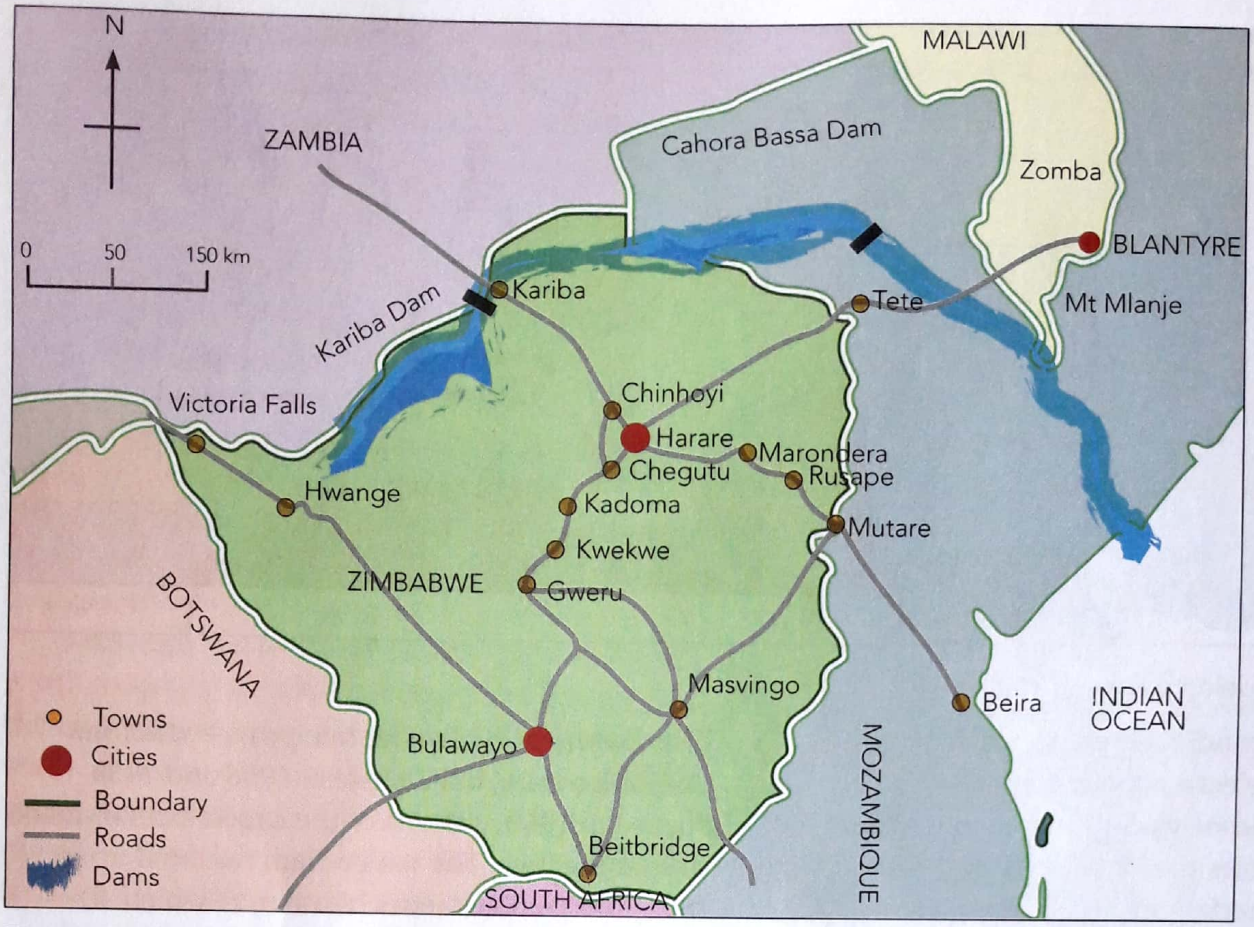


Figure 5.4 The Kariba and Cahora Bassa schemes

The development of the Kariba power station and dam has had some problems. These include:

- the displacement of over 50 000 Tonga people from the Zambezi Valley on both sides of the river
- flooding of plants, animals and heritage sites (however, when Lake Kariba filled up, Operation Noah was organised to rescue more than 4 700 animals and life forms from the rising waters)
- the filling up of the dam led to tremors as the surrounding land adjusted to the added water mass. Increased water intakes, especially in wet seasons, also result in tremors related to the ground adjusting to the changed weight. These tremors have been common in the Zambezi Valley
- frequent droughts reduce water intake, limiting power production
- the construction of a water body such as Lake Kariba resulted in the increased incidence of waterborne and water-related diseases such as bilharzia and malaria.

Other hydropower plants on the Zambezi

The Zambezi River has the potential to produce 20 000 MW of power. But of this, only 4 684 MW has been harnessed. The Cahora Bassa power station in Mozambique is the other major power plant on the Zambezi with a capacity of over 2 000 MW. It was completed in 1975. It is the largest hydropower plant in the SADC region, followed by the Inga Scheme on the Congo River in the Democratic Republic of Congo (DRC). Zimbabwe and South Africa are the major users of Cahora Bassa power. Refer to Figure 5.3 and the colour map for the location of the Kariba and Cahora Bassa schemes.

Table 5.2 shows some of the potential hydroelectric power sites on the Zambezi that Zambia and Zimbabwe could develop jointly.

Table 5.2 Potential hydroelectric power sites for Zambia and Zimbabwe

Potential site	Capacity (MW)
Mutapa Gorge	640
Batoka Gorge	1 600
Devil's Gorge	1 600
Victoria Falls	300

Activity 4

Using your school atlas, draw a diagram of the Zambezi River to show the established and potential hydroelectric sites.

Environmentalists are concerned about the establishment of dams for hydroelectric production as dams would flood a lot of valuable land. At times, floods chase wildlife away and damage heritage sites. The Cahora Bassa Dam disturbed processes downstream such as delta formation on the coast. So, the establishment of these stations, while providing much needed power, has its own disadvantages.

Other potential sites in Zimbabwe

Many potential sites exist in the Eastern Highlands at places such as Duro in Honde Valley, on the Mutarazi Falls in Nyanga and along the Save and Limpopo rivers. At Risutu, an independent power producer operates a small HEP station, while at Gaerezi in the Tangwena area a small potential hydroelectric power generator is in operation.

Solar energy

Solar power is energy from the sun. It is the ultimate source of energy for the earth. Obtaining it involves tapping sunlight using solar panels or photovoltaic cells which convert and store solar power into usable electricity or heat energy. The photovoltaic cells enable energy to be available even at night.

In 1996, the World Solar Energy Summit was held in Zimbabwe. Thereafter, the Global Environment Facility (GEF) solar energy project, which promotes the use of solar energy, established over 10 000 solar energy units in the rural areas of Zimbabwe. Table 5.3 summarises the advantages and disadvantage of solar energy.

Solar energy, like wind energy, is said to be the energy of the future. It is forecast that in 15 to 20 years' time, photovoltaic cells will be small and cheap enough to compete with fossil fuels.

Table 5.3 Advantages and disadvantages of solar energy

Advantages	Disadvantages
It is renewable. It is non-polluting/environmentally friendly. The use of solar cookers reduces deforestation. The sun shines almost all day (in Zimbabwe, solar panels are mostly placed in a north-facing direction because the sun takes a mostly northerly route, especially in winter). Deserts and other uninhabited areas can be used for solar energy production. It can be stored and used at night (appliances such as solar energy TVs are now usable in rural areas). Satellite forms of trapping and delivering solar energy by microwave are possible. It is estimated to reduce urban energy costs by 40%.	Solar components and installations are expensive for the ordinary household. Equipment that is adapted to solar energy, such as the parabolic solar cooker, is bulky and complicated, needing further adaptation. The sunshine hours vary from place to place and the intensity of sunshine varies with the seasons. Areas of the greatest solar energy supply are usually remote deserts or the tropics, which are least in need of such energy.

Geothermal energy

Geothermal energy is energy derived from volcanic areas such as hot springs. Geothermal heat is generated from hot rocks underground. These hot rocks heat the water above them, turning it into steam. The steam is tapped by drilling wells through the rock to the steam reservoirs. The steam is directed to turbines, turning them to produce electricity by processes similar to those of other hydroelectric and thermal power stations.

The advantages of geothermal energy are that it:

- is freely available
- is a continuous energy resource
- leads to little or no pollution in the generation of electricity.

The major disadvantage of geothermal energy is that it is limited to a few areas or countries, such as Iceland and active volcanic areas.

Tidal energy

Tidal energy is produced by tapping the water brought onto the coast during high tides. The water is channelled through turbines, which produce electricity as they turn generators. Like geothermal energy, this energy type is renewable and non-polluting but it is restricted to coasts with high tides and countries with technological knowledge. In France, some power stations have been built to tap tidal power.

Hydrogen cells

Hydrogen cell energy burns hydrogen molecules as a fuel to power vehicles. Although this process is still new, it is believed that in future clean hydrogen extracted from water will replace oil as a fuel for vehicles. This would ensure more or less endless forms of fuel which are non-polluting when compared to current petroleum-based fuels.

Animal power

Domesticated animals such as cattle, donkeys, horses, camels, mules, water buffalo and even dogs – are used to provide **draught power** in transport (pulling carts and sledges) and in tilling fields. In Zimbabwe, ox and donkey power is widely used for transport and agricultural tasks. The bar graph in Figure 5.4 shows the average load carried by selected animals.

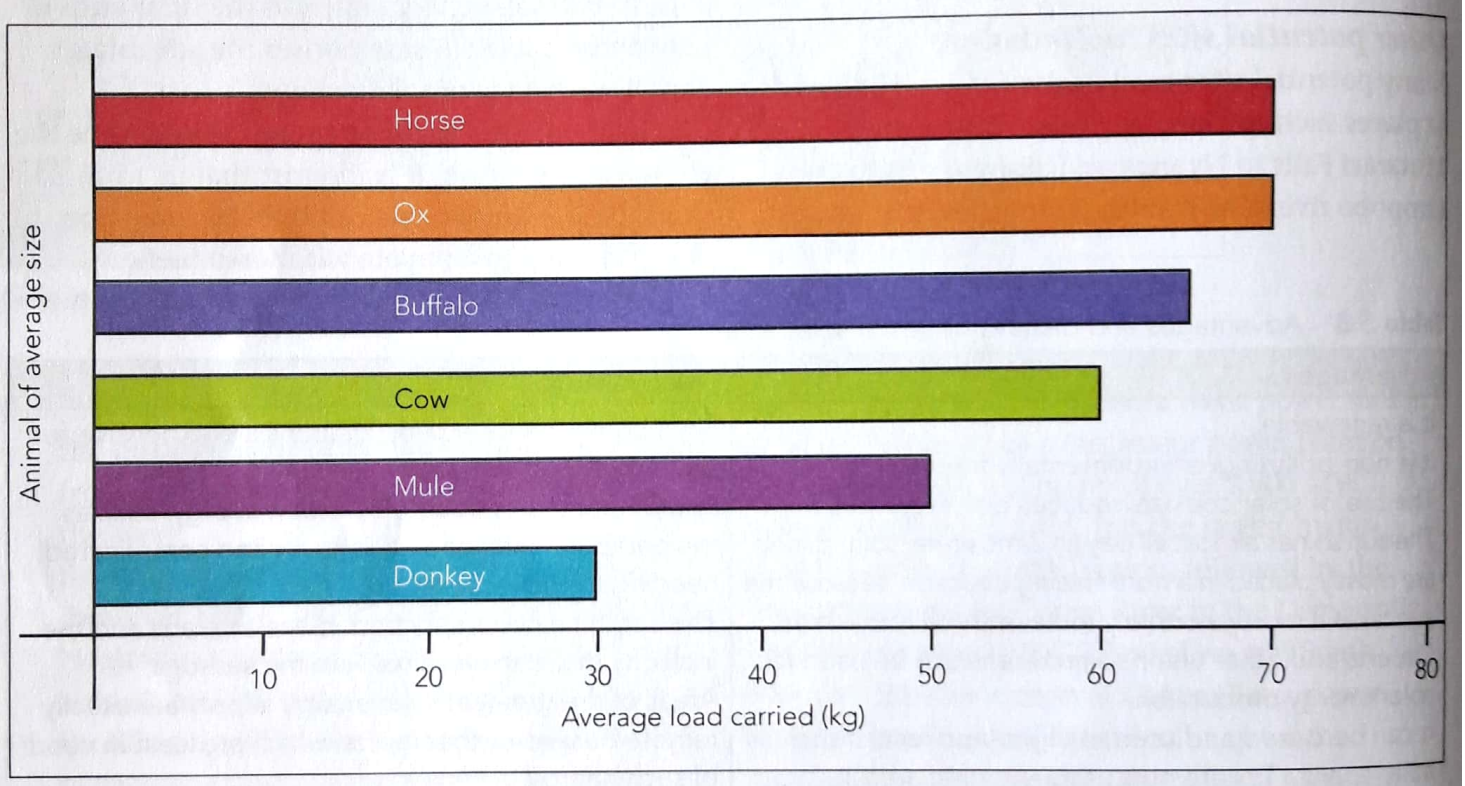


Figure 5.5 Loads that different animals can carry

Activity 5

Use the information in the bar graph in Figure 5.4 to describe the work done by the various animals.

The use of draught animals such as cattle and donkeys has advantages and disadvantages for the individual farmer or user. They have the following advantages:

- Draught animals are easily available to most households.
- They are suited to work on small plots and on bad roads or pathways.

However, its disadvantages are the following:

- Heavy work cuts short an animal's lifespan.
- Compared to tractors and mechanised farming, animal power is slow.

Project

With the help of your teacher, form a Conservation Club.

The aims and objectives of your club are as follows:

- To research and produce a list of energy sources in your local area.
- To come up with a list of problems associated with these energy sources.
- To document and highlight energy conservation in your local area.
- To list the contributions of the local authority towards energy conservation.
- To assess the effects of energy production in your area.
- To come up with proposals on how energy conservation can be done at your school.

Your Project Document should be supported by pictures, drawings and video/DVD clips. You will present your findings at a school assembly.

Summary

- Energy is the force propelling people, animals and machines to do work. Power is the amount of energy used or applied.
- Fuels are substances such as wood, coal, gas, plant waste, petrol, diesel and paraffin that are burnt to produce heat or light. Electricity from fossil fuels is called thermal energy.
- Renewable energy forms are inexhaustible in that they can be used continuously. Non-renewable energy forms get finished and include fossil fuels such as coal, oil and gas.
- Hwange is the leading coal-powered thermal plant in Zimbabwe. To produce thermal electricity, coal is burnt to produce steam. The steam turns turbines that turn generators to produce electricity.
- Kariba South Hydro Power Plant is the leading source of hydroelectric power (HEP). Hydroelectric power has the advantage over coal thermal power of being clean, non-polluting, and renewable, and of having low running costs. However, the building of dams for hydroelectric power has negative effects that include the displacement of people and animals, the destruction of life through flooding, the increased frequency of Earth tremors and the high incidence of waterborne and water-related diseases.
- Rural electrification has widened the power grid to rural areas resulting in rising standards of living through the provision of power and light for commercial, agricultural (irrigation), industrial and domestic activities.
- Biomass fuels are fuelwood, biogas and plant and animal waste. Firewood is by far the most widespread form of fuel in rural areas. Its use has led to problems of deforestation, siltation and erosion, which could be minimised by the use of efficient stoves, other power alternatives, afforestation and reforestation. Animal draught power is an important source of energy in Zimbabwe.
- Newer energy forms such as solar and wind energy are called the energy of the future. Their main advantage is renewability. However, the technology for their use is not widespread, especially in developing countries. Hydrogen fuel is another energy form that is gaining popularity. Other forms of renewable energy such as geothermal and tidal energy are less common.

Glossary

bagasse – waste from sugar processing used as fuel
commercial energy types – sources of energy that are bought and sold, for example, electricity and liquid fuels
draught power – the pulling power of yoked or harnessed animals such as bullocks, horses and donkeys
electricity – power derived from moving charged particles, which is used for lighting, heating and mechanical processes
energy – force that gives people, animals and machines the ability to do work
fuel – a substance that can be burnt to provide energy in the form of heat that can be used in a mechanical or electrical form to perform work
fossil fuel – organically-derived substances such as coal or petroleum (hydrocarbons) burnt to produce heat
head of water – the vertical drop through which water has to fall to flow fast and turn the turbines in hydro-electric power plants
infinite – that which does not get finished; inexhaustible or renewable
liquid fuel – fuel such as petrol, paraffin and diesel
penstock or headrace – tunnels that lead water to turbines in an hydroelectric power plant
power utility – an establishment or company such as ZESA Holdings, SNEL (DRC), ZESCO (Zambia) or EDM (Mozambique) responsible for the generation, transmission and distribution of electricity in a country
power outage – power cuts due to load shedding, faults or maintenance work
tailrace – tunnels that lead water from the turbines in a hydroelectric power plant back into the river
turbine – a machine with fan blades that rotate as they are hit by water or steam

Topic test

1. Which of the following is a biomass fuel?
   A bagasse
   B oil
   C hydrogen cell
   D coal
2. In HEP plants, the head of water is:
   A the height of the dam wall
   B the height between the water reservoir and turbines
   C the distance across the dam wall
   D the distance of the penstocks
3. As a member of a rural household, which would you recommend as an affordable form of power?
   A thermal
   B nuclear
   C hydroelectric
   D a biodigester
4. Which of the following contains renewable energy sources only?
   A hydroelectric, solar and coal
   B wind, oil and nuclear
   C geothermal, tidal and gas
   D solar, tidal and wind
5. Study the illustration in Figure 5.5
   a) List the sources of energy and their use as shown in the illustration.
   b) Classify the energy sources into renewable and non-renewable forms.
   c) How similar and how different would an urban family be in its use of energy compared to the rural family in the illustration?
6. **a)** List three different fuels used in producing electricity in power stations in Zimbabwe.
   b) **i)** Say what wind power and solar power are used for in Zimbabwe.
   ii) Why is the use of solar power limited in Zimbabwe?
   c) **i)** Name the commercial, domestic and agricultural use of fuelwood in Zimbabwe.
   ii) Describe two problems and their possible solutions associated with the use of fuelwood.
7. List three measures that can be taken to minimise the effects of electricity shortages.

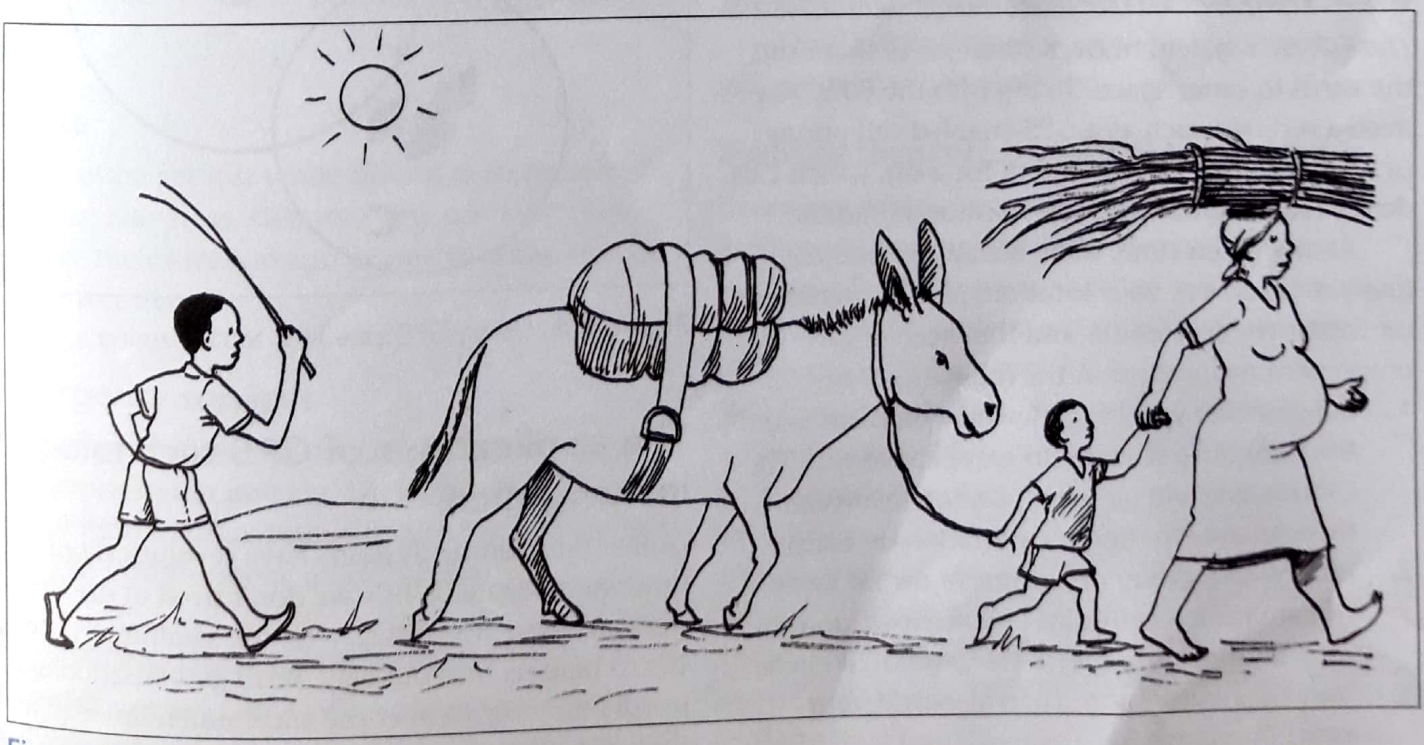


Figure 5.6

Topic 6 Mapwork and Geographical Information Systems

Objectives

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

- explain the concept of GPS
- apply GPS technology in navigation
- calculate time using longitude
- describe the concept of light as a wave
- explain the visible wave bands of the electromagnetic spectrum
- apply the electromagnetic spectrum in the interpretation of photographs.

In the past, navigators used the stars to determine where on Earth they were. Today, with advances in technology, we can use cell phones and car-tracking devices to make use of Global Positioning Systems (GPS). These systems determine our location using satellites. In this topic, we find out about using GPS. We also learn how to calculate time using longitude and about the electromagnetic spectrum.

The Global Positioning System and world time zones

The GPS is a system of over 30 satellites that orbit the earth in outer space. To tap into the GPS, you need a receiver such as a GPS-enabled cell phone or a satellite navigation system for a car, which can detect radio signals that the satellites broadcast.

At any given time, there are approximately four satellites over your location, almost anywhere on Earth. These satellites and the receiver can pinpoint your location in the following ways:

1. Imagine that you are somewhere on Earth and there are three satellites in space above you. The GPS receiver will use your position relative to these satellites to find your location on Earth.
2. First, your receiver determines how far away you are from Satellite A. This narrows down your location to somewhere in the first circle.
3. Your GPS receiver can then also find your location relative to Satellites B and C.
4. Your location is where the three circles overlap.

Bear in mind that this process happens in three dimensions, so the circles are actually three-dimensional spheres being used to determine your location.

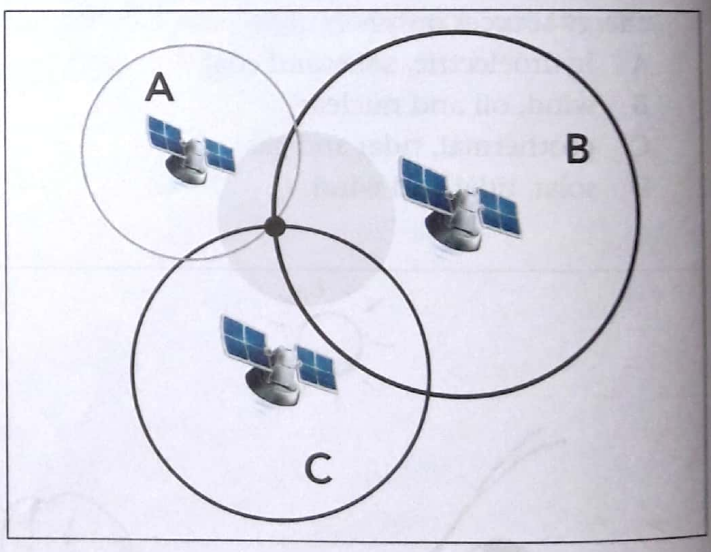


Figure 6.1 Using GPS satellites to determine a location

The applications of GPS technology in navigation

Global Positioning Systems have revolutionised how we navigate. While we don't need to use the stars anymore, we still rely on the satellites in the sky to help us find our way. With globalisation and people moving all over the earth much faster than they did in the past, GPS technology has a wide range of applications.

In everyday vehicles

Many people have hand-held or built-in GPS receivers in their cars. These can be programmed to talk to the driver while they drive, making it easier to find a destination. This helps the driver to pay better attention to the road and find where they need to be quicker.

Figure 6.2 A GPS device used to navigate in vehicles

In aeroplanes and ships

GPS technology allows anyone with a receiver to pinpoint their speed and position on land or sea with a high degree of accuracy. This has helped make it much easier for pilots and sea captains to navigate.

Hikers

People often get lost while hiking in mountains or in unfamiliar areas. GPS receivers can help them identify their location and ensure that they are on the correct route.

Emergency services

Emergency services can use GPS to locate emergency scenes quickly. They can then also send the location to other responders in the area so that they can find the scene quickly, too.

Monitoring geological activity

Scientists can use GPS to monitoring geological activity such as earthquakes and volcanic activity.

Activity 1

1. Explain in your own words how a GPS works.
2. Describe any two applications of the GPS.
3. Write a short paragraph describing how you have used GPS or would use it to make your life easier.

Time

The world's time is based on the Greenwich Meridian, which is **Greenwich Mean Time** (GMT). Due to the rotation of the earth from west to east, people in the east are always more ahead in time than people in the west. For every 15° east of Greenwich, one hour is added to GMT because the earth turns through 15° every one hour and for every 15° west of Greenwich, one hour is deducted from GMT.

Every 24 hours, the earth will rotate through 360°. In one hour, the earth rotates through 15°. If we divide 60 minutes (1 hour) by 15°, we will see that the world rotates by 1° every four minutes. For example, the time at a place 1° east is 12h04 if the GMT is 12h00 and the time at a place 1° west is 11h56. The time at a place 15° east is 13h00 and the time at another place 15° west is 11h00.

Only places along the same line of longitude will experience the same time.

Calculating time using longitude

Travelling from one area to another involves changes in time. If you travel east or west, you are bound to be moving ahead or behind in time, respectively. To understand this, it is necessary to refer to longitude and the earth's rotation. The Earth rotates from west to east through 360° of longitude in 24 hours. This translates to 15° of longitude travelled in one hour. If we divide 60 minutes (1 hour) by 15°, we will see that the world rotates by 1° every four minutes. In other words, 1° of longitude is covered in four minutes. Given places on different longitudes, time is ahead at places in the east and behind at places in the west. The longitude of London and Accra is

taken as 0° and is called the prime or **Greenwich Meridian** (named after the point it passes through in London). The world's time is based on the Greenwich Meridian, which is the **Greenwich Mean Time** (**GMT**). Thus, a place that is 15° east of London has time that is one hour ahead, while a place that is 15° west is one hour behind. Therefore, if the local or sun time for London is 12h00 (noon), places 1° west of London have a local time of 11h56, while places 1° east of London have a local time of 12h04; and places 15° west of London have a local time of 11h00, while for those 15° to the east, the time is 13h00.

Due to the fact that countries may cover several degrees of longitude along their east-west breadth, there was need to divide the world into time zones, which are broad longitudinal zones in which there is the same or standard time. If two people were to move from Greenwich, one eastwards and one westwards, at the same speed and gaining and losing time respectively, they would eventually meet on the 180° longitude. However, the one moving eastwards would be 24 hours ahead of the one moving westwards.

International agreement has mandated that a day starts for places to the east and a day ends for places to the west along the 180° longitude. The 180° longitude has been called the **International Date Line** (IDL). The map in Figure 6.3 shows the position of the IDL.

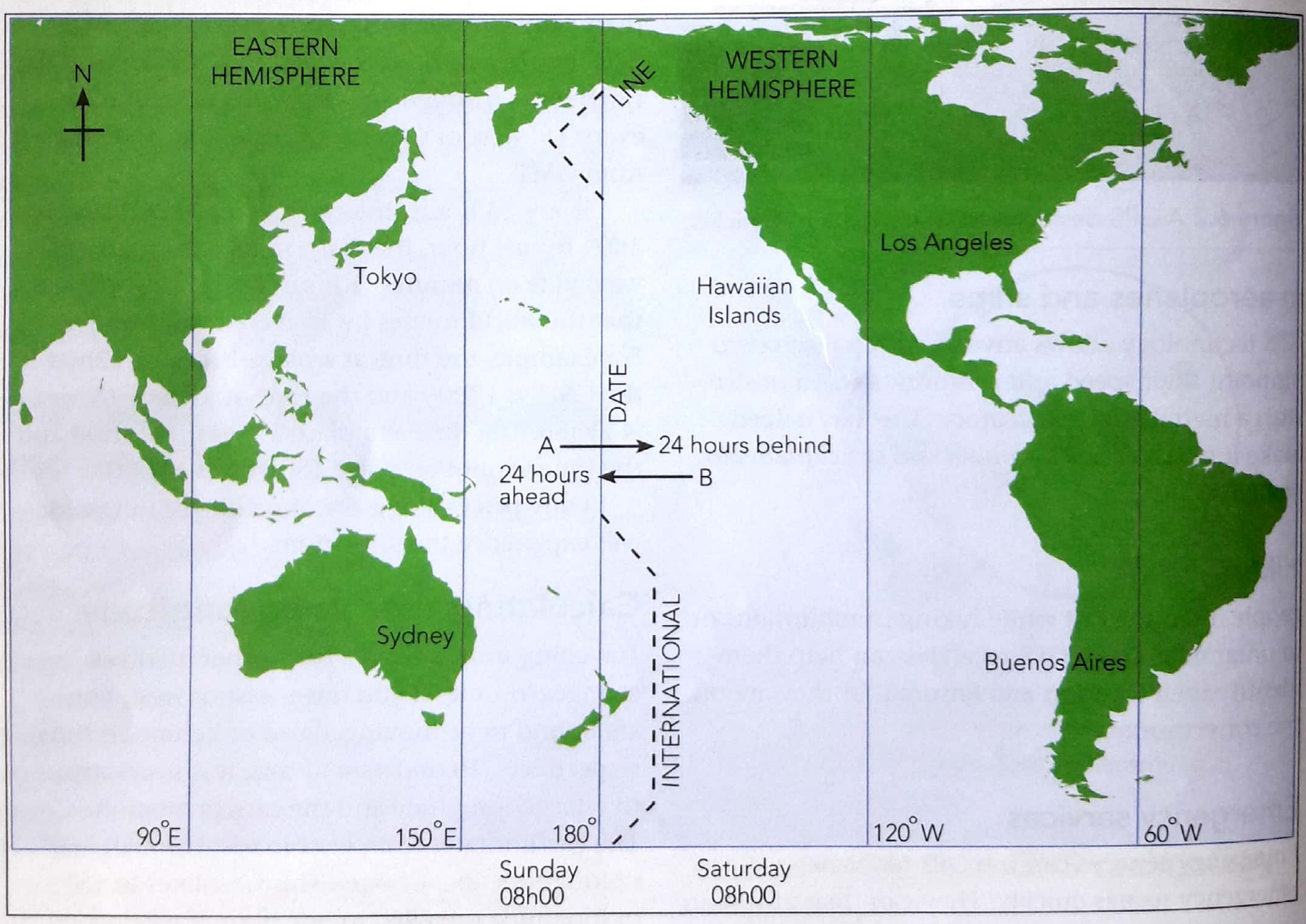


Figure 6.3 International Date Line

The IDL does not always run together with or along the 180° longitude. It zigzags so that countries or islands in the same country are not in separate time zones. As can be seen from the map, if you cross the IDL from the west to the east (arrow A), a day is lost. A day is gained when you cross the IDL from the east to the west (arrow B).

Air and sea travellers have to change the date on crossing the IDL.

Activity 2

1. It is 12 pm in London. What time will it be in:
   a) Zimbabwe
   b) Senegal
   c) India
2. What is the time at the following longitudes?
   a) 30° W
   b) 75° E
   c) 150° E
   d) 45° W

The electromagnetic spectrum

Heat from the Sun reaches the earth as waves known as electromagnetic waves. These waves exist in different wavelengths. For example, if you drop a small ball into some water, you will see small waves ripple out. If you drop a much bigger ball into water, you will see much bigger waves. The electromagnetic spectrum describes the wavelengths of light and their properties, most of which humans have learned to use in a variety of ways. Only a very narrow part of the electromagnetic spectrum is visible to the human eye.

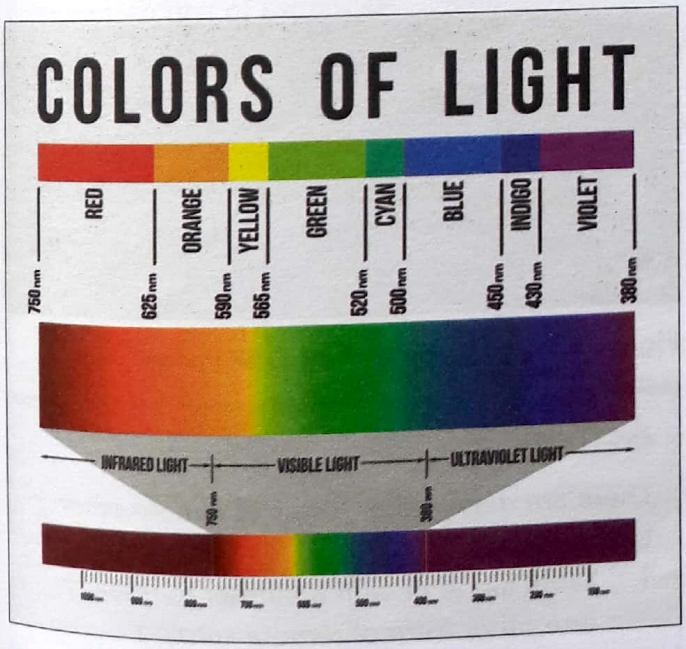


Figure 6.4 The electromagnetic spectrum

Light as a wave

Light is a visible form of energy that behaves like a wave. It has a wavelength (shown by the Greek letter lambda, λ), a frequency (how many waves pass through a point at any time) and an amplitude (the height of the waves). The crest is the highest point in a wave and the trough is the lowest point.

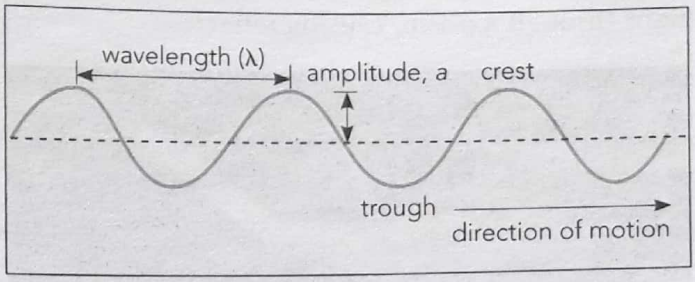


Figure 6.5 Light as a wave

Waves can be refracted (bent), which you can see if you put a straw in a glass of water. The speed of light changes as it moves from water to air, bending it slightly. Light can also be reflected, such as when it is reflected off a mirror or when sunlight bounces off a smooth surface.

The different wavelengths are all collectively known as the electromagnetic spectrum. In the figure, you can see how the different wavelengths vary between each other. Wavelengths are measured as the distance between two crests after each other. Microwaves have relatively long wavelengths, while gamma rays have shorter wavelengths.

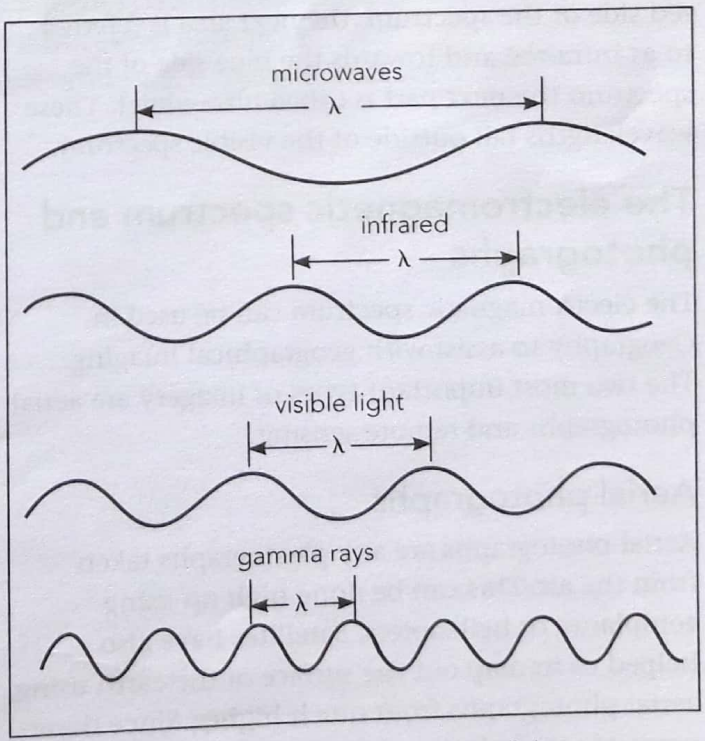


Figure 6.6 The different wavelengths of the electromagnetic spectrum

The visible wave bands

The visible part of the electromagnetic spectrum can be seen by the human eye. This visible part of the spectrum can be broken up by passing white light through a prism, causing refraction.

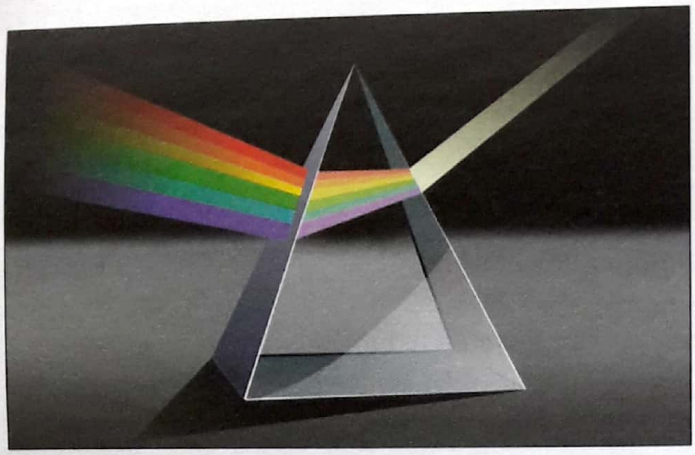


Figure 6.7 Refraction from a prism

These are the colours that you see every time you look at any object. Light from the object is reaching your eyes and allowing you to see different colours that fall within the visible spectrum. Different colours on the spectrum correspond to different wavelengths of light. If you look at the red side of the spectrum, it has a longer wavelength than the blue/violet side. Towards the red side of the spectrum, the next area is referred to as infra-red and towards the blue side of the spectrum the next part is called ultra-violet. These wavelengths fall outside of the visible spectrum.

The electromagnetic spectrum and photographs

The electromagnetic spectrum can be used in Geography to assist with geographical imaging. The two most important types of imagery are aerial photographs and remote sensing.

Aerial photographs

Aerial photographs are any photographs taken from the air. This can be done high up using aeroplanes or helicopters. Satellites have also helped us to map out the surface of the earth using aerial photographs from much higher. Since these types of aerial photographs take pictures of visible land and sea structures, they make use of the visible light in the electromagnetic spectrum.

Remote sensing

Remote sensing is the science of getting information about objects (such as geographical objects) from a distance. One example of remote sensing is Light Detection and Ranging (LIDAR). LIDAR uses a laser pulse to measure various distances on Earth. The light pulses are combined with other data in computer software to create a three-dimensional image, providing information about the Earth and its surface features.

A laser, scanner and a GPS receiver are used to take LIDAR images, usually from an aeroplane or helicopter. There are two types of LIDAR: topographic (land) and bathymetric (sea). Topographic LIDAR uses infrared lasers to map the land. Bathymetric LIDAR uses water-penetrating green light to penetrate water and measure elevations on the sea floor and river beds.

Scientists can use LIDAR to create accurate maps of shorelines and make digital models of land features and elevations.

Note that although scientists might use invisible light wavelengths in their studies, geographical information systems and software can convert the data into something visual to observe.

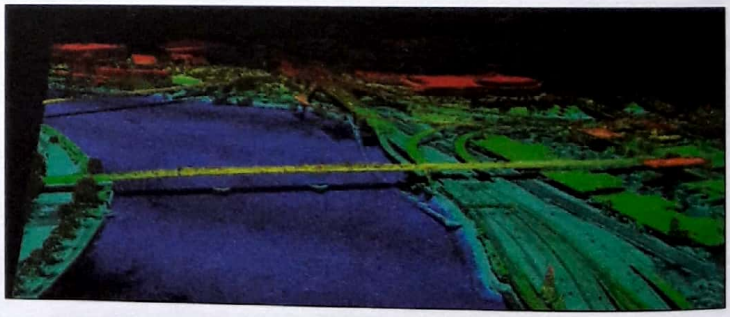


Figure 6.8 An example of a LIDAR image

Activity 3

There are many other forms of remote sensing to investigate.

1. Work alone or with a partner to research one other form of remote sensing.
2. Write a one-page report on your findings. Ensure that you describe the wavelengths of light used in the remote sensing technology. What type of imagery does the remote sensing make? How is this information applied in Geography?

Summary

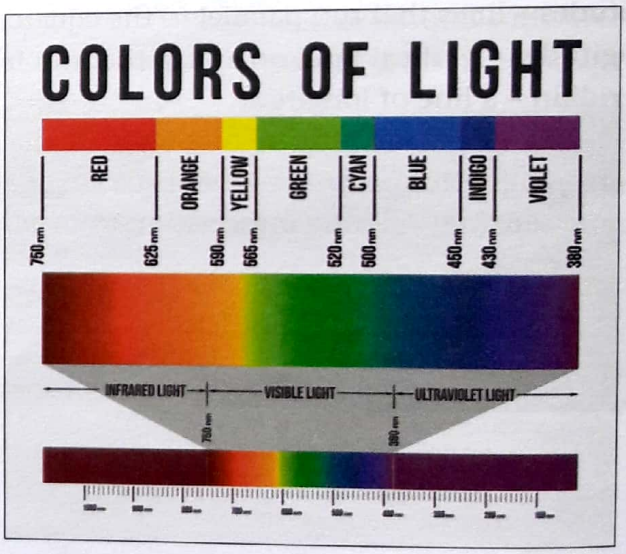
- The Global Positioning System (GPS) uses an array of satellites and a receiver to pinpoint a person's location.
- The world's time is based on Greenwich Mean Time (GMT).
- Every degree on the earth's longitude represents a time difference of four minutes. If it is east of the GMT, it's four minutes ahead. If it is west of the GMT, it is four minutes behind.
- On the International Date Line (IDL), a traveller loses a day when crossing the line from west to east and vice versa.
- The electromagnetic spectrum consists of visible and invisible wavelengths of light.
- Light behaves like a wave, with wavelengths, amplitudes and frequency.
- Only a very narrow band of the electromagnetic spectrum is visible to the human eye. The other wavelengths in the spectrum have a wide range of technological applications.

Glossary

GPS – Global Positioning System
Greenwich Mean Time – the world's time, based on the Greenwich Meridian
Greenwich Meridian – the 0° line of longitude that passes through Greenwich in London. It is also called the prime meridian
International Date Line (IDL) – the line which mostly follows the 180° meridian and at which a traveller gains or loses a day
latitudes – lines that run parallel to the equator
longitudes – vertical lines on a map that run from the North Pole to the South Pole
meridian – a line of longitude
prime meridian – the 0° line of longtitude that is also known is the Greenwich Meridian
electromagnetic spectrum – the spectrum of all known wavelengths of light
remote sensing – getting information from a far distance using electromagnetic waves

Topic test

1. GPS stands for
   A Geographic positioning system
   B Global positioning system
   C Global positioning sequencing
   D Geographic photograph systems
2. When calculating time in different time zones, we use:
   A Longitude
   B Latitude
   C Altitude
   D Sun dials
3. If a place is 1° west of London, how many minutes will the time difference be?
   A One hour behind
   B Four minutes ahead
   C One hour ahead
   D Four minutes behind
4. If a place is 15° east of London, how many minutes will the time difference be?
   A One hour behind
   B Four minutes ahead
   C One hour ahead
   D Four minutes behind
5. Wavelength refers to:
   A How tall a wave is
   B The direction of a wave's motion
   C The overall distance a wave travels
   D The distance between two successive wave crests
6. Are the following statements true or false? If false, explain why.
   a) GPS uses an array of satellites and a receiver to pinpoint a location.
   b) The earth rotates through 18° of longitude in one hour.
   c) We can see all the wavelengths of the electromagnetic spectrum.
   d) White light can be refracted through a prism into the visible spectrum of light colours.
   e) Remote sensing is when we obtain information about objects from a far distance.
7. Name and explain any two applications of GPS technology.
8. Briefly describe how to measure time using longitude.
9. Explain what is represented in the accompanying figure.



Topic 7

Minerals and mining

Objectives

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

- describe small-scale mining
- describe the contribution of small-scale mining to the economy of Zimbabwe
- explain the challenges and solutions to small-scale mining
- outline the legislative framework on mining and mining rights
- explain the processing of selected minerals in Zimbabwe.

Mining involves the extraction of minerals from the earth. Large-scale mining operations are expensive and involve the use of large machinery. They use technology and they are formally organised. Small-scale operations u are not expensive as they use little technology or machinery. They are not formally organised. In this topic, we focus on the small-scale mining operations of Zimbabwe.

Small-scale mining in Zimbabwe

What is small-scale mining?

A small-scale miner, also known as an artisanal miner, is a subsistence miner. These small-scale miners are not officially employed by a mining company, but they sell their ore to established mining companies. They work independently as individuals, groups, families or communities, often informally. Most of the miners operate illegally. The small-scale miners are involved mainly in the extraction of gold or gold panning, chrome ore and diamonds. They use simple hand tools to mine and semi-process their produce. Most of these miners work seasonally, especially if there is no work to be done in their family fields.

The contribution to the economy

Small-scale mining is an important socio-economic sector for the rural poor people of Zimbabwe, as well as for many other rural communities in developing countries. Small-scale mining contributes a great deal to the economy of the country. This sector creates employment for a considerable number of people. Their activities in Zimbabwe are now organised through the Zimbabwe Artisanal and Small Scale for Sustainable Mining Council. (ZASMC). There are believed to be about 600 000 registered miners and about 100 000 unregistered miners, giving a total of 700 000 people working as small-scale miners.

The small-scale mining sector generates revenue for the government through the selling of the gold and other products. In 2015, Zimbabwe generated $684.4 million from the export of gold with small-scale miners accounting for more than $273 million.

There has been a lot of development in the rural areas through the activities of small- scale miners. The miners have invested money in agricultural development by buying modern farming tools, chemicals, seeds and fertilizers.

The investment in agricultural sector has resulted in increased food production and improved food security and also in improved standards of living.

The challenges of small-scale mining

The small-scale mining sector faces a number of challenges, such as a lack of equipment, a lack of support from government, poor working conditions, a lack of good health and safety measures and a lack of capital to buy equipment. They have a major challenge in the marketing of their produce and also their activity being criminalised by government regulations and acts.

Activity 1

Work with a partner. Discuss and then write a report on what measures can be put in place to ensure the health and safety of the small-scale miners in your area.

The legislative framework on mining and mining rights

The Mine and Minerals Act

The extraction and processing of minerals in Zimbabwe is governed by acts of government. Extraction is the mining of the ore. Processing relates to the stages that the ore goes through to form a product. In gold mining, gold ore is mined and then processed to form pure gold bars and coins.

The acts are the legislative frameworks which govern the mining and mining rights. The Mines and Mineral Act was put in place in Zimbabwe in 1961, but sections have been revised and amended throughout the years. The act governs the registration of miners or prospectors and the issuing of mining licences. The act also stipulates rules and regulations on how to carry out the mining and the payment of fees to local Authorities.

The Environmental Management Act

The mining of mineral ores is also governed by acts such as the Environmental Management Act 13 of 2002. This Act stipulates rules and regulations to protect the environment from the negative effects of mining activities. It governs water pollution, hazardous waste, effluent and sewerage discharges by the mining companies. The act also governs air and noise pollution and the use of pesticides and toxic substances.

The National Social Security Authority Act

The mining industry is also regulated by acts of government, in particular those concerned with social security, such as the National Social Security Authority Act of 1989. The act deals with the social needs of both the employer and the employees and was put in place to look into the issues of hazards and risks at work places.

Activity 2

1. The Mine and Minerals Act controls the exploitation of mineral resources. It is a very powerful act and overrides most other acts as far as mining is concerned. However, there are problems with the act in terms of combatting the negative effects on the environment caused by deforestation, poaching, siltation and mine dumps. Can you think of any other problems?
2. What problems are likely to be faced by National Social Security Authority (NSSA) officials with regard to providing social security to small-scale miners?

The processing minerals in Zimbabwe

Gold

Gold occurs as small grains in a solid rock. To get to the grains of gold, the rock has to be crushed into fine powder. This is done by heavy machinery or on a small scale by hand. The pounded ore is then washed, or chemicals such as mercury and cyanide are used to separate the gold. The separated gold grains are then melted and poured into moulds to produce pure gold bars ready for the market.

From a tonne of rock, a miner may produce 6 g or less of gold. The rest of the rock is waste and this is piled up near the mine, creating mine dumps.

Gold is one of Zimbabwe's most valuable minerals. It is used as the basis of the world's money. The gold is usually sent to the London Bullion Gold Market where it is then sold all over the world.

Gold does not rust or deteriorate so it is mixed with other metals, for example, silver, nickel and copper, to produce jewellery and ornaments. Gold is the leading mineral foreign currency earner in Zimbabwe, followed by asbestos, nickel, coal, chrome and diamonds.

Diamonds

Diamonds are formed in igneous rocks, especially in volcanic pipes. They are formed from molten rock that solidified slowly. Not all volcanic pipes contain diamonds, however. Some of the diamonds are brought to the surface during eruptions. Erosion processes expose the pipes and the diamonds are eroded, transported and then deposited as alluvial diamonds.

The diamonds that occur in Marange area of the Eastern Highlands of Zimbabwe are alluvial diamonds. The first diamonds discovered in South Africa along the Orange River were also alluvial diamonds.

When the rocks bearing the diamonds are brought to the surface after mining, they are crushed and washed. The crushed rocks are passed onto a conveyor table covered in grease with water flowing over it. The wet pieces of rock will slide over the table as waste but the diamonds will stick to the grease since they do not hold the water on their surface. The table is regularly stopped and the grease with the diamonds is removed and the diamonds are collected.

Alluvial diamonds are much bigger than other diamonds and do not have to be crushed and washed. Diamonds are one of the hardest minerals, so they are used in industry for cutting and polishing some of the hardest metals. They are also used for jewellery because they reflect light brilliantly. The drills used in the mining industry are diamond-tipped.

The marketing of diamonds is controlled by the government through the Minerals Marketing Corporation of Zimbabwe (MMCZ).

Chrome

When chrome ore is brought from the ground, it is sorted, screened and then loaded into wagons for further processing. Further processing is currently done in Kwekwe and Gweru where the ore is checked for quality, weighed, heated in furnaces and mixed with iron to produce ferrochrome. The molten ferrochrome is poured into moulds. The ferrochrome is then cast into different sizes and is packed ready for the market, either locally or abroad. A large percentage of the chromium or chrome products are exported to the USA, Europe, Australia, Japan and China.

Chrome has helped a lot in the growth of other industries within the country. Chrome ore has resulted in the growth of ferrochrome industries in Gweru and Kwekwe. In the refining of chromium, a large number of raw materials are required and these are coke, quartz, oxygen, lime and coal.

Chrome is used as an alloy with other metals. When mixed with iron it produces steel that is strong and rust-resistant. Chromium steel is used in the manufacture of cans and aeroplanes. Stainless steel has a high content of chromium and is used in the making of cutlery and laboratory equipment.

Coal

When coal is extracted from the ground, it is crushed, washed and then graded. The grading is done to create different sizes of coal pieces to suit customers' requirements. The coal can be sold as dry coal for use in industry or for domestic use.

The coal is also processed to produce coke for smelting ores in steel and ferrochrome industries. Coke is the hard grey residue produced when coal is heated to above 1 200 °C in the absence of air. Coke gives off a lot of heat for use in melting ores. The red-hot coke is cooled with water, drained and then graded for sale to the consumers.

Figure 7.1 Coal mining

During the production of coke, by-products such as ammonia, tar and benzol are produced. Some of the by-products are used in the production of plastics, inks, pesticides, explosives, solvents and detergents.

The major local markets of coal are railways, smelting industries, farms (especially tobacco farms), domestic users and power stations. Coal is also exported to Zambia, the Congo, Mozambique and Malawi.

Coal mining at Hwange

Most of the coal mined in Zimbabwe comes from Hwange. Hwange is located 336 km from Bulawayo and 106 km from Victoria Falls. The mines are located only a few kilometres south of the main Victoria Falls road near the town of Hwange. Figure 7.2 shows the location of Hwange.

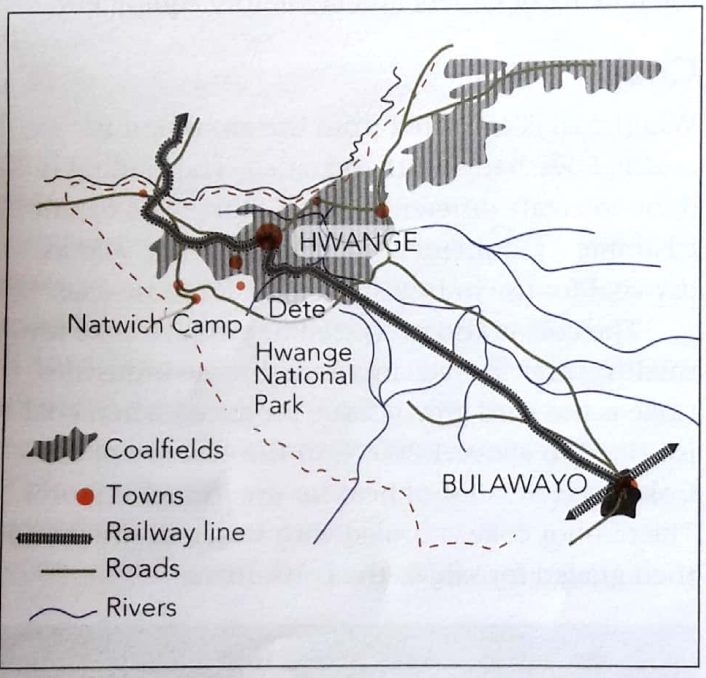


Figure 7.2 The location of Hwange

Coal mined at Hwange is a sedimentary rock produced from tropical vegetation that was subjected to the pressure of overlying rocks over 250 million years ago. The coal seam is found under the ground and reaches depths of up to 900 m below the surface. The overburden, that is, surface layers of soil and rock which lie over the coal, consists of volcanic basalt rock at the surface, then sedimentary rocks, followed by the coal seam. The coal seam itself is between 10 m and 12 m thick, and lies on top of a sandstone layer with basement gneiss beneath it. Figure 7.3 shows the geological setup at Hwange Coalfield.

Hwange coal is called bituminous coal, which is the most commonly occurring type, making up about 80% of the world's coal reserves. This type of coal is hard, black and compact. The quality of coal is measured by the amount of carbon contained in it. The higher the carbon contents, the more the heat value will be. Hwange coal contains about 74% carbon and this gives it a good heat value. However, the coal also has a high ash content of about 13,5%, which lowers its value because ash cannot be burnt. The other types of coal are anthracite and lignite.

Activity 3

List problems likely to be faced by small-scale miners in the processing of their gold ore for marketing.

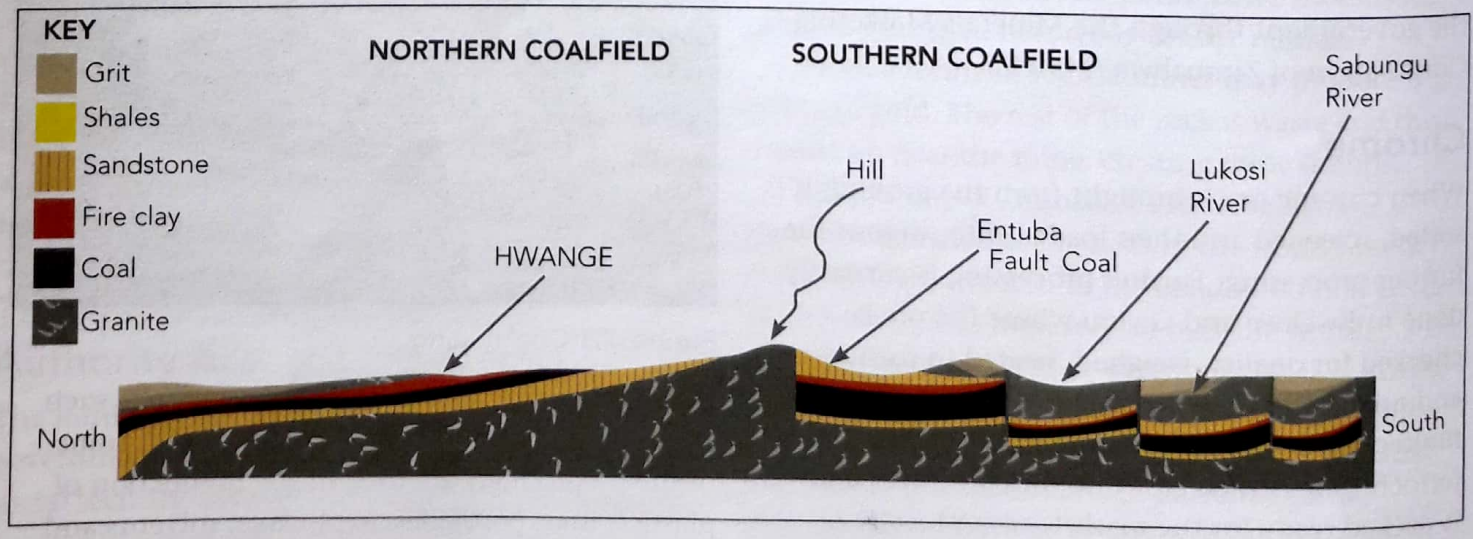


Figure 7.3 The geological setup at Hwange Coalfield

Beneficiation and value addition

The marketing of mining products is very important to a country because the mining industry plays a very big role in industrial development. A country will not benefit much if it exports unprocessed mineral ores because these will be of a lesser value. In addition, the processing of the ores leads to the establishment of new industries and also to the production of other useful by-products.

Most mining is done by large transnational companies, which may siphon the money earned to their mother countries or export the semi-processed ores to their countries of origin at a lower price. So, governments are sometimes involved in the processing and marketing of mineral ores.

In Zimbabwe, the government established the Minerals Marketing Corporation of Zimbabwe (MMCZ) in 1983. This was to ensure that Zimbabwe receives the highest possible returns from the export of its minerals. The corporation buys and sells certain minerals and gives authority to companies to sell minerals to foreign buyers. It also contracts large companies to search for minerals and open up processing plants near mines.

When minerals are extracted from the ground, a major percentage is waste rock. Mineral ores need to be processed for further use or export. One of the most important processes linked to mining is the **beneficiation** process. This is the conversion of ores into concentrated metals, for example the conversion of chrome ore and iron ore and their mixture into **ferro-alloys**. An **alloy** is a mixture of two or more metals to produce a particular product with specific characteristics such as rust-resistance or heat-resistance.

The processes after getting the ores from the ground involve crushing and grading, and in some cases, **smelting**. Smelting is the heating of the mineral ore to a molten state to be able to remove impurities or waste products.

Activity 4

List the benefits a country receives from selling processed minerals.

Health and Safety in mining

Mining is a hazardous occupation. There are high risks of fires, floods, collapsing of mines and explosions. These risks can cause the death of a large number of people in a single incident. For example, during the Hwange disaster of 1976, 427 people were killed in an explosion in the underground mines.

Health and safety managers at a mine are responsible for drafting and controlling all health and safety regulations within the company. The managers have to identify workplace hazards and risks to employee health and safety and to recommend solutions to the issues to avoid accidents and disasters.

Health and safety can include anything from the safe operation of heavy equipment to the handling of chemicals, fire-fighting, rescue, the wearing of protective clothing and the lifting of items at workplaces. Some mineral ores are a health hazard. Asbestos, for example, contains fibres which can cause lung cancer. Regulations have to be put in place to protect the people involved in asbestos mining.

Activity 5

Create a poster to inform the local people about the health and safety problems created by the illegal small-scale mining of gold.

Summary

- Mining is the extraction or removal of useful minerals from the earth.
- Processing relates to the stages which the ore goes through to form a product.
- Small-scale miners do not belong to formal mining companies
- Gold panning by small-scale miners contributes greatly to the economy of the country.
- Many small-scale miners operate illegally.
- Small-scale miners face a number of challenges such as using poor equipment and working in hazardous working environments.
- The mining and processing of minerals is governed by acts of government such as the Mines and Minerals Act.
- The government regulates the effects of the mining and processing of minerals through the Environmental Management Act.
- The health and safety of the miners and other people who may be affected by the mining activities is regulated by the government's social security acts, such as the National Social Security Authority Act of Zimbabwe.
- Gold is one of Zimbabwe's most valuable minerals and is used as the basis for the world's money.
- Gold does not rust and can be mixed with other metals such as silver, nickel and copper to produce jewellery.
- Diamonds can be polished to form jewellery and because it is one of the hardest minerals, they are used in industry for cutting some of the other hard metals and for drilling.
- Chrome is used as an alloy with other metals such as iron to produce steel which is strong and rust-resistant.
- Coal is used in many industrial sectors for heating purposes and has a number of important by-products such as ammonia, tar and benzol.

Glossary

alloy – a mixture of metals
alluvial mining – extracting minerals from river bed deposits
beneficiation – the conversion of ores into concentrated metals
ferro-alloy – a mixture of steel or iron with another mineral, for example, ferro-chrome (a mixture of steel and chrome)
minerals – useful materials extracted from the earth
mining – the extraction of minerals from the ground surface, from underground or even from the seabed
ore – unprocessed mineral rock
small-scale mining – is subsistence mining by individuals or groups using simple hand tools
smelting – the extraction of a mineral from its ore through melting

TR's copy

Topic test

1. Which one of the following is a gold mine?
   - A Gaths
   - B Renco
   - C Sutton
   - D Buchwa
2. Answer these questions about coal:
   - a) Besides Hwange, name two other areas where coal is mined.
   - b) Name two by-products of coal.
   - c) Suggest two possible problems that coal miners may face, and give possible solutions.
3. a) Define the term beneficiation.
   b) Describe briefly how coal is processed to be made ready for marketing.
4. a) What is gold panning?
   b) Give three problems faced by small-scale gold miners.
   c) Give possible solutions to these problems.
5. Suggest four ways in which the government can help improve the health and safety of small-scale miners.

Topic 8 Environmental management

Objectives

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

- explain environmental management legislation
- assess the effectiveness of the requisite legislation on environmental management
- discuss challenges and solutions of implementing environmental management legislation.

Environmental management is the way in which governments, industries and individuals undertake to protect the health of the natural environment. It involves taking steps to encourage behaviours that will have a positive impact on the use of natural resources. This includes managing waste, protecting biodiversity, conserving wildlife, protecting natural resources, controlling the quality of air and water and managing ecosystems. In this topic, we examine the laws regarding environmental management in Zimbabwe.

Legislation for environmental protection

As we use resources, we need to think of future generations. We must not pollute the environment so that we can preserve it for others in future. This is called sustainable development. This enhances ecological sustainability in which human activities do not irreversibly damage the ecosystem of which we are a part.

The government of Zimbabwe has put in place a number of policies or laws (legislation) to protect the environment. These include the following:

- The Mines and Minerals Act
- The Water Act
- The Parks and Wildlife Act
- The Forest Act
- The Environmental Management Act.

The Mine and Minerals Act

The Mine and Minerals Act controls the exploitation of mineral resources. It is a very powerful act and overrides most acts as far as mining is concerned. However, there are problems with the act in terms of combating the negative effects on the environment caused by deforestation, poaching, siltation and mine dumps.

The Water Act

The Water Act focuses on the development and utilisation of water in a sustainable manner. The act ensures that pollution of natural water courses or agricultural waste conform to minimum pollution standards set by the Zimbabwe National Water Authority (ZINWA). The discharge of effluent is acceptable only by the people holding permits, which have to be applied for.

The Parks and Wildlife Act

The Parks and Wildlife Act is legislation that established a Parks and Wildlife Board, as well as the Department of National Parks and Wildlife Management. It is responsible for national parks, safari areas and recreational parks. This law, therefore, looks at wildlife management in the national parks, safari areas and recreational parks so that the wildlife is used and managed in a sustainable way. It was through this act that programmes such as CAMPFIRE were developed in Zimbabwe.

The Forest Act

The Forest Act's primary objective is the protection, management and utilisation of forests in a sustainable manner. It therefore discourages deforestation and regulates cultivation, stipulating that cultivation should not be undertaken 100 m within a river bank.

The Environmental Management Act

The most recent legislation passed by the Government of Zimbabwe was the Environmental Management Act of 2002 which brings together laws and measures that protect, conserve and manage the environment and its resources. The Statutory Instrument 7 of 2007 (Environmental Impact Assessment and Ecosystems Protection Regulation) is an addition that makes it compulsory for projects listed in the first schedule of the act to undergo an environmental impact assessment process before they can be implemented.

Environmental Impact Assessments

An Environmental Impact Assessment (EIA) is a planning tool used to identify, predict and assess the potential impact of human activities on ecosystems (either negative or positive). It also describes measures that will be taken to minimise the negative impact and enhance the positive ones. It is used to determine whether a project should proceed and how it should proceed. The purpose of EIAs is to make projects sustainable.

In Zimbabwe, EIAs began as a policy in 1994. It was a new initiative that was started to contribute towards sustainable development in the country. As a policy, there was no legal backing and so it was initially implemented on a voluntary basis.

These are the types of projects that require Environmental Impact Assessment:

1. Dams and man-made lakes
2. Drainage and irrigation
3. Forestry
4. Housing developments
5. Industry
6. Infrastructure
7. Mining and quarrying
8. Petroleum production, storage and distribution
9. Power generation and transmission
10. Tourist resorts and recreational developments
11. Waste treatment and disposal
12. Water supply

The effectiveness of legislation

The Environmental Management Agency (EMA) is a legal body responsible for enforcing environmental protection laws and the protection of the environment. The EMA ensures that natural resources are managed in a sustainable way. The EMA was established in 2003 to protect the environment and prevent pollution and environmental degradation. You can read more about the EMA on it's website: www.ema.co.zw.

Activity 1

Do some research on EMA and other environmental management authorities anywhere in the world and answer these questions:

1. What is the environmental problem shown in each of the three pictures below?
2. What solution(s) can be implemented to help solve each problem you identified?

Figure 8.1

Figure 8.2

Figure 8.3

Challenges and sustainability

Enforcing environmental protection laws can be difficult for a number of reasons. For example, the Mines and Minerals Act does not give explicit guidance on how to combat the negative effects on the environment caused by deforestation, siltation and mine dumps.

Gold or diamond panning are some examples of mining that lead to degradation as shown in Figure 8.1. One question that is difficult to resolve is: who rehabilitates an area when 'illegal' panners (whose composition and stay is ever changing) are through with their work?

Figure 8.4 People panning for alluvial diamonds in Chiadza.

However, there are ways of making sure that environmental management is sustainable. CAMPFIRE, which you learnt about in Topic 4, is an example of an environmental management programme that is successful and sustainable. It demonstrates how important it is for people to be motivated to live in a way that is sustainable and benefits both themselves and the environment.

Even at a local level such as at school, rules and regulations are put in place to address environmental issues and to ensure a safe and clean environment. When we take the initiative to protect, manage and use natural resources and the environment responsibly, we become environmentally conscious citizens.

Summary

- Environmental management is the way in which governments, industries, organisations, including schools and individuals, make and implement plans to protect the health of the natural environment.
- The government of Zimbabwe has put in place a number of policies or laws (legislation) to protect the environment.
- The Mines and Minerals Act controls the exploitation of mineral resources.
- The Water Act focuses on using water in a sustainable way.
- The Parks and Wildlife Act is responsible for **wildlife management in the national parks, safari areas and recreational parks.**
- The Forest Act is responsible for protecting the forested areas.
- The Environmental Management Act **protects, conserves and manages the environment and its resources**
- Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impact of a proposed project or development, taking into account socio-economic, cultural and human-health impacts, both beneficial and adverse.
- The Environmental Management Agency (EMA) is a legal body responsible for enforcing environmental protection laws and the protection of the environment.

Glossary

environmental management – organised attempts to control the human impact on the environment to preserve natural resources

environmental impact assessment – a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse

legislation – laws or a set of laws made by government

sustainable development – economic development that is conducted without depletion of natural resources

Topic test

1. Which of the following best describes the environment?
   - **A** The air and atmosphere around us
   - **B** All living and non-living things in an area
   - **C** The biosphere and its elements
   - **D** The outermost crust of the earth's surface
2. The Environmental Management Act of 2002 controls:
   - **A** The management of local authorities
   - **B** The management of the environment and its resources
   - **C** The management of wild giraffe
   - **D** The management of ecosystems
3. Name two other acts that aim to protect the environment. Briefly describe what aspects of the environment these two acts cover/control.
4. **a)** Use your own words to describe what an environmental assessment impact is.
   b) Explain why they are necessary.
5. The role of the Environmental Management Agency (EMA) is to:
   - **A** appoint managers
   - **B** report to government on issues relating to natural resources
   - **C** enforce environmental protection laws and the protection of the environment
   - **D** protect wildlife in animal sanctuaries
6. Gold and diamond mining generate extensive wealth for the country. What is one of the major problems, identified in the topic, that these two activities cause?

Topic 9

Agriculture and land reform

Objectives

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

- describe land tenure
- identify forms of land tenure in Zimbabwe
- explain characteristics of each land tenure system
- compare land tenure systems
- describe land reform
- explain forms of land reform
- identify reasons for land reform in Zimbabwe
- explain the land reform process in Zimbabwe
- outline the contribution of small-scale farming to food security.

During the period of colonial rule, most of the land in Zimbabwe was in the hands of white European settlers. Since independence, a number of land reforms have taken place in a bid to make land ownership equitable. In this topic, we will examine the different forms of land tenure and land reforms. We will also find out about the reasons for land reform and the land reform process.

Land tenure

The landholding system is termed **land tenure**. The landholding and owning system affects farming in significant ways in that it influences the decisions of a farmer.

In Zimbabwe, prior to the changes made in 2006, the main forms of land tenure were freehold, leasehold and communal.

Forms of land tenure

Freehold tenure

With freehold tenure the farmer owns the land on which he or she farms. This was the type of land ownership for large-scale and small-scale commercial farming areas prior to the 2006 land tenure changes.

Leasehold tenure

Leasehold tenure gives the owner the right to use the land for a specified period of time.

In the large- and small-scale commercial areas farmers started as leasehold users and would be granted freehold ownership after making the required infrastructural improvements.

Communal tenure

Communal tenure is found in communal and resettlement areas other than the A2 resettlement areas. Communal land tenure affects about half of all land users in Zimbabwe. The land is held in trust by the Head of State. This customary tenure gives all members the right to use but not own land (usufructuary rights).

State-owned tenure

In Zimbabwe, since the end of 2006, changes to the land ownership and tenure system have meant that commercial farms, which include A2 farms, are used under a 99-year lease. This means that the owner of the land is the state. If the farm changes hands from one leaseholder to another, the incoming user pays for improvements on the land. These changes in land tenure are part of the Land Reform Programme (LRP).

Advantages and disadvantages of different tenure systems

The major advantage of freehold and leasehold tenure systems is that the farmer can make improvements on the land that benefit the farming process. Another advantage is that the lease or title deed can be used as security in borrowing money for conservation, improvement and production. Communal tenure does, however, ensure a more equitable access to land than freehold and leasehold tenure systems. Another disadvantage of freehold and leasehold tenures is that farmers may pursue personal profitability in ways that are socially or environmentally unsound.

Table 9.1 lists some of the advantages and disadvantages of the communal system of land tenure.

Table 9.1 Advantages and disadvantages of communal land tenure

Advantages	Disadvantages
• On coming of age, members especially sons, are entitled to their own fields. • Improvements are made on the land through ridges, fencing and tree or hedge planting since, once allocated, the land practically becomes one's own. • Offers chances for community co-operation when deciding on common issues like destocking, paddocking and general conservation. • As land becomes scarce, it is possible for farmers to intensify (that is, increase) productivity on the same piece of agricultural land. • People have access to woodland resources like fruit, honey, insects and game. • Most urban families own land in the communal areas. They are able to improve agriculture through inputs, equipment and possible expert knowledge.	• The need to allocate every member some land leads to the use of pastureland, steep areas and stream banks and can cause land degradation as arable land is extended. • No title deeds and collateral security are available for loans to improve agriculture. • No inbuilt incentives are felt to improve, conserve and use sustainably the common resources such as pastures, firewood, game and other wildlife and forest products. A carefree attitude to resource conservation can result. • Inheritance of a father's land by his children leads to land fragmentation, making one's fields too small and isolated for high production and mechanisation. • Traditional and local authorities have, at times, disagreed over the use of common resources. • Some resettlement farmers and urban-based people have continued to own land in their former communal areas. This may lead to the under-utilisation of land and its scarcity for new members needing land. • Land ceases to belong to any one farmer after the harvest. Everyone's cattle are then allowed to feed on the remaining crop residue. This makes double cropping almost impossible and exposes the soils to erosion when the next rains commence.

Activity 1

In a small group, discuss possible situations in which farmers who have freehold or leasehold tenure over agricultural land may pursue personal profitability in socially or environmentally unsound ways.

Figure 9.1 The type of land tenure system in place affects a farmer's productivity and motivation.

TRIS COPY

Activity 2

Work in pairs to discuss the following issues relating to land:

1. The reasons why fair systems of land tenure are important in agricultural economies like Zimbabwe.
2. The reasons that led to the redistribution of land in the post-colonial period.
3. Fair methods of land redistribution that do not involve dispossession or forced removals.

Land reform in Zimbabwe

The history of land distribution in Zimbabwe in the period of colonial rule from 1890–1980 was characterised by numerous acts of land dispossession and forced removals. The initial dispossession started with the defeat of Africans in the wars of pacification and primary resistance in the 1890s. Thereafter, a series of laws and actions, among which were the 1930 Land Apportionment Act, the 1951 Land Husbandry Act and the 1969 Land Tenure Act, were put in place. The end result was that many African communities were forcibly removed from their original fertile home areas to infertile, drier and, in many cases, pest-infested areas with little agricultural potential. Table 9.2 shows that by 2000, communal farming was supporting 51% of the population, and had 72% of its entire area in the marginal agro-ecological regions IV and V. In contrast, white commercial farmers constituting some 0,1% of the population occupied 45% of agricultural land in the areas of highest agricultural potential in regions I and II. It was in an effort to redress inherited colonial unequal land distribution that post 1980 resettlement programmes were undertaken.

Table 9.2 The distribution of population by land use category and agro-ecological region by 2000

Land use category	Population density (Persons per km²)	Percentage of population	Percentage category in agro-ecological region				
			I	II	III	IV	V
Communal farming	33	51	0.8	7.7	17.3	44.9	29.3
Large-scale commercial farming	10	11	2.8	27.6	20.6	25.7	23.3
Small-scale commercial farming	6	2	0.5	17.8	37.9	36.9	6.9
Resettlement areas	14	4	-	-	-	-	-
State land and other non-agricultural land, e.g. game reserves	Variable	32	2.3	0.5	12.2	51.3	33.7
National	27	100	1.8	15.0	18.7	37.8	26.7

What is resettlement?

Resettlement is the relocation of families and individuals from their original homes and farming areas to other areas. In Zimbabwe, resettlement is part of the land reform process which involves changes in land tenure and land ownership. Resettlement, as a form of internal **migration**, consists of cross-provincial and district movement, and intra-district movement of both urban and rural, but mostly communal households.

Figure 9.2 shows the major land categories prior to resettlement. The map gives a general idea of the direction and pattern of resettlement movement, which has largely been from communal lands to the general (large-scale commercial farms) and other vacant land.

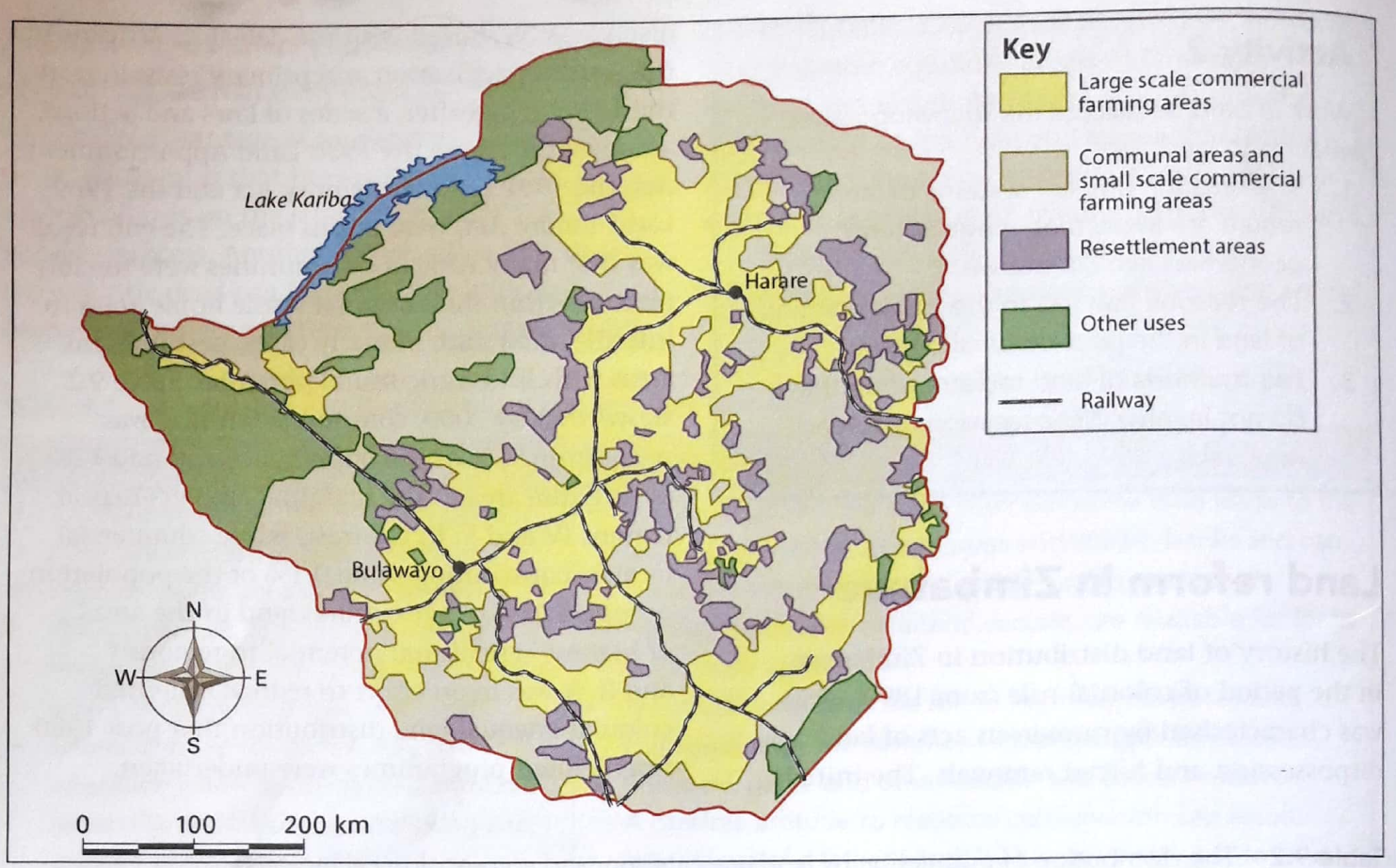


Figure 9.2 Major land categories prior to resettlement

Objectives of resettlement

The specific conditions and aims of the land resettlement programme up to 2000 are as follows:

- To have equitable land distribution by giving land to the landless who made up 30% of rural households.
- To relieve livestock and human pressure affecting an estimated 70% of communal areas. As we have already noted, 74% of communal areas are situated in the marginal agro-ecological regions III, IV, and V. Population pressure on arable land in these areas was 53 persons/km^2 compared to 31 persons/km^2 nationally with 28% of communal farmers owning less than one hectare of arable land. The pressure on communal areas is characterised by overgrazing, over-cropping, stream-bank cultivation, land fragmentation, deforestation and the use of marginal land.
- To increase agricultural production and have sustainable development.
- To improve the standard of living and food security for the majority and poorest section of the population through increased agricultural production and incomes. Resettlement is a means of alleviating poverty as shown by the fact that some resettled farmers of the 1980s increased their incomes by five times after resettlement. Resettlement enhances food security, for example, for the 2005/6 seasons, A1 and A2 farmers were more food secure (78%) than communal farmers (56%).
- To offer employment opportunities to the unemployed and landless.
- To bring idle and underused land into full production and maximise land capacity utilisation.
- To prevent conflict over land between communal households, between farmers and between the landless and owners of pieces of land. Land redistribution ensures rural development and political stability.

The cartoon (Figure 9.3) and the case study highlights type of conflict that can accompany land use.

Activity 3: Case study

Conflict over land in communal areas

Study the cartoon and extract and answer the questions that follow.

Families left homeless without food

Several hundred villagers from Mount Darwin and Centenary last week fought a pitched battle over a disputed boundary area and in the end 36 families were left homeless and without food.

An army of up to 200 men from Mount Darwin district, wielding traditional weapons – axes, knives, knobkerries, spears, bows and arrows – invaded the new Chiridza Village and ordered the 36 families who were building their homes to vacate the land, accusing them of squatting. Following a brief meeting, the armed men began pulling down structures under construction and temporary shelters erected by the Centenary families, who had moved into the empty land between the two districts.

Men from Chiridza tried without success to restrain the 200 men, who claimed to be legitimate owners of the land and were from Mukumbura in Mount Darwin.

For the next hour, the Chiridza families, who are subjects of the Kasekete chieftainship in Muzarabani, watched in horror as their settlement was razed to the ground. Food was destroyed while property belonging to the villagers was vandalised.

[Source: The Herald, 8 August and 12 August 1998]

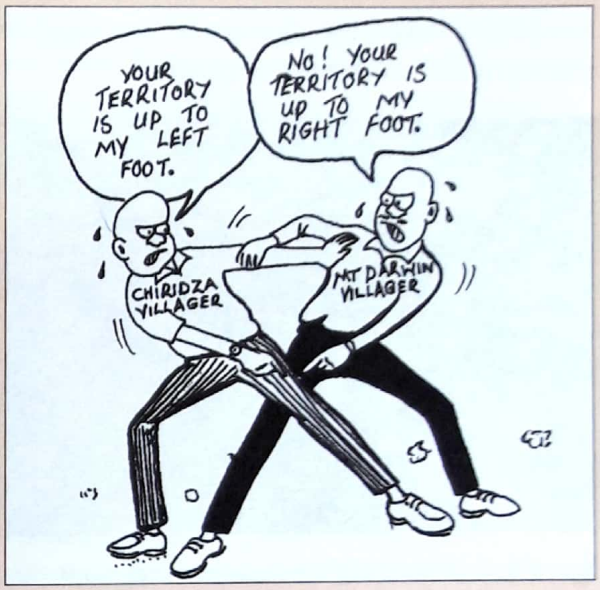


Figure 9.3 Villagers clash over boundary

Questions

1. Describe and explain the nature of conflict over land shown in Figure 9.3.
2. Say how the factor of historically unjust land distribution may have led to the conflict.
3. Assuming you were a land resettlement officer in the area, suggest how this conflict could have been resolved.

The land resettlement programme (post 1990)

With the expiry of the 1979 Lancaster House Conference constitution in 1990, the government could now acquire land without the requirement of the willing-seller/willing-buyer condition. A number of government legislations were enacted to pave way for compulsory land acquisition. The 1992 Land Acquisition Act was reinforced by other subsequent acts such as the Land Occupier Protection Act (2000) and the Constitution of Zimbabwe Amendment No. 17 Act 2005. The process of land acquisition first entailed the listing or designation of the farms, followed by compulsory acquisition in which payment would only be made for improvements on the land and for not the land itself. By 1997, a total 1 471 large-scale commercial farms had been listed for compulsory acquisition.

The land resettlement process took on a new turn when landless peasants and war veterans embarked on spontaneous and unplanned occupations of large-scale farms from 1998–2000. This resettlement process (mid 2000–2002) has been called the Fast Track Land Resettlement Programme (FTLRP), given its rapidity and that in most situations the government action and land resettlement process followed behind settlers to try and regularise the process. Two main models of resettlement

characterised the post 1998 process, namely model A1 and model A2. By mid 2005, a total of 140 866 families had been settled on 2 611 farms under the A1 model while the A2 scheme had absorbed 14 500 people on 2 331 former large commercial farms. Over 50% of large-scale commercial farms had been designated for compulsory acquisition.

Figure 9.4 The FTLRP scheme transformed agriculture in Zimbabwe.

The FTLRP transformed the structure of Zimbabwean agriculture in the following ways:

- The number of small producers increased as a result of the Model A1 scheme.
- Small-, medium- and large-scale farmers increased through the Model A2 scheme.
- In addition, there already existed communal pre-FTLRP and long established large-scale commercial farmers.

Model A1

In terms of this model, settlers have three to six hectares of arable land away from residential stands that are located in one area. Residential stands are 0,4 hectares (one acre) in size.

The other land is reserved for infrastructural services such as dip tanks, cemeteries, boreholes, schools, and service centres. In addition, communal grazing and woodlots take up the rest of the land, which averages 170 hectares for each resettlement village.

The settlers come from a variety of backgrounds and include the landless, the poor, retrenched farm workers and even urban dwellers.

Model A2

This consists of self-contained plots due to subdivision of former large-scale commercial farms. Each plot has arable land. The farmer has to establish a homestead and water points such as boreholes. The settlers use existing roads and service centres, which are usually former farm stores. Farm workers' compounds are left intact. People from the compounds can offer their labour to resettled farmers while cropping on small homestead yards. The recommended A2 farm sizes vary according to the region and scale of farming. These are summarised in Table 9.3.

Table 9.3 Recommended A2 farm size (in hectares)

Natural agro-ecological zone	Small-scale commercial farms	Medium-scale commercial farms	Large-scale commercial farms	Peri-urban commercial farms
I	15–25	100	250	15–50
IIa	25–40	200	350	
IIb	40–50	250	400	
III	60–80	300	500	
IV	150–200	700	1 500	
V	250–350	1 500	2 000	

As can be noted from Table 9.3, the farms get larger in the drier and marginally extensive farming areas. The peri-urban farms are small, indicating the high demand for land and possible intensive use. It should be noted that specialised production such as that of seed farming, forestry, wildlife conservancies and dairy may require larger farm sizes than those recommended. The guiding aim in determining farm sizes is to prevent excessive land concentration or land fragmentation.

Case study

The progress and characteristics typical of Model A2 resettlement in the Mvurwi area in Mashonaland Central

Plot allocation and size

- Most settlers were allocated or occupied plots in the year 2000. Settlers were from varied backgrounds. They included central and local government employees, communal farmers and liberation war veterans.
- The size and number of plots on former large-scale commercial farms (LSCFs) varies. For example, a 500-hectare ex-LSCF with 20–30 settlers has plot sizes ranging from 20 hectares, on good arable land, to as much as 42 hectares on vleis and rough terrain. Farm workers' compounds and water bodies such as rivers and dams are state land, which could not be subdivided.
- Homesteads, initially of the rondavel type, are found on each plot.

Land preparation and farm produce

- Perennial crops such as maize, soya beans, cucumbers, beans, groundnuts, pumpkins, sweet potatoes and, on a few farms, tobacco, are grown. **Horticultural crops** such as onions and leaf vegetables are grown where farmers have access to water sources.
- A few farmers keep limited numbers of livestock such as cattle, goats and chickens. Farmers on wholly arable plots are usually unable to keep cattle due to the lack of grazing pasture.
- Many farmers do not have cattle to use as draught power when ploughing. They rely on hiring tractors from individuals or the District Development Fund (DDF) tillage units, or use zero tillage.
- At some farms where irrigation was practised, problems of centre pivot and other equipment disrepair, the lack of electricity and suitable transformers and cables are common.

Use of labour

- Model A2 farmers need labour when planting, weeding and harvesting. Each farmer has a core of permanent workers whose number varies according to the scale of production at the farm. Casual labour can be hired from the farm compound.
- Some farmers with little or no labour force, resident on their farm compounds, can hire labour from neighbouring compounds. This has been a source of conflict between farmers since workers prefer to work for 'outsider farmers' due to the higher wage inducements. As a solution some farmers have put in place a system whereby workers resident on their ex-LSCF can only work for outsider farmers if their labour requirements are met. Farm workers who work for outsider farmers when local farmers can offer them work, risk being served a police eviction order to go and settle elsewhere.
- To supplement their income and food, ex-LSCF workers engage in vegetable gardening.

Source of capital

- The AGRIBANK is the leading source of credit finance for buying inputs such as fertilisers, herbicides and seed.

Marketing of produce

- Maize and other small grains are sold to the GMB.
- Horticultural crops, sweet potatoes and pumpkins are sold in nearby towns and to passersby on the main road.

Challenges encountered with the LRP and FTLRP

Typical problems included the following:

- A lack of adequate infrastructure such as roads, schools, clinics, established service centres and regular public transport.
- A lack of draught power especially for A2 farmers, some of whose plot sizes do not allow or do not have a lot of grazing land.
- A shortage of labour and the high cost of hired labour. Many former farm workers have also been resettled in A1 schemes.
- A lack of capital and equipment to begin farming on a strong basis. For example, the shortage of wheat combine harvesters has often forced some farmers to use sickles.
- Absent farm owners who return to the farms at weekends and month ends only, resulting in poor management of farming activities. They have been nicknamed 'the cell phone farmers.'
- The change from LSCF to A1 and A2 farms led to reductions in farm sizes and the level of operations. This in turn reduced the efficient use of invested infrastructure. For example:
  - the subdivision of irrigable land with infrastructure, meant for a single farmer, made it unsuitable for multiple users.
  - large farm infrastructure such as barns and dams become underutilised where land holdings are now small and farmers do not coordinate their production to utilise this infrastructure.
- A problem of pilferage or theft of property and crops.
- Troublesome wild animals such as baboons, monkeys and wild pigs.
- A lack of sound knowledge about farming.
- The under-utilisation of some farms.
- The soils were heavily fertilised under former large-scale commercial farmers and some are exhausted.
- Resettled farmers lack the resources to utilise the soils and also may not be skilled in producing the crops which go with such soils. Some settlers on A1 farms, for example, find it hard to grow tobacco, which is suited to their new farms.
- Land resettlement characterised by land invasions and compulsory acquisition has led to negative effects such as:
  - conflict between settlers and previous farm owners and between settlers themselves
  - bad publicity
  - multiple land ownership
  - corrupt practices in land allocation
  - resource depletion through such activities as fuelwood use.
- Conflicts between established farmers and newly settled farmers over land, fuelwood and grazing areas.
- A lack of title deeds inhibited developments and investing in the land.
- The poor selection of settlers, corrupt practices in land allocation and poor management.
- Other problems such as those common to communal farming such as the lack of draught power, the lack of expertise, ignorance and personal problems of laziness.

These problems can be regarded as teething problems, which should be eliminated with time. Some of the measures and solutions include:

- The availability of loans from AGRIBANK.
- The establishment of conservation committees by the Environment Management Authority (encompassing the former Natural Resources Board) to monitor the use of natural resources to ensure substainable development.
- Farmers pursuing other income-generating activities such as gardening.
- Back-up service through AREX officials
- The development and adoption of user-friendly technology suitable for A1 and A2 farmers. The Scientific and Industrial Research and Development Centre (SIRDC), AREX and Agricultural Engineering (AE) departments have an important role to play in this regard. By 2002 the ratio of AREX extension officers to farmers increased from 1 for 1 000 farmers to 1 for 600 farmers or 6 officials per ward.
- Carrying out land audits to ensure maximum use of land and to eliminate multiple farm ownership including ownership of communal land.

- Encouraging full-time farming.
- Granting a 99-year lease to farmers who are productive.
- Educating farmers on good farming methods, handling farming as a business and environmentally sustainable use of natural resources surrounding them.
- Eradicating corruption in land allocation and equipment through the involvement of all stakeholders, for example, NGOs, private companies and political parties.

Activity 4

1. Using the description of model A1 and A2 schemes and your own experience, draw maps to show the layout of these schemes.
2. Imagine that you have been asked to present a talk on the need for land resettlement. Write a one-page presentation of your arguments.

Small-scale farming and food security

Most of the families in Zimbabwe produce the food they eat. In rural areas, all the family members plough the fields, plant the seeds, weed them and finally harvest the crops. When the crops are gathered, the family as a whole prepares the grain for storage. The family threshes the crops, places the grain into bags or into the granary and when the time comes, takes the grain to the miller to turn it into mealie-meal. The young children also play a part in providing food for the family. In most rural areas, it is the children who look after cattle, goats and sheep. From these animals, the family gets meat, milk and manure that they use to fertilise their gardens and fields. It is clear that everyone, therefore, has a duty to produce food for the family.

The statement that 'everyone has a duty to produce' means that duties are done by both the young and adults, males and females. The carrying out of different tasks by different people is the division of labour.

Agriculture is an important form of livelihood for many people in Zimbabwe, in both rural and urban areas. The following sections highlight this importance as they cover issues such as livelihoods, **food security** and food insecurity or food insecure **households**.

Livelihoods

The term *livelihood* refers to the activities which households, that is, people who live and eat together, rely on to earn a living. Figure 9.5 shows the livelihood activities on which rural households are commonly dependent.

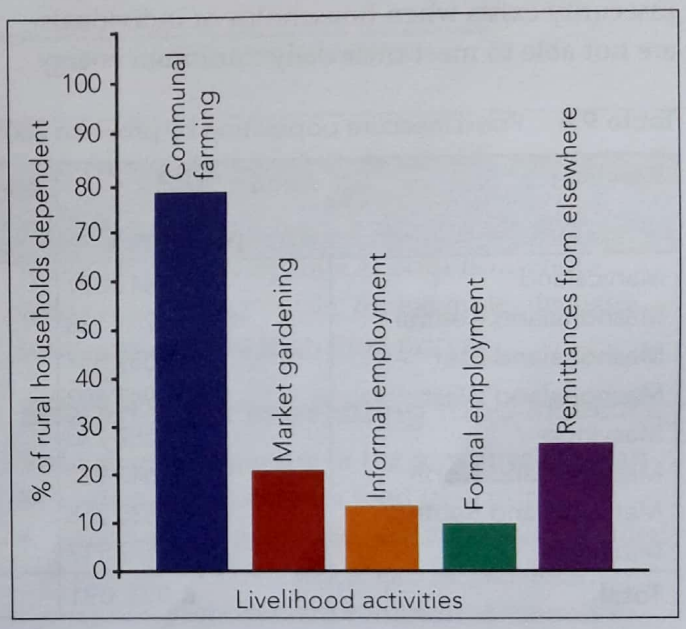


Figure 9.5 The percentage of rural households dependent on selected livelihoods

As can be seen from Figure 9.5, farming and market gardening, which are forms of agricultural activity, are the leading ways in which people earn a living. In terms of income sources for rural households, 41% is from farming, 13% from vending and market gardening, 11% from casual agricultural labour and 27% comes as remittances from working relatives, usually outside the rural area. It can be noted that the percentage of households dependent on a livelihood may not be the same as the percentage of households deriving income from that same livelihood. For example, many rural people (81%) depend on agriculture for a living, but only 41% would be producing surplus

for sale as a source of income. The proportion of households getting income from a particular livelihood is usually lower than the proportion dependent on the livelihood because households get food directly from it and not necessarily financial income.

Food security and food insecurity

Food security is the availability of adequate food to a household, obtained through its own farming activities, food purchases and from other sources, which is necessary for productive and healthy living at any given time. In contrast, food insecurity exists when households or individuals are not able to meet their daily minimum energy requirements of 2 100 kilocalories. Some 70% of this calorie intake should be from cereals.

Household food deficit is when the available food is below the required daily calorie intake. Food insecurity is said to occur when there is a food deficit. Food insecure households are those experiencing food deficits. Table 9.4 below shows the population distribution of food insecure people in the provinces from April 2005 to March 2006.

The table shows that Masvingo and Manicaland provinces had the highest food insecure population. The pie chart showing variations in the number of food insecure people for January to March 2006 illustrates this.

Table 9.4 Food insecure population by province 2005–2006

Province	August 2005 Rural population	Apr–June	Jul–Sep	Oct–Dec	2006 Jan–Mar
Manicaland	1 342 821	139 939	285 833	416 840	529 983
Mashonaland Central	991 538	110 918	191 585	278 975	352 920
Mashonaland East	1 039 557	121 704	205 376	256 086	301 725
Mashonaland West	947 803	85 692	181 770	290 833	276 524
Masvingo	1 257 270	183 292	320 761	441 047	549 877
Matabeleland North	643 927	74 658	141 851	190 378	246 372
Matabeleland South	635 258	31 274	105 550	172 008	222 829
Midlands	1 172 917	57 289	132 669	214 080	304 536
Total	**8 031 091**	**804 767**	**1 565 397**	**2 260 248**	**2 784 766**

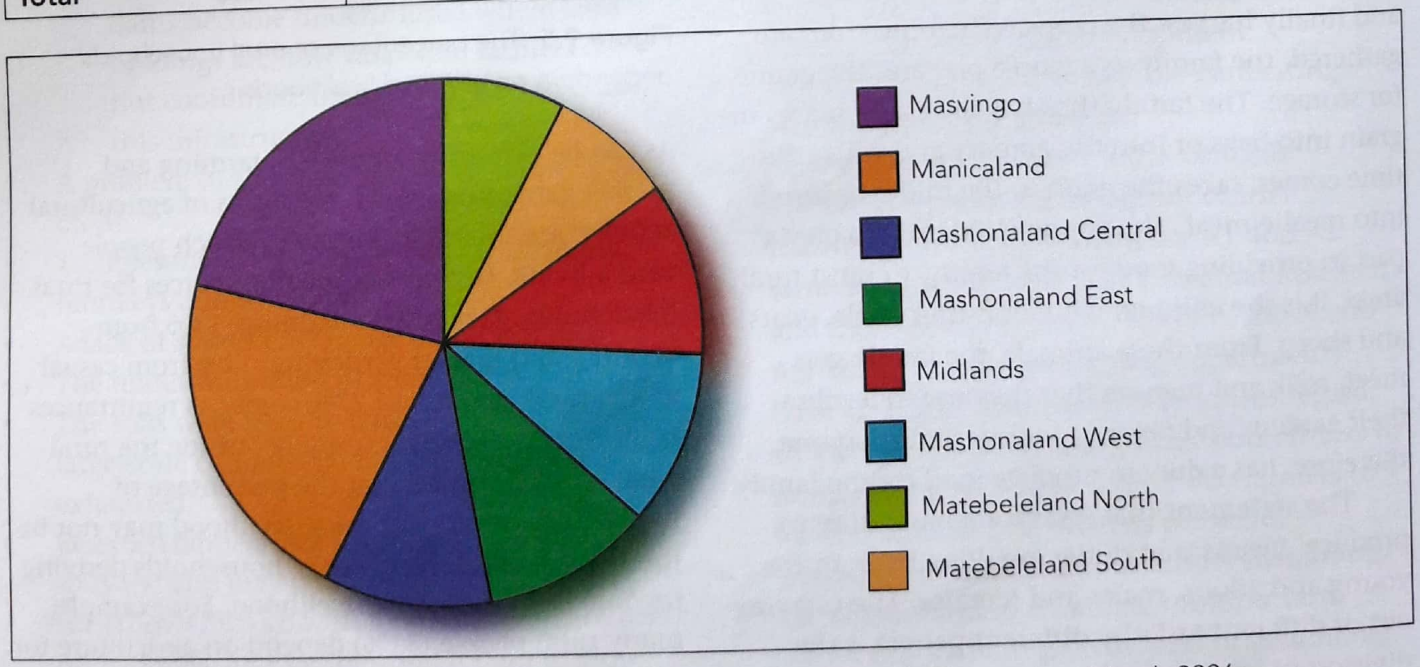


Figure 9.6 Variation in food insecure population by province for the period January – March 2006

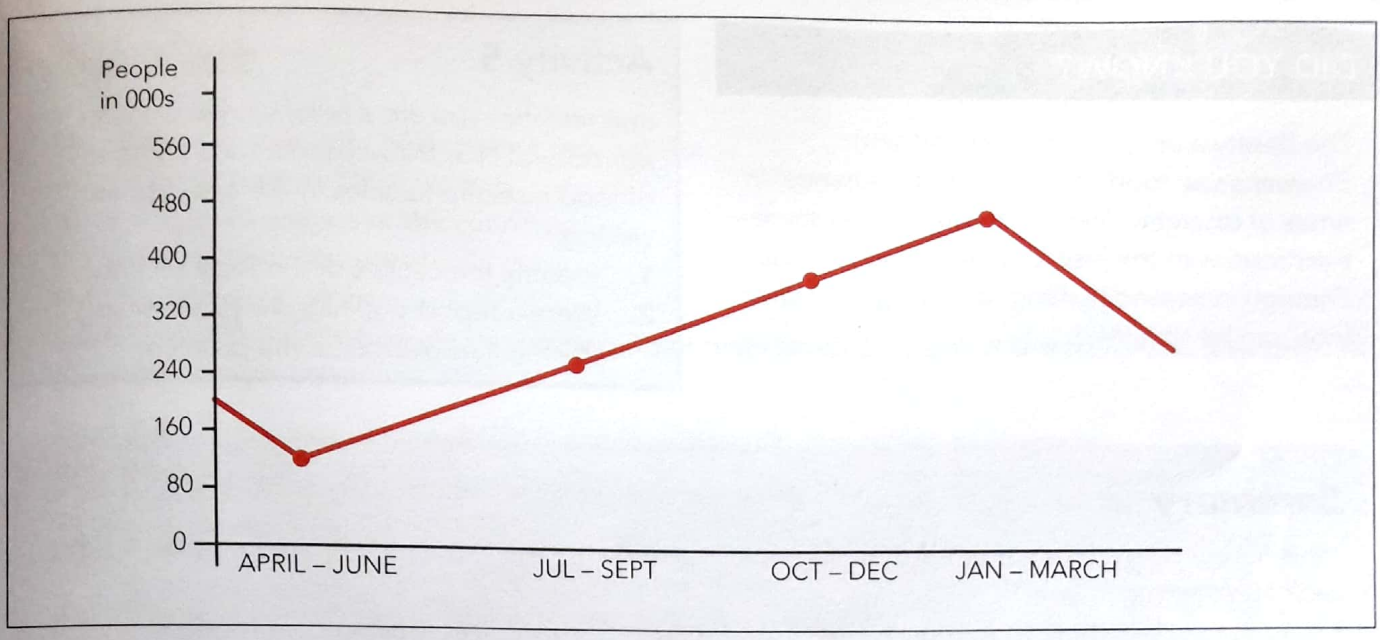


Figure 9.7 Changes in food insecure populations in Manicaland Province, April 2005–March 200

Food insecurity is lowest or less severe during the post-harvest period from March. However, it becomes more severe with time so that the October to February period has the severest food shortage. Figure 9.7 shows the changing number of food insecure people with time in Manicaland.

The distribution of food insecure people at district level does not however reflect the provincial pattern. Thus, the most affected people in this period were in the marginal districts of Kariba, Rushinga, Mudzi, Gokwe and Binga. On average, 36% of the rural population was classified as vulnerable to food insecurity between April 2005 and March 2006.

Characteristics of food insecure households

Food insecurity and the risk of hunger is greatest where households have, or are headed by:

- a child, and with orphans
- the elderly
- single parents, especially mothers
- widows
- people with a low education level
- a frequently ill person
- regular family bereavements.

It is important to note that the conditions leading to food insecurity operate at both household level and at a larger scale, for example, drought, inaccessibility and high food prices.

Strategies for preventing food insecurity

The following are some of the measures that can be undertaken to counter food insecurity:

- Food aid, in particular, assistance to the elderly and vulnerable groups, can be provided. Feeding schemes are common at schools in periods of food shortages.
- Food shortages can be prevented by storing grain for consumption and not selling it all.
- Community-based practices such as Zunde Ramambo/Isiphala Enkosi and seed multiplication schemes can be implemented.
- Using proper post-harvest storage through the use of pesticides to preserve food.
- Having nutritional gardens/other food sources.
- Strengthening and using social safety nets such as assistance or remittances from members of the extended family.
- Drought mitigation measures can be put in place and various activities meant to ensure food crop production.
- Growing traditional food crops.

DID YOU KNOW?

The Basarwa or San people in northern Botswana use food sharing as 'risk insurance' in times of drought. The well-to-do families share their food with the less fortunate in such times. Through increased hunting and foraging, extra food can be obtained.

Activity 5

Imagine that you are a relief worker from an agricultural NGO. You encounter a number of food insecure families in the area you are visiting.

1. Identify the causes of the food security.
2. Write a report outlining ways of helping the families overcome the problem.

Summary

Land tenure refers to landholding systems, which governs the ways in which people rent or own the land they live in.

- In Zimbabwe, there were three forms of land tenure: freehold, leasehold and communal.
- Freeholders own the land they live on.
- Leaseholders have the right to use the land for a specific period of time.
- Communal landholders have the right to use the land they live on, but the land generally belongs to the state.
- State-owned tenure is when the state owns the land.
- Land resettlement involves the relocation of families and individuals from their homes and farming areas to new ones. The historical and colonial imbalances and shortages in land distribution necessitated the land resettlement programme in Zimbabwe resulting in the A1 and A2 models and the associated FTLRP of 2000 to 2003.
- Land resettlement, especially the FTLRP, encountered many challenges which were and still are being tackled as an ongoing process.

Zimbabwe's agricultural economy is governed by small-scale farming enterprises in which family members all have a responsibility towards working the land.

- Such systems can lead to food insecurity, which is when households do not produce sufficient food to feed the people they are responsible for. The ideal scenario is to achieve food security which is the availibility of sufficient food to feed a household.

Glossary

food security – the continued availability of a food supply through increased production, storage such as in a granary, diversified sources, equitable distribution and food revenues

horticultural crops – crops such as leaf vegetables, cucumbers and flowers which are grown for sale as fresh products in urban market. The crops are normally grown under market gardening or horticulture.

household – people that live and eat together

land tenure – a system of land ownership such as communal, freehold and leasehold

migration – the movement of people across boundaries (local, national or international borders) for purposes of permanent residence

Topic test

1. The most important aim of resettling people is to:
   - A accommodate ex-LSCF workers
   - B open up all regions of the country
   - C reduce population pressure
   - D increase social services
2. Study Table 9.5 below showing the proportion of households facing food insecurity and how they cope with this problem.

Table 9.5 Percentage of households facing food insecurity and coping mechanisms

Percentage of household facing food insecurity	Mechanism for coping with food insecurity
62	reducing number of meals
41	reducing expenditure on education
36	reducing expenditure on health
35	reducing expenditure on agricultural inputs
43	consuming treated cereal seeds

   a) Explain the terms 'food security' and 'food insecurity'.
   b) By means of a bar graph show the information in the table.
   c) Comment on the nature of household coping responses in the face of food insecurity.
   d) As an agricultural adviser, what measures would you suggest to ensure household food security?
3. Table 9.6 below shows the status of former LSCF workers in a particular district in the aftermath of FTLRP.

Table 9.6 Status of former LSCF workers in one district after the FTLRP

Status	Percentage
Allocated land	20
State farm	17
New farms (models A1 and A2)	0
Relocated to other LSCF	10
Relocated to communal area	50
Squatting	3

   a) Draw a pie chart to represent the information in Table 9.6.
   b) Describe the status of ex-farm workers shown in the table.
   c) Comment on the agricultural implications of the situation depicted in the table.
   d) In what ways can A2 farmers benefit from the continued existence of ex-LSCF workers on their farms? (**Tips**: using their skills and knowledge)

Topic 10 Industry

Objectives

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

- describe the causes, characteristics and location of small to medium enterprises
- discuss the role of informal industries in Zimbabwe
- discuss measures adopted in industries to promote occupational safety and health
- identify solutions to challenges facing manufacturing and processing industries in Zimbabwe.

Industry refers to all forms of economic activities carried out by an individual or a group of people in a building or outside. The word `industry' covers a very wide range of activities. These activities may take place in the formal sector of the economy or in the in-formal sector. They may be large or small. In this topic, we focus on small to medium enterprises and informal industries. We also examine ways that industries promote occupational safety and health and identify solutions to the challenges that Zimbabwean industries face.

Small to medium enterprises

Small and medium enterprises (SMEs) are key components of most economies in developed and developing countries. In Zimbabwe, SMEs account for about 70% of the country's economic activity and in the European Union (EU), SMEs represent 99% of all businesses.

Globally, SMEs outnumber large companies by a wide margin and also employ many more people. SMEs are found in many economic sectors such as manufacturing, retail, transport, mining, energy, construction and service industries.

SMEs are independent firms which employ less than a given number of employees. This number varies across countries. The most frequent upper limit designating an SME is 250 employees as in the EU. On the basis of employee numbers, SMEs can be divided into three groups to form; micro, small and medium enterprises. The definition of SMEs also varies from one country to another but is generally based on the number of employees involved. In the EU, very small or micro enterprises have up to 10 employees, small 11 to 50 and medium 51 to 250. In South Africa, very small enterprise workers range from 6–20, small from 21–50 and medium from 21–200. In Zimbabwe, very small enterprises have less than 10, small 10–50 and medium from 50–100. SMEs in Zimbabwe are grouped under the term informal sector. The enterprises are also generally referred to as cottage or home-industrial activities.

Activity 1

Visit your local authority to research small and medium enterprises in your area. Write a report, using the following headings:

1. Location (accompanied by a map)
2. Characteristics
3. Reasons for its formation

The role of informal industries in Zimbabwe

The growth of small-scale and cottage industries (home industries), together referred to as the informal industrial sector, was promoted in Zimbabwe by the Economic Structural Adjustment

Programme (ESAP) between 1990 and 1995. Currently, a large proportion of the country's population is engaged in the informal sector due to the shrinking of the formal sector as a result of the severe economic problems experienced since 2000.

Apart from creating employment, informal sector enterprises have a number of unique advantages that provide the potential for improvement. These include the following:

- Managers are usually the owners of the enterprise, so improvements in productivity and working conditions can be carried out quickly.
- The relationship between the workers and managers is closer and this leads to closer co-operation.
- Managers often work on the shop floor and therefore understand technical problems. So, they can adopt innovative, informal and flexible approaches to solving the problems.
- Entrepreneurs are highly innovative and are responsive to better and safer technology.

Small-scale and home industries in Zimbawe

In Gweru and Bulawayo, informal sector operations are located in three main areas:

1. In neighbourhoods close to the home in Monomotapa, Ascot, Mkoba (Gweru) and Makokoba, Mzilikazi, Mpopoma (Bulawayo)
2. In industrial sites
3. In the central business districts.

The informal sector is a very important sector in a country. The Zimbabwean government has recognised its importance by setting up a fund to finance some of these activities and by building factory shells and areas for home industry.

The major activities that take place in the home industries of Bulawayo and Gweru range from motor mechanics to food catering and grocery shops. Motor mechanics are involved with panel beating, repairs and spray painting. Carpentry concentrates on the production of furniture and related items. Tinsmiths produce buckets, dishes, chicken fowl equipment, letter and electricity meter boxes and metal paraffin lamps. Welders produce burglar bars, window and door frames, gates, fences, scotch carts and ploughs. Tyre enterprises are involved in the mending, polishing and selling of tyres. Spare part enterprises buy and sell spare parts that range from household to vehicle parts. Food catering and grocery shops are involved in the preparation of *sadza*, rice and stew or chicken. There are also other activities such as the sale and repair of pipes and bath tubs, electric appliances, asbestos, art and painting, upholstery, textiles and straw basket and battery charging.

The main sources of the raw materials for the home industries are recycling, waste dumps, formal companies and even neighbouring countries. Welders obtain their raw materials from recycled waste material and recycle small scrap to repair scotch carts and ploughs. Motor mechanics obtain their raw materials from old car shells to repair other vehicles. The formal sector is also an important source of raw materials for the home industries, from which they obtain spare parts, timber, metal sheets, engine oil, tyres and food items.

Informal sector activities are a common feature in Harare. The situation we describe here was mostly before mid-2005, before Operation Clean Up or Restore Order (Murambatsvina), which saw the destruction of most illegal structures. New well-organised legal home industry structures are being established in the areas where these were once operating. They are concentrated in the high-density suburbs of Mbare, Highfield, Budiriro, Mabvuku, Tafara, Kuwadzana, Glen View, Warren Park, Mufakose and Glen Norah. Mbare home industry is the largest site of home industries in Zimbabwe. It is commonly referred to as Siyaso. Another prominent concentration of home industries is found in Highfield in the Gazaland area.

Mbare is the oldest high-density residential area in Harare, with over 680 residential stands. The Siyaso home industries are located in the northern part of Mbare in the Magaba area (See Figure 10.1). The area is serviced by sanitary facilities, tap water and electricity to selected trades such as welding.

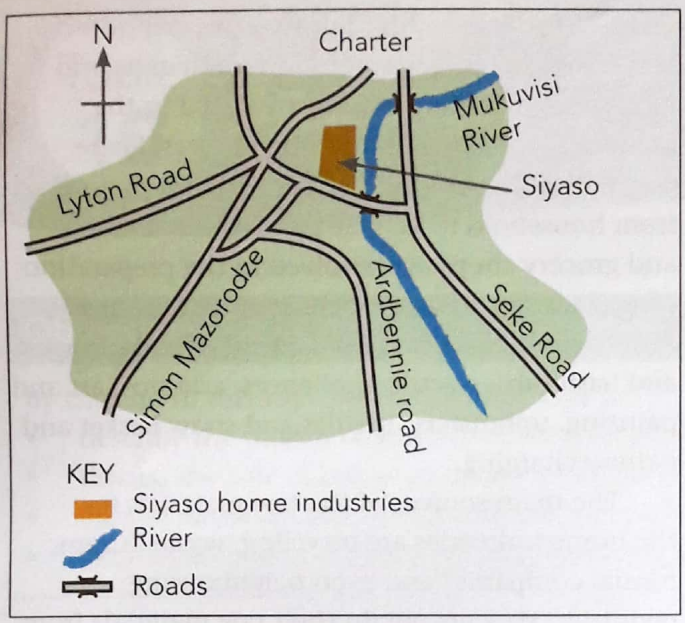


Figure 10.1 The location of Siyaso in Mbare

Highfield is located between the Willowvale industrial area and Waterfalls residential area. It also shares boarders with Glen View and Glen Norah. The main centres in Highfield are Gazaland, Machipisa and Lusaka. Gazaland home industries (See Figure 10.2) are located between the shops and New Canaan residential areas.

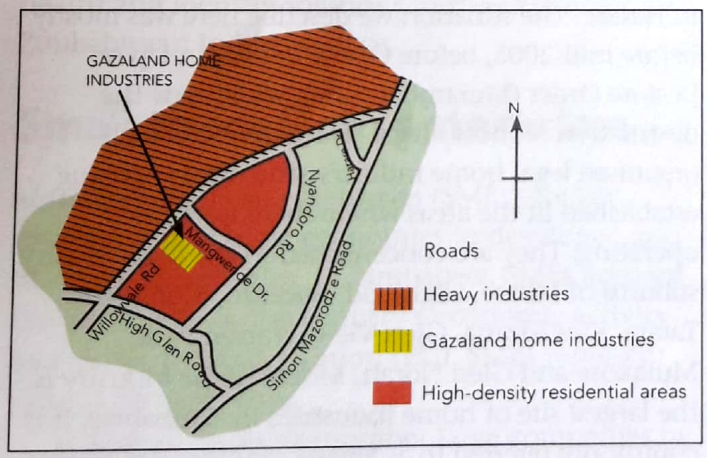


Figure 10.2 The location of Gazaland in Highfield

The industries at Mbare and Highfield home industries are family-owned with skills having been acquired from the formal sector or having been passed on within the family. Activities at the home industries include welding (production of window and door frames, burglar bars, ploughs, scotch-carts, gates and fences); carpentry is another important activity here with furniture production being prominent; and other activities involve motor mechanics who undertake panel beating, spray painting and repairs. Tinsmiths produce dishes, buckets, chicken-rearing equipment and letter boxes. Some people concentrate on mending, polishing and selling tyres whilst food catering and grocery shops are involved in food preparation. Other enterprises deal in electric appliances, battery charging, repairing pipes, straw basket making, art and painting. Welders constitute the largest number of enterprises whilst the food, catering and grocery shops constitute the smallest number.

Motor mechanics and welders obtain raw materials from recycled waste whilst the motor mechanics use parts of old car shells to repair other vehicles. The welders may recycle scrap metal to repair scotch-carts and ploughs. Some industries also get their raw materials from waste dumps. The formal sector is also a source of raw materials such as spare parts, tyres, engine oil, timber and food, indicating a link between the formal and informal sectors.

Activity 2

1. Why do you think waste dumps are also a popular source of raw materials for the home industries of Gweru and Bulawayo?
2. Describe the challenges that might face small and medium scale industrialists at the Gazaland site.

The advantages of the informal industrial sector are as follows:

1. It reduces unemployment because a lot of people get involved. This sector employs more than 60% of the country's workforce.
2. It uses little capital, so it is easy to start.
3. Materials that would otherwise have been wasted are recycled.
4. Practical and low-cost on-the-job training occurs and trained people can be engaged by the formal industrial sector.
5. Affordable products are produced for the majority of the people.
6. It promotes artistic skills such as carving, basketing and pottery.

The major constraints faced by informal sector enterprises include the following:

1. There is minimal or no supervision by city authorities or occupational safety and health authorities such as the National Social Security of Zimbabwe (NSSA), because most of the enterprises are family based and operate outside the main institutional and regulatory framework.
2. Occupational safety and health standards are too low to meet the requirements for registration as places of work.
3. Occupational diseases and accidents are rarely reported and never compensated.
4. Workers are not covered by the national social security nets and health insurance and there is therefore no security during old age.
5. In some cases, obsolete production methods are used and raw materials of inferior quality are substituted.
6. Workers are not provided with protective clothing to protect them against work hazards.
7. The small workshops mean that there is limited space for storage, so materials and tools may be difficult to reach, resulting in musculoskeletal strain that causes poor body postures.
8. Noise levels may be very high in some workplaces where processes such as tinsmithing, welding, drilling and motor mechanics take place. The noise levels sometimes exceed the recommended 85 decibels during a normal working day of eight hours and this can result in hearing impairments.
9. There is a lack of proper sanitary facilities in some enterprises, especially those at roadsides and in open air spaces.
10. Some of the enterprises use makeshift structures and workers are exposed to extreme heat or cold.
11. The risk of fire outbreaks is high due to the lack of fire-fighting appliances in the enterprises.
12. Some of the premises are poorly lit and ventilated.
13. There is also a lack of clean drinking water and washing facilities in most enterprises.

The informal sector operations are also supported by institutions and organisations such as the Small Enterprises Development Corporation (SEDCO) under the Ministry of Small and Medium Enterprises and the Affirmative Action Group (AAG). They also have their own association known as the Small and Medium Enterprises Association of Zimbabwe (SMEA).

Activity 3

Work in small groups.

1. a) You can sell anything that you can make or buy as long as there is a market for it. Brainstorm different kinds of small, informal business that will serve your community. Think of what people need or would like to have. Think of ways that you can provide the goods or service. Think about the skills members of your group have, for example, hair braiding, painting or singing. Think about things you could sell to your community. Think about items you have that your community could use, for example, if you have a bicycle with a carrier how can you use it to create an informal business?
   b) Report back to the class on your ideas.
2. a) Decide on an item to make from recycled materials such as plastic bags, boxes, plastic bottles or empty tin cans. For example, you could make bracelets from plastic bags, bird feeders from plastic bottles, pencil holders from tin cans, or solar cookers from cardboard boxes and newspapers.
   b) Report back to the class on your ideas.

Activity 4

1. Visit a home industrial area and list the activities that are found there. Share your findings with the class.
2. What benefits have been derived from home industries in Zimbabwe?
3. Examine the problems that are faced by home industry operators and suggest solutions to these problems.

4. Outline the major differences between conventional industries and home industries. Consider issues such as the size of operation, the labour force, types and sources of raw materials and the premises from where they operate.

Occupational safety and health in industry

Occupational safety and health is all about unsafe or unhealthy working conditions that expose workers to the risk of accidents or occupational illnesses. It is the duty of the government and industrial managers to ensure the health and safety of employees at work places.

The main custodian of occupational safety in Zimbabwe is the Ministry of Labour through the Division of Occupational Health and Safety of the National Social Security Authority of Zimbabwe (NSSA). NSSA's responsibility is to create awareness and to promote health and safety in the workplaces. Managers have to report all accidents to NSSA within 14 working days. It is the responsibility of managers to make sure employees are trained with regard to health and safety measures at their premises such as fire drills, the handling of hazardous materials and the use of protective clothing.

NSSA established the Accident and Prevention and Worker's Compensation Scheme which was put in place to meet all costs related to workplace injuries such as transport, drugs, hospital fees, hearing aids, artificial limbs, crutches and so on.

Activity 5

With the help of your teacher, visit three different major industrial firms to research the measures they have for occupational safety and health.

Challenges associated with manufacturing and processing industries in Zimbabwe

The challenges facing manufacturing and processing industries include the following:

1. Old equipment: Most of the major industrial equipment is 50 years old. With old equipment, frequent break-downs occur leading to the plant being out of action, high maintenance costs, poor quality products, high-energy consumption and high environmental pollution. Old equipment results in high manufacturing costs, which makes the products less competitive in a global environment. It is also difficult to get a part to repair old equipment.
2. The lack of spare parts: Most of the equipment used in industries is imported and most of the machinery is no longer being manufactured in the countries of origin. To make matters worse, some of these spare parts are no longer being manufactured at all.
3. Poor energy supply: Manufacturing is powered by energy, mostly electricity. In recent times, electricity supply in Zimbabwe has been very erratic, due to load shedding. When load shedding occurs, companies can be cut off in the middle of production or go for hours without power. All this may result in the loss of raw materials especially for industries dealing with the melting of metal, glass and plastic products.
4. Water supply: Companies need water for cleaning processes and steam generation. Most industrial activities in Harare and Bulawayo suffer due to a lack of water.
5. Raw materials: The success of industries is based on the reliable supply of raw materials. Most industries using coal and coke suffer due to raw materials not getting to industries on time or due to erratic supplies. In some cases, it takes a long time for imported raw materials to reach the country. The success and performance of

industries such as beverages, tobacco, textiles, clothing and leather hinges on the performance of the agricultural sector which has been affected by uncertain climatic conditions and the land reform programme.

6. A lack of skills: When new equipment arrives, workers may lack the necessary knowledge to operate and maintain the machinery. Since 2000, many companies have been affected by the brain drain.
7. A lack of capital: The use of the US Dollar as currency resulted in some companies failing to raise capital for equipment, spare parts and wage bills. Banks have not been supportive and charge high interest rates. They also have tended not to offer short-term lending solutions.
8. Poor market conditions: Due to high unemployment, there is a low demand for products. Local consumers are buying critical products only and leaving out what they may see as luxury goods. Alternatively, they have been buying cheap imports. The poor market has also been linked to cheap imports of textile and clothing items from China and South Africa.
9. High utility bills: This has resulted in the high cost of production. Electricity, water, phone calls and other service charges are very expensive in Zimbabwe's Urban Councils. Water and electricity bills were at one time based on estimates, making it difficult for companies to practice water or power management.
10. Mismanagement: Most industries fail to perform well due to corruption and mismanagement.
11. Poor transport systems: Industries rely on the transportation of raw materials and products. The transport sector failed to perform up to standard due to poor roads and railway systems.
12. A lack of Investment: The Zimbabwean manufacturing industrial sector lacked new investments due to perceived country risks.

Solutions to challenges facing manufacturing and processing industries

It is clear that the manufacturing and processing industries in Zimbabwe face many challenges. However, there are a number of possible solutions to these problems and some of these solutions are presented here:

- Reviewing import tariffs for the motor industry, the beverage industry, agricultural commodities and the clothing and leather sectors
- Mobilising affordable lines of credit to local industries for re-equipment and re-tooling
- Increasing import duties on vehicles and other products or even banning the import of certain goods
- Improving border management to prevent the import of cheap foreign products
- The government and private sectors coming up with strategies to ensure the availability of cheap and reliable sources of energy
- Companies needing to invest in new equipment and technology
- Developing infrastructure such as roads, rail, airports, dams and communication
- Controlling the pricing of utilities such as water, electricity and communication.

Activity 6

List five challenges facing manufacturing and processing industries in Zimbabwe and offer solutions to these problems.

Summary

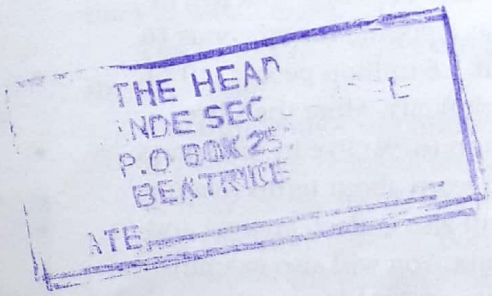
- The location of an industry is governed by factors such as raw materials, power, labour, transport, markets, capital, historical factors and government policies.
- The distribution of industries in Zimbabwe is mainly a function of historical factors and the availability of raw materials. The major industrial centres are Harare, Bulawayo, Mutare, Kwekwe and Gweru.
- Home industries have contributed greatly to the country. The Zimbabwean government has realised this and is helping by providing funding, setting aside areas and building sites for home industries.
- Informal sector activities consist of self-employed people operating small-scale family enterprises. They play a vital role in the economy of a nation by alleviating unemployment problems.
- The problems that industries face include inadequate capital, competition, a lack of raw materials, high taxation, a lack of markets, corruption and mismanagement and a lack of skills, technology and infrastructure.
- Solutions to the problems faced by industries should come mainly from the government through export incentives, tariff protection and infrastructure development.

Glossary

small-scale industries – industries which produce low-bulk goods and in small quantities and usually for a local market

Topic test

1. a) What are small and medium enterprise?
   b) Describe he locations of three SMEs you have studied.
   c) State and suggest solutions to the challenges faced by these SMEs.
2. a) Name five advantages of an SME to a local area.
   b) Describe the negative effects of SME activities in an area.
   c) Suggest possible reasons why local authorities may not be keen on establishing SMEs in their areas.
3. a) What is occupational health and safety in industries?
   b) Describe the role of NSSA in promoting health and safety at workplaces.
   c) Suggest reasons why it is difficult to implement health and safety at SMEs.
4. a) What are the problems faced by industries in developing countries?
   b) Suggest possible solutions to the problems you mentioned above.



Topic 11 Settlement and population

Objectives

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

- describe population terms
- apply population terms at local or national levels
- collect population data within the school or local community
- analyse population data
- present population data
- interpret population data
- describe population distribution in Zimbabwe, Africa and the world
- explain differences in population density in Zimbabwe, Africa and the world.

Population is the number of people that live in a place. Zimbabwe has a population of about 16 million people. About 1.6 million people (10%) live in Harare the capital city. More than two thirds of the population (67%) live in rural areas. In this topic, you will learn about terms relating to population. You will also collect, analyse and present population data. You will also examine the population distribution of Zimbabwe, Africa and the world and explain the differences between them.

Population terms

The population of an area does not stay the same. There are times when more babies are born and fewer people die, which means that more people are added to an area. Population is affected by the birth rate and death rate, which result in a growth rate or a natural increase, or in a decrease if there are more deaths and fewer births.

The definitions of some of the terms we use in population studies are as follow:

- **birth rate:** the number of live births per year per 1 000 people
- **death rate:** the number of deaths per year per 1 000 people, also referred to as the mortality rate
- **infant mortality rate:** the number of deaths of children below one year per 1 000 children per year; also defined as the number of infant deaths per year per 1 000 live births
- **fertility rate:** the biological capacity of females in a population to produce offspring
- **life expectancy:** the number of years that the average person in a given area may expect to live
- **natural increase:** this is obtained by subtracting the death rate from the birth rate. It does not include migration into or out of the area. So, the calculation is as follows: natural increase = birth rate – death rate.

Table 11.1 below shows the crude birth and death rates and the rate of natural increase by province from the Zimbabwe 2012 census.

Table 11.1: Crude birth and death rates by province, Zimbabwe 2012

Province	Crude birth rate (per 1000)	Crude death rate (per 1000)
Bulawayo	27.3	9.3
Manicaland	33.4	10.3
Mashonaland Central	34.1	11.4
Mashonaland East	32.5	11.6
Mashonaland West	34.0	10.7
Matabeleland North	27.5	10.0
Matabeleland South	26.8	12.5

Province	Crude birth rate (per 1000)	Crude death rate (per 1000)
Midlands	31.7	10.1
Masvingo	30.9	10.6
Harare	33.3	7,7
Total	31.9	10.2

The crude birth rates for the Midlands were obtained by dividing the number of births occurring in the year by the total population, multiplied by 1 000. The crude birth rate for the Midlands province was 31 per 1 000.

The crude death rate is the number of deaths per 1 000 people. The crude death rates for the Midlands were obtained by dividing the number of deaths in the last 12 months (of that period) by the total population multiplied by 1 000.

$$\text{Crude birth rate} = \frac{\text{births per year} \times 1\,000}{\text{total population}}$$

$$\text{Crude death rate} = \frac{\text{deaths per year} \times 1\,000}{\text{total population}}$$

Activity 1

1. Study Table 11.1 and answer the questions that follow.
   - a) Which province has:
     - (i) the highest birth rate?
     - (ii) the lowest birth rate?
     - (iii) the highest death rate?
     - (iv) the lowest death rate?
   - b) (i) Calculate the natural increase for each of the provinces.
     - (ii) Which province had the highest and lowest natural increase? List possible reasons for this.
   - c) Draw bar graphs to show the birth and death rates for Harare, Bulawayo and the Midlands.

Factors affecting birth and death rates

Table 11.2 shows the birth rates and death rates of two developed countries and two developing countries in 2014.

Birth rates are higher in the developing countries (Zimbabwe and Zambia) than in the developed countries (Britain and Australia).

Table 11.2 Birth and death rates in two developed and two developing countries

Country	Birth rate	Death rate
Zimbabwe	35	10
Zambia	40	9
Britain	1312	9
Australia	13	7

Factors that affect birth rates

The birth rates in the world differ from country to country and from place to place. Usually the developed countries in Europe and North America have lower birth rates than those of developing countries in Africa and Asia. Within a country such as Zimbabwe, birth rates are higher in rural areas than in urban areas.

The factors that affect the birth rates include the following.

- **The importance of children:** In countries such as Zimbabwe, children are seen as a source of security for the future when their parents get old. The more children born, the better the security for the parents. This encourages parents to have larger families. Children are used as a source of labour in the fields, especially in rural areas. They also help to look for water and firewood. This motivates people to have larger families. In urban areas, children help with vending activities such as selling fruits and vegetables, bringing more money to the home.
- **Early marriages:** These lead to high birth rates because there will be a very long time for the husband and wife to have as many children as they can.
- **The need for a male child:** Couples who do not have a male child keep on having children with the hope that they will eventually have a male child who can carry on the family name.
- A **symbol of greatness:** Having many children is regarded as a symbol of greatness so people tend to bear many children.
- **Religious beliefs:** Some religions do not allow abortion or the use of contraceptives. As a result, birth rates become high.

- **Family planning programmes:** The planning of families through clinics can result in child-spacing. Families become small and reasonable to manage. This lowers the birth rate.

Factors that affect death rates

The death rates of most countries of the world have dropped because of many factors. In Zimbabwe, the Ministry of Health and Child Welfare introduced many measures to reduce the deaths that were due to some common diseases. These measures include the following:

- **Reducting of the infant mortality rate:** The infant mortality rate refers to the number of children who die before reaching the age of one year per thousand live babies. The infant mortality rate has been reduced by vaccinating against the child-killer diseases such as measles, polio and smallpox.
- **Water and sanitation:** Tap water and borehole water is safer from diseases and is less likely to be polluted. The government of Zimbabwe has ensured that most parts of the country have safe water for domestic use. This has helped to reduce the death rate. In many parts of the country, improved toilet facilities, for example Blair toilets in rural areas, have helped to improve sanitation and reduce disease.
- **Food:** A balanced diet is important for our bodies. Where there is a shortage of food, people are malnourished, resulting in more deaths. The government and some non-governmental organisations help by giving food to needy people in the rural areas.
- **Wars:** When a country is at war, people may be killed, causing an increase in the death rate of able-bodied men and women who are usually involved in the fighting.

The collection, presentation and interpretation of population data

Collecting of population information

Population information is very important for a country such as Zimbabwe. At your school, it is very important for your head to know how many students there are so that he or she knows how many books to buy for each class. The school head might also want to know how many girls and boys there are and how many children are aged 13, 14, 15, 16 and so on, for planning purposes.

Likewise, a country needs population information. The country's population information can be used in many ways:

- to plan for the country's present and future requirements such as food, accommodation, employment, health facilities, schools, colleges, universities, water and transport
- to make boundaries for districts, provinces or election constituencies
- to check the movements of people within, or out of and into the country.

The most common sources of population information are the **census** and **vital registration** records.

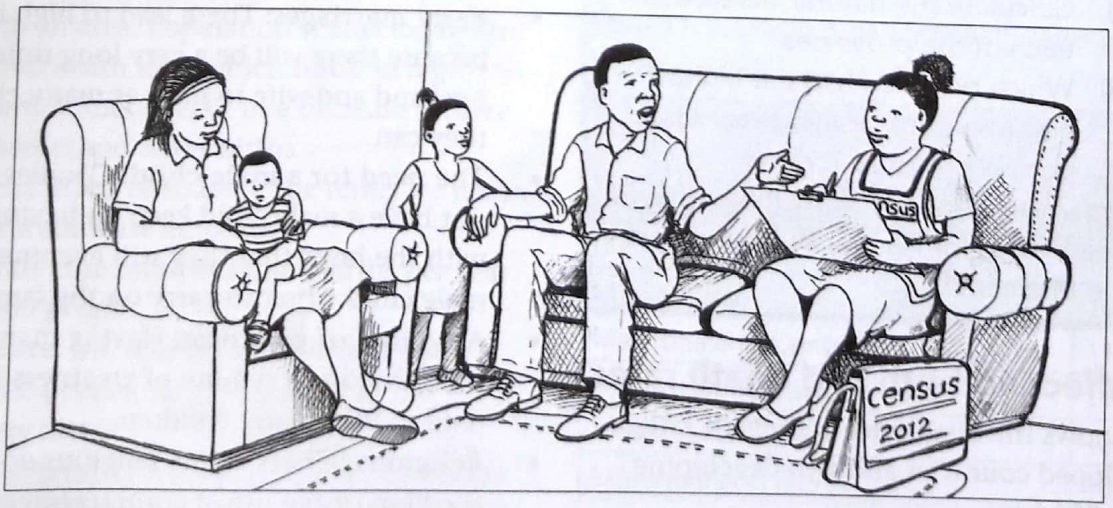


Figure 11.1 An enumerator collecting population information

Censuses

A census is the main source of population information. A census involves counting the people in a country and publishing the results of the counting.

It is not very easy to undertake a census because it involves counting people in the whole country. The census requires a lot of money for the counting of the population and administration. Money is required to buy stationery, for transport, to pay the people involved in the counting who are called the **enumerators** and for other administration purposes. The census process also takes some time. It starts before the actual counting by planning the dates of counting, preparing maps of all the areas to be visited by the enumerators, training the enumerators and educating the people in the country about the census.

A census is held at regular intervals. In Zimbabwe, a census is held every 10 years. The census process in Zimbabwe was formerly administered by the Central Statistical Office, but is now administered by the Zimbabwe National Statistics Agency (ZIMSTAT). Since independence in Zimbabwe, censuses were held in 1982, 1992, 2002 and the latest in 2012. In Zimbabwe, a person is counted wherever that person is found during the census time. A person is counted where he or she was during the census night: for example, if the census started on 18 August, the census night is the night from midnight 17 to 18 August midday. This way, the chances of one being counted twice is slim. This means that if your usual home is Gutu and during the census period you are in Lupane, you are counted in Lupane and the enumerator does not have to wait for you to return to Gutu.

Activity 2

1. When was the last census that you remember?
2. Were you counted in the last census and where were you?
3. If you were not counted, what was the problem?

Mini-census project

4. In groups of three, prepare a list of the following aspects you would use for a census at your school: age, sex, citizenship, usual residence, education, religion, place of birth.
5. Go around the school and ask about 30 people to provide you with their details.
   a) Which age group has the most people and which has the fewest?
   b) How many boys and how many girls are in each age group?
   c) What is the most common citizenship among the people you counted?
   d) Out of the 30 people you counted, which education level is common?

Information collected using a census

The information collected during a census differs from country to country. However, the following information is generally collected in Zimbabwe and other SADC countries:

- the name or address of the place of counting
- the age of the person being counted
- the sex of the person
- whether the person is married
- the number of children the person has
- the person's citizenship
- the person's place of birth
- how the person is related to the head of the house
- the person's religion
- the highest education level reached
- employment status
- house ownership (self-owned, renting or company)
- water supply situation
- cooking facilities.

Figure 11.2 A census will enquire about a person's citizenship.

Vital registration

Registers of births and deaths, which are important or vital life-beginning and life-ending records, can also be used to get information about a population. You have a birth certificate that shows information such as your age, sex, parents, place of birth, nationality and citizenship. Study your birth certificate and see if it shows this information.

Vital registration also considers the recording of marriages that take place, divorces and migration. This information from vital registration can be unreliable when a country does not have enough money to record these events, or people simply do not bother to get birth, death or marriage certificates.

The presentation and interpretation of population information

Population structure

One of the most important aspects in the study of populations is **population structure**, which is the composition of the population by its age and sex. The structure of a population is important for planning purposes because you can tell future social and economic implications.

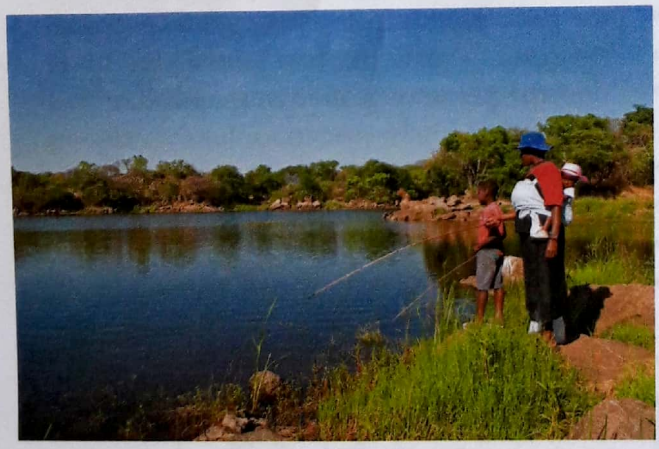


Figure 11.3 To determine its population structure, it is important to find people's age and gender.

Population pyramids

The population structure of a country or an area can be shown by an age-sex pyramid. Age–sex pyramids are bar graphs that show the population of males and females that are in each age group; 0–4, 5–9, 10–14 etc. The males are placed on the left and females on the right and each age group is given as a percentage of the total population. The percentages are placed on the horizontal scale. Figure 11.4 is an example of an age-sex pyramid.

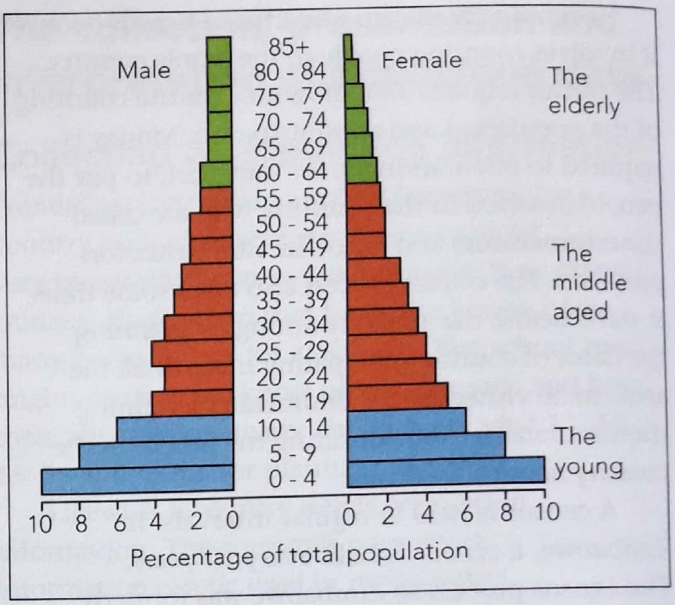


Figure 11.4 An age-sex pyramid

DID YOU KNOW?

Population pyramids are in reality divergent bar graphs. The males and females bar graphs are sharing the same age scale. The term 'population pyramid' has been internationally accepted and agreed upon.

From the shape of the pyramid, you can tell at a glance whether the population is expanding, stationary or decreasing. The pyramids can also show past changes in the population, as well as predict both short-and long-term changes in the population.

The pyramids also reveal the proportions of the youthful, economically active and elderly populations whereby those aged above 0 to 14 are considered as youthful dependants, 15 to 64 as the working population or the economically active population, and those aged 65 and over as the elderly dependants. The ratio of the dependants versus the working population is called the dependency ratio.

The dependency ratio can be expressed as: children (0–14) and elderly (65 and over) × 100 divided by the working population (15–64).

$$\text{Dependency ratio} = \frac{\text{(0–14) + (65 and over) population} \times 100}{\text{(15–64) working population}}$$

The shape of a country's pyramid can reveal:

- the effects of migration
- the age and sex of migrants
- the effects of past fertility and **mortality** rates
- the effects of major wars and epidemics of diseases
- the effects or lack of population planning policies.

Each country has a unique structure but model pyramids have been produced for study purposes and for assessing how far a country conforms or does not conform to the given model.

There are three main types of population pyramids.

Expanding population pyramids

Figure 11.5 illustrates an expanding population pyramid.

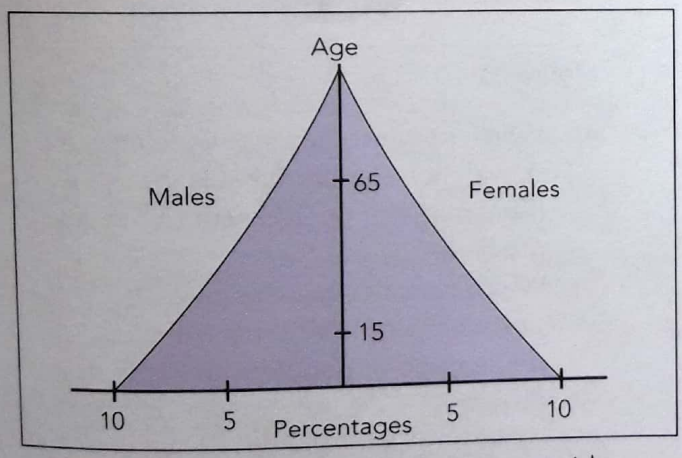


Figure 11.5 An expanding population pyramid

This pyramid is characterised by high birth rates, high death rates and a low life expectancy. This pyramid is typical of most developing countries. It is regarded as expanding because of the high birth rate. The pyramid has a narrow and short top indicating low life expectancy. Life expectancy is the number of years a person born at a particular point in time, given the health and environmental conditions, can be expected to live.

Stationary population pyramids

Figure 11.6 shows a typical stationary population pyramid.

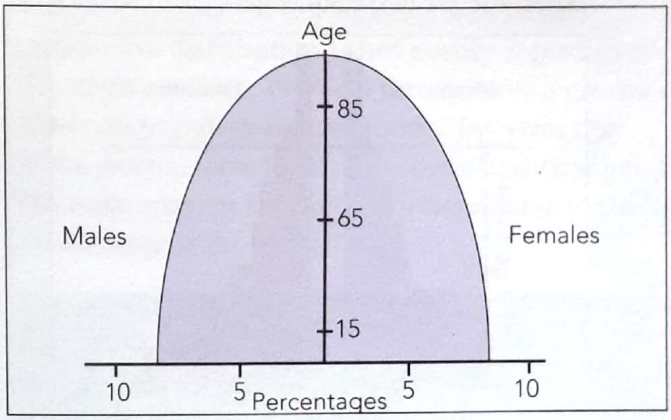


Figure 11.6 A stationary population pyramid

The stationary population pyramid is characterised by declining birth rates, low death rates and more people living to an older age, which means a highier life expectancy. This pyramid is typical of most developed countries.

Contracting population pyramids

Figure 11.7 illustrates a contracting population pyramid.

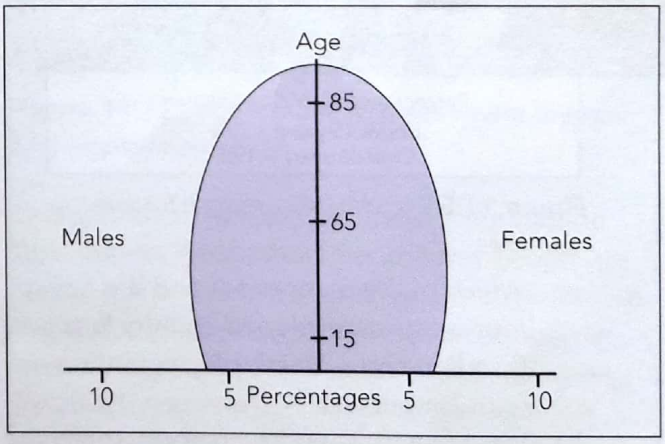
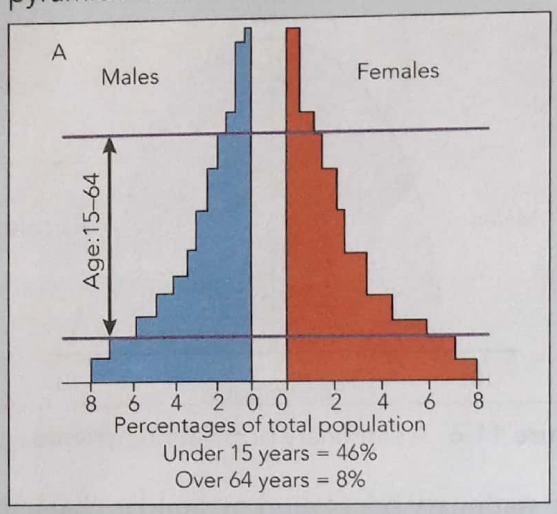


Figure 11.7 A contracting population pyramid

The contracting population pyramid has a narrow base and a broad top. This population pyramid is characterised by low birth rates, low death rates, and a higher life expectancy. It is characteristic of a developed country with high living standards, high education, good health facilities, good food and high social awareness. Good examples would include countries such as the UK, Sweden and Japan.

Activity 3

1. Figure 11.8 below shows population pyramids for two countries.



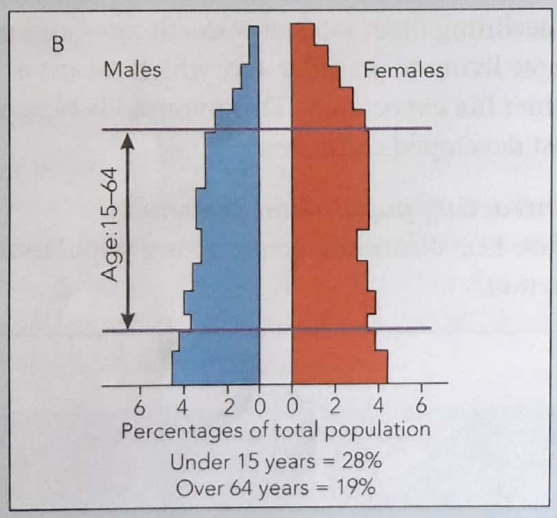


Figure 11.8 Population pyramids for two countries

   a) Which of the diagrams A and B represents a developed country (e.g. Sweden) and a developing country (e.g. Zimbabwe)?
   b) Identify and name four demographic differences between the pyramids.
   c) Suggest two possible future population related problems likely to be faced by the two countries and offer possible solutions to overcome the problems.

2. Figure 11.9 shows two population pyramids for Zimbabwe. Describe and explain the differences between the two population pyramids.

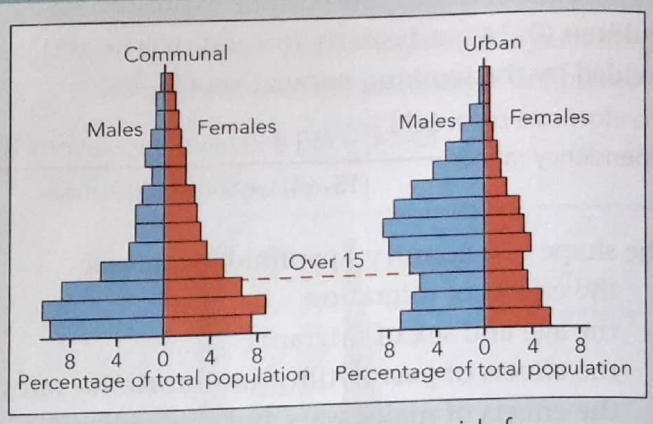


Figure 11.9 Two population pyramids for Zimbabwe

3. Refer to the map below showing the prevalence of HIV per province. Use it to answer the questions that follow.

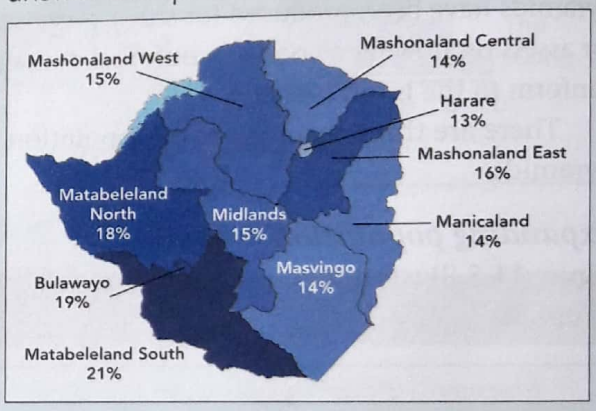


Figure 11.10

   a) Which province has the highest prevalence of HIV? What is the percentage of people with HIV in this province?
   b) Which province has the lowest prevalence of HIV? What is the percentage of people with HIV in this province?
   c) What is the prevalence of HIV in the province in which you live?

4. Zimbabwe is among the countries in Sub-Saharan Africa worst affected by the HIV and AIDS epidemic. There are more than 1.4 million people living with HIV in Zimbabwe. In a group, discuss the following:
   a) How does the high rate of HIV in Zimbabwe affect the economy?
   b) What can we do to decrease prevalence of HIV?

5. Refer to the population pyramid below, which shows Zimbabwe's projected population for 2030 with and without AIDS. In groups, discuss the effect HIV and AIDS has on the population structure of Zimbabwe. Refer to the effect on different age groups and on men and women.

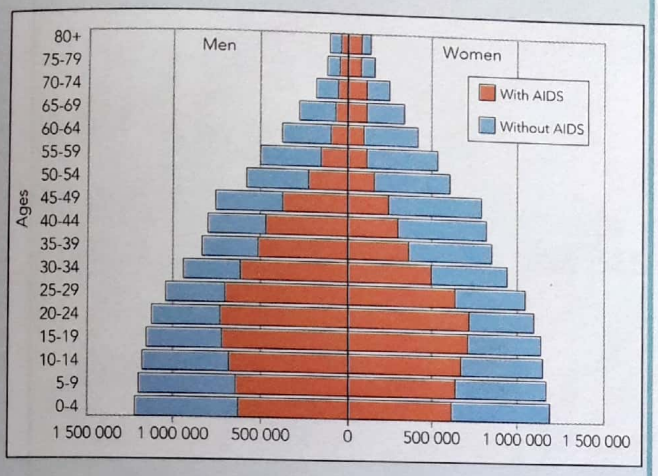


Figure 11.11

DID YOU KNOW?

Data is information or facts. *Demography* is the study of populations, and the term *demographer* refers to a person who studies populations, especially births and deaths, population growth and the general living conditions of people in a community or a country. *Demographic data* is information relating to an aspect of population.

Population distribution and density in Zimbabwe, Africa and the world

In the study of population, it is important to know where people of the world live and why. The location of these people across the world and in different countries is a result of a number of complex dynamic human and physical factors accompanied by millions of years of historical developments.

People in any given area of the world are distributed as a result of choice or necessity. Generally people are located in the environment where there are favourable factors such as farming land, availability of water and favourable climate. The environment is not uniform and hence population distribution is not evenly spread over the earth's surface. Physical factors have a greater effect on population distribution, but over the years, people have learnt to control and change the environment for their own needs and so the distribution is far wider.

Figure 11.12 People move to areas where they can find employment.

In the study of population, there is population distribution, which describes the way people are spread out in an area. This is usually shown by the use of dot maps, where a dot represents a given number of people. It is a more realistic method, because it shows where we have high and low concentrations of people. We also have population density, the number of people per unit area, which could be people per square kilometre or mile. Population density for a country is calculated by dividing the total population of the country by its land area. Population density is usually shown using shaded maps. The densities are grouped into classes, each shaded lighter to reflect less, or darkened to reflect greater density. These two methods are shown in Figures 11.13, 11.14 and 11.15.

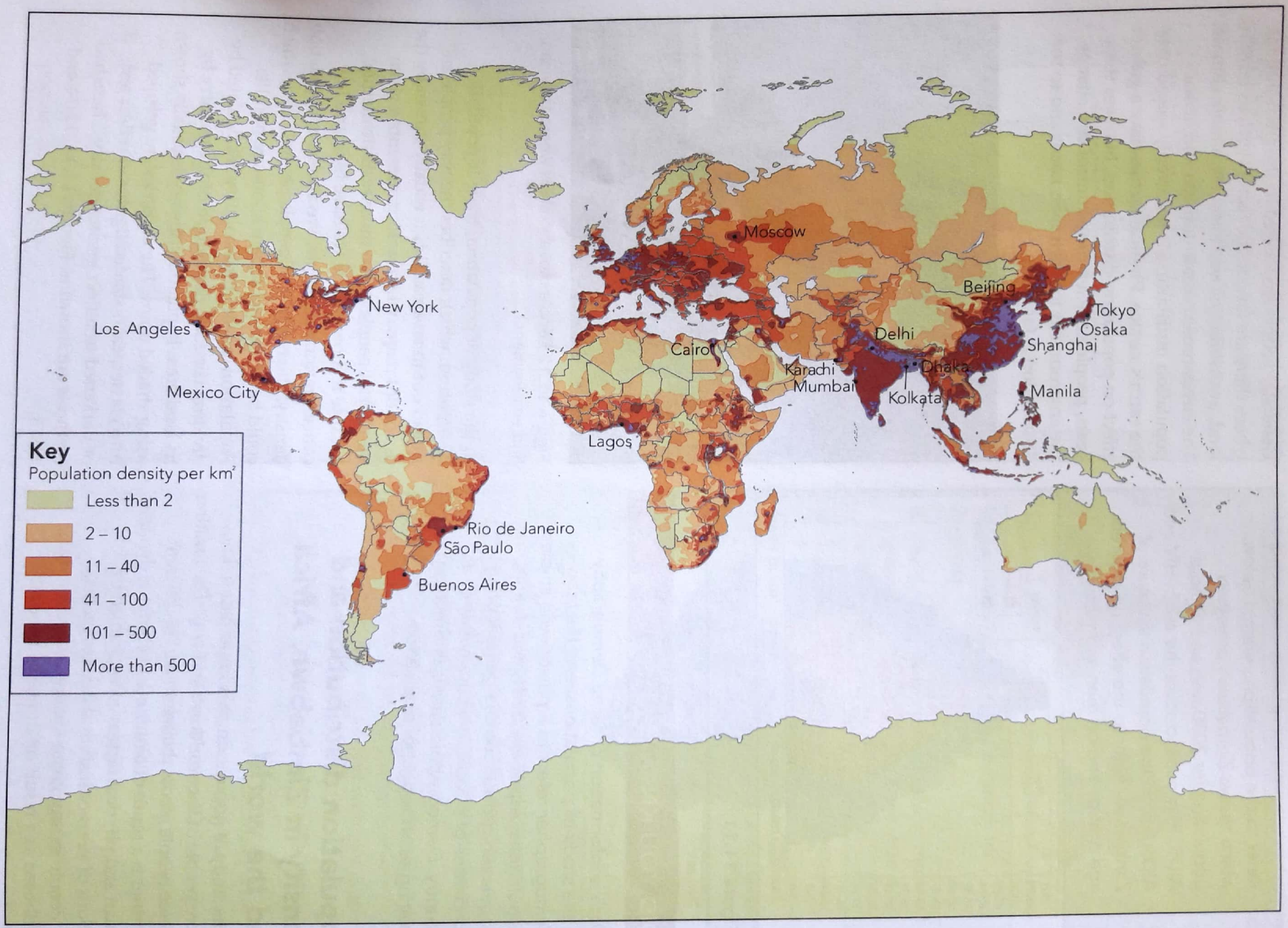


Figure 11.13 A map showing world population distribution

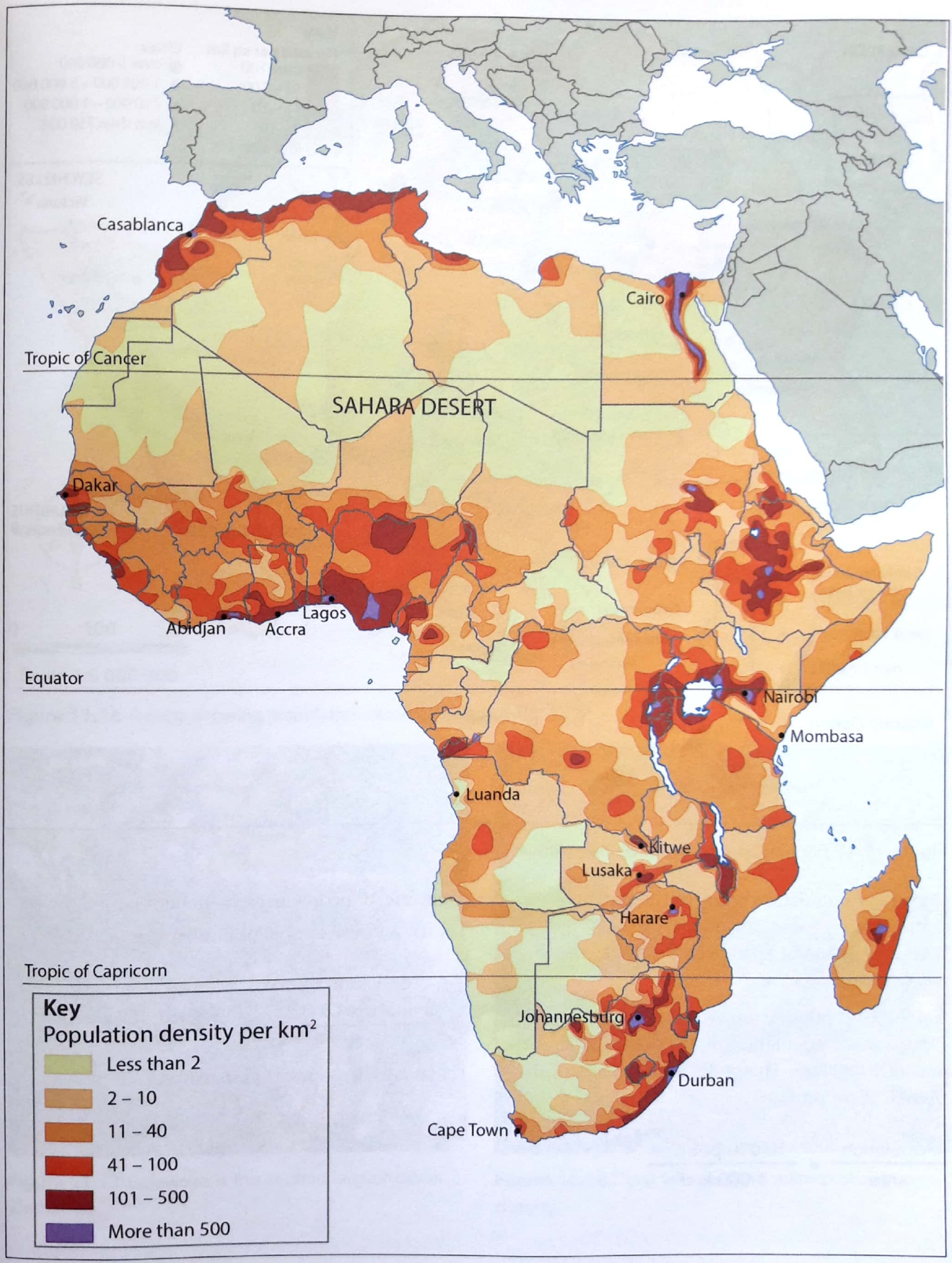


Figure 11.14 A map showing population density in Africa

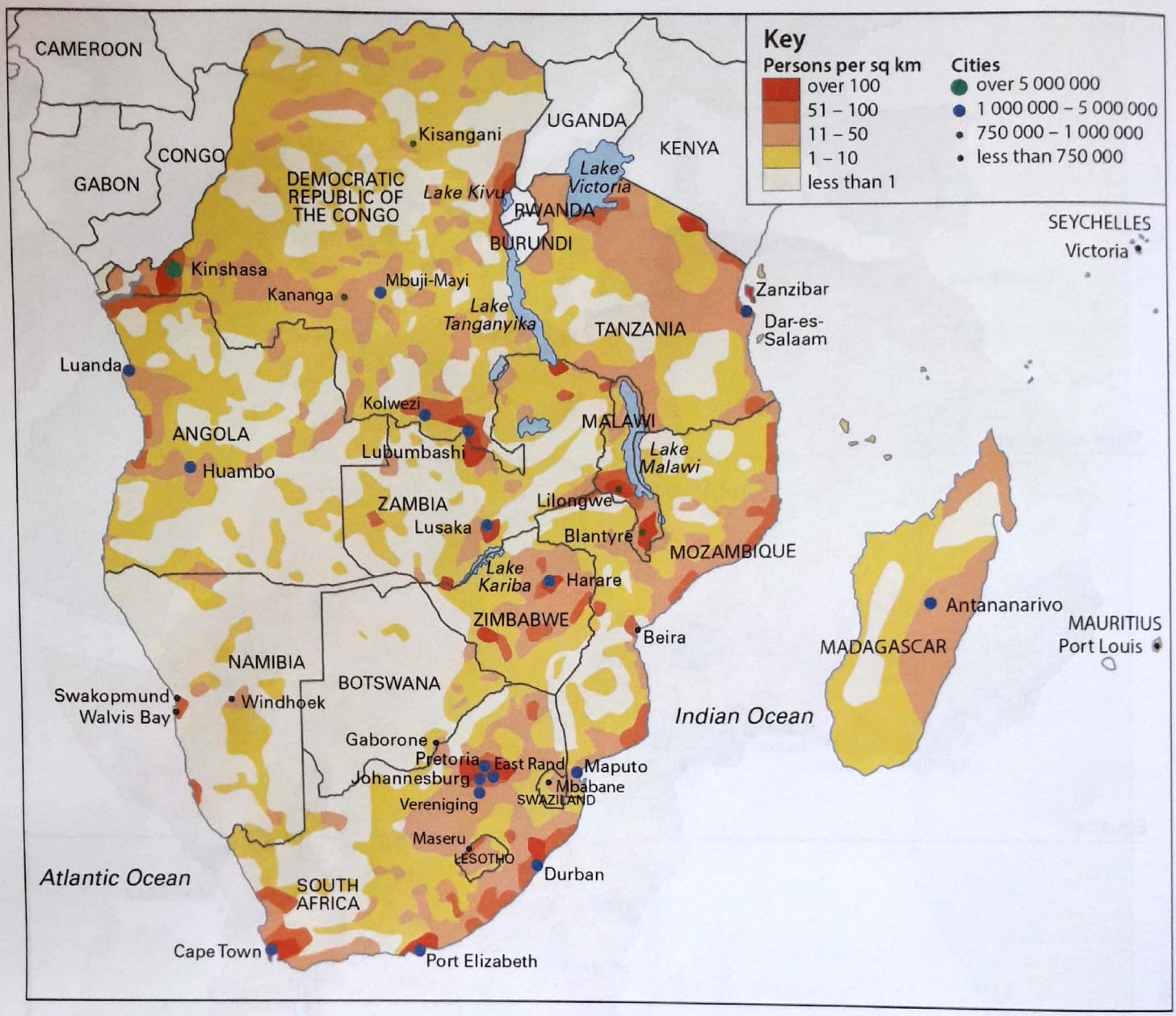


Figure 11.15 Population density in southern Africa

Density of population refers to the number of people per unit area. It is found by dividing the total population of an area by its area as shown in the calculation below.

Calculating population density:
Place X has a population of 10 000 people and an area of 1 000 km². The population density of the place is therefore:

$$\frac{\text{Population}}{\text{area}} = \frac{10\,000 \text{ people}}{1\,000 \text{ km}^2}$$

There are 10 people per square kilometre.

Let us use the example of Zimbabwe:

$$\frac{\text{Population of Zimbabwe (2002)}}{\text{Area}} = \frac{11\,631\,657 \text{ people}}{390\,759 \text{ km}^2}$$

Calculate the population density.

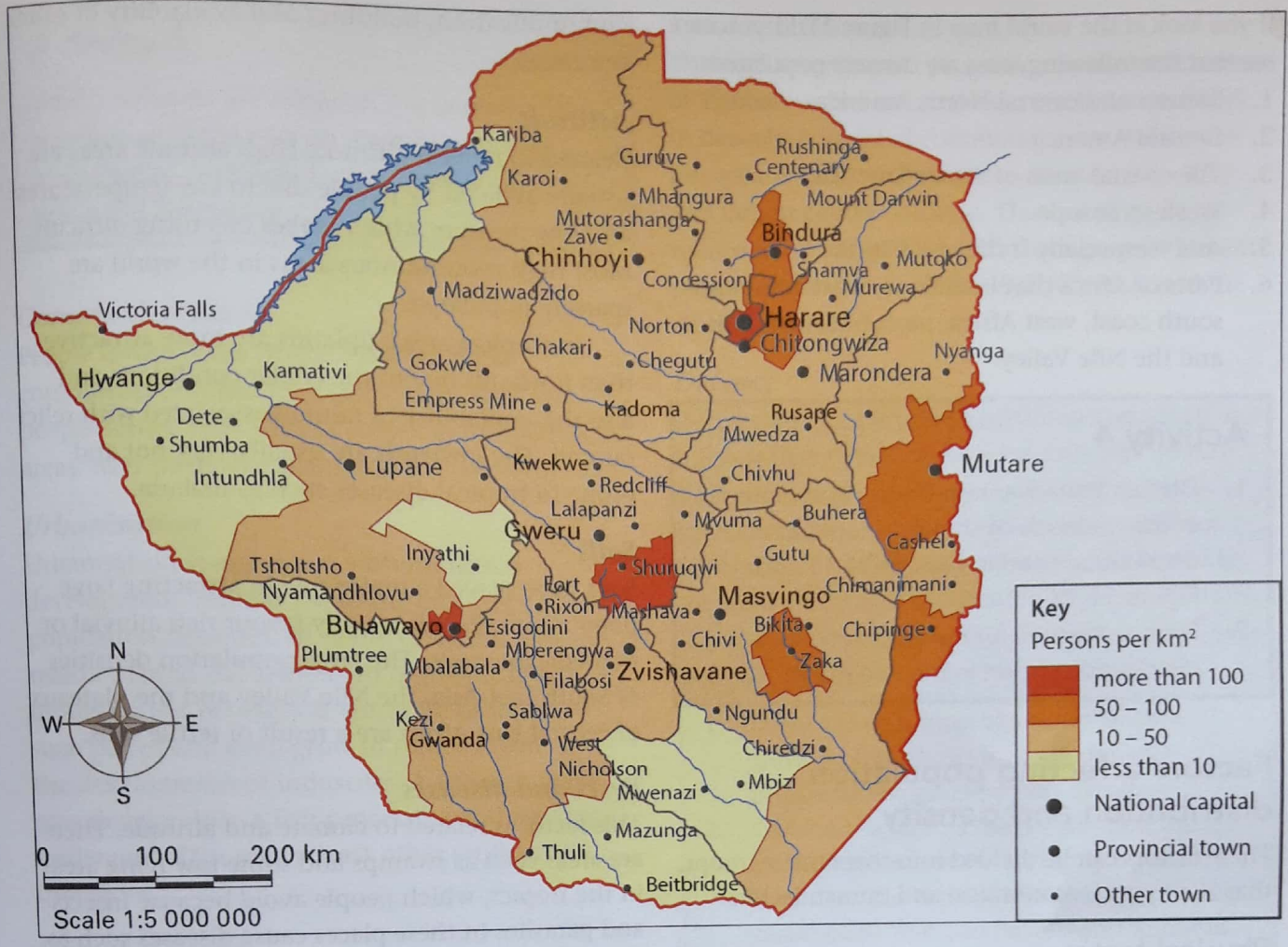


Figure 11.16 A map showing population density in Zimbabwe

Figure 11.17 Bulawayo is the second largest city in Zimbabwe.

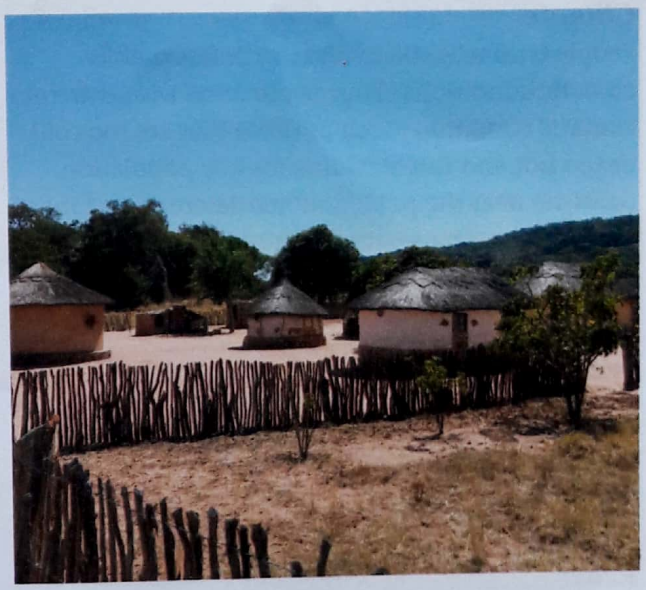


Figure 11.18 Rural villages have a low population density.

If you look at the world map in Figure 11.11 you can see that the following areas are densely populated:

1. Eastern and central North America
2. Central America
3. The coastal areas of South America
4. Western Europe
5. Asia – especially India and China
6. Parts of Africa that include the east coast and south coast, west Africa, parts of central Africa and the Nile Valley.

Activity 4

1. Discuss the advantages and disadvantages of the methods of showing population distribution used in Figures 11.11 and Figure 11.12.
2. Discuss reasons for the population distribution shown in the two maps.

Factors affecting population distribution and density

These factors can be divided into three main groups, that is, physical, economical and human factors.

Physical factors

Climate

People tend to settle in areas with favourable climatic conditions. They avoid areas with extreme climatic conditions such as those that are too cold or too hot and this accounts for low population densities near the poles and hot desert areas. Linked to climate, we have areas with high humidity being avoided, as well as areas that experience low annual rainfall and long seasonal droughts.

Water supplies

Water is very important in people's lives and so people tend to favour areas with water supplies such as springs and rivers and areas that receive reliable and also heavy seasonal rainfall.

Relief

Generally, people prefer level terrain and therefore avoid high rugged mountains. Fairly level lowlands have a lot of advantages in terms of cultivation, communication, buildings and availability of other resources.

Altitude

Related to relief is altitude. High altitude areas are usually avoided by people due to low temperatures and low pressure which makes breathing difficult. Most high mountainous areas in the world are sparsely populated.

In tropical areas, uplands are more attractive than lowlands due to the cooler conditions and also the availability of rainfall associated with relief rainfall. The lowlands are usually very hot and prone to tropical diseases such as malaria.

Soils

Soils have played a major role in attracting large populations. People usually favour rich alluvial or rich volcanic soils. The large population densities of South East Asia, the Nile Valley and the plateaux of central East Africa are a result of fertile soils.

Pests and diseases

This factor is related to climate and altitude. There are areas such as swamps and some low lying areas in the tropics, which people avoid because insects and parasites in these places cause diseases such as malaria, sleeping sickness and river blindness.

Vegetation

Densely forested areas such as the rainforest areas of Africa support low population densities. These areas include the Congo and west African tropical rainforest, as well as the Amazon Basin in South America. These forests cannot be easily penetrated. They may also be home to dangerous pests.

Economic factors

Natural resources

The occurrence of resources, especially mineral resources, has played a major role in the creation of densely populated areas. Most of the world's areas of high population are linked to the exploitation of mineral resources. Good examples are the Copperbelt of Zambia and the Rand area of South Africa. In Zimbabwe, settlements that developed due to mining include Shurugwi, Zvishavane, Hwange, Kwekwe, Kadoma, Bindura, Mhangura, Mashava and Shamva.

Activity 5

Which minerals are mined in the settlements mentioned in the text on mineral resources? Name other settlements that developed from mining in Zimbabwe.

Communication

People favour areas where there are good communication facilities and hence, long ago, people settled near gaps or passes in mountainous areas, near navigable rivers and in coastal areas.

Urbanisation

Urbanisation is associated with industrial development and has led to the creation of high population densities. In many cases, the initial reason behind the settlement of people may disappear but people will continue to settle in such places and even grow in numbers due to the development of industries. A fishing village may develop into a fish-processing and packing settlement. This may attract other services and industries.

Human factors

Political

Governments, through policies, can stimulate the creation of population densities in unsettled areas. A good case is that of the Jewish people in the Gaza Strip, where Jewish people from all over the world were made to settle. The other cases are the resettlement schemes of independent African countries such as Zimbabwe and Tanzania that wanted to redress the colonial land imbalances.

Historical

Some areas have a long history of settlement, resulting in them being densely populated through the natural growth of population. Areas that are highly populated due to this factor are Western Europe and the river valleys of China. The other historical factor is trade. Trade led to the creation of densely populated areas on coastal areas, especially in West and East Africa and also in some rather unfavourable areas of northern Nigeria.

Land resettlement

Through resettlement programmes, the government of Zimbabwe has reduced the population pressure in densely populated communal areas. When the Europeans came to Zimbabwe, they took the best and largest portion of land. This has since been redressed by the government through resettlement programmes such as Model A, B, C and D and the A1 and A2 models.

Defence

In the past, people used to settle in areas such as hilltops that provided security. This was because wars were common. Hilltops in Nigerian areas such as the Jos Plateau were settled for defence purposes. This is no longer a major factor due to the availability of sophisticated modern weapons.

Activity 6

1. Draw a sketch map of your local area showing the places that are densely populated or sparsely populated.
2. Outline the factors that influenced the distribution of settlements in your area. (Consider the factors affecting population distribution that you have learnt about in this section.)
3. Study the satellite photograph below, which shows the world at night.
   a) Explain how the photograph can help you determine population density of different parts of the world.
   b) Use an atlas map of the world to identify the regions in the world that appear to be the most densely populated.
   c) Study southern Africa on the map. Describe the location of the regions where there appears to be most population.

Figure 11.19

Population distribution in Africa and Zimbabwe

The population distribution and density in Africa can be explained using some of the factors highlighted in the previous section. Figure 11.19 shows the population density of countries in Africa. The map shows a general population distribution and as was pointed out earlier, the population density is a function of the size of the country and hence small countries such as Rwanda and Burundi tend to have the highest population densities.

Activity 7

Using Figure 11.19, answer the following questions:

1. Why do you think most of the population clusters are found in coastal areas?
2. Give reasons for the high population densities in the eastern African highlands.
3. Give reasons why the Congo River Basin is less populated compared to the Nile Valley.
4. Discuss the statement that says, 'With reference to Africa's population distribution, it is true that people settle in areas with favourable physical conditions'.

Population distribution in Zimbabwe

Population in Zimbabwe is unevenly distributed. Seventy per cent of the population lives in rural areas and thirty per cent is found in the urban areas.

Figure 11.21 shows population distribution in Zimbabwe using the dot and the proportional circle methods. From the map, we can identify areas of high population density mostly on the highveld and the Eastern Highlands and low population densities in the Zambezi and Limpopo Valleys. From the map, you can clearly identify the major national parks of Hwange and Gonarezhou in the south-eastern corner of Zimbabwe. Also refer to the colour map in Figure 11.16.

Zimbabwe's urban centres, which are also its main areas of population density, are found in the highveld area. The distribution or location of these urban centres can be attributed to communication in the form of the main Bulawayo to Mutare railway line, the occurrence of minerals, the cool temperatures of the highlands, the good fertile soils of the highveld and historical factors.

The historical factors of colonial settlements later resulted in industrial development and the further growth of the urban centres.

The areas that have low population densities are found in the north-west along the Zambezi Valley and around Hwange National Park in the south-west. These areas are associated with the tsetse fly that causes sleeping sickness and some areas are affected by malaria. These areas are also not suitable for agriculture. Gonarezhou and Hwange National Parks are found in these areas. The densities are between 6 and 14 people per square kilometre.

Moderate population densities cover a third of the communal areas. These areas include north-eastern Zimbabwe, southern Zimbabwe and south-western Zimbabwe (Masvingo and part of Midlands and Matebeleland).

High population densities occur in the rest of the communal areas. These areas include northern and north-eastern Zimbabwe (Chiweshe, Murewa, Goromonzi) and south-eastern and south-western Zimbabwe (Gutu, Zaka, Bikita and parts of Matebeleland and Midlands provinces). Population density may exceed 39 people per square kilometre.

The middle part of the area along the main watershed and line of railways contains towns that are areas of great population concentration.

Activity 8

1. Give reasons why most of Zimbabwe's communal areas are densely populated and what the possible effects of this situation are. Refer back to Chapter 9 on reasons for resettlement.
2. What possible factors resulted in low population densities in the Zambezi Valley and south and south-east lowveld areas of Zimbabwe?

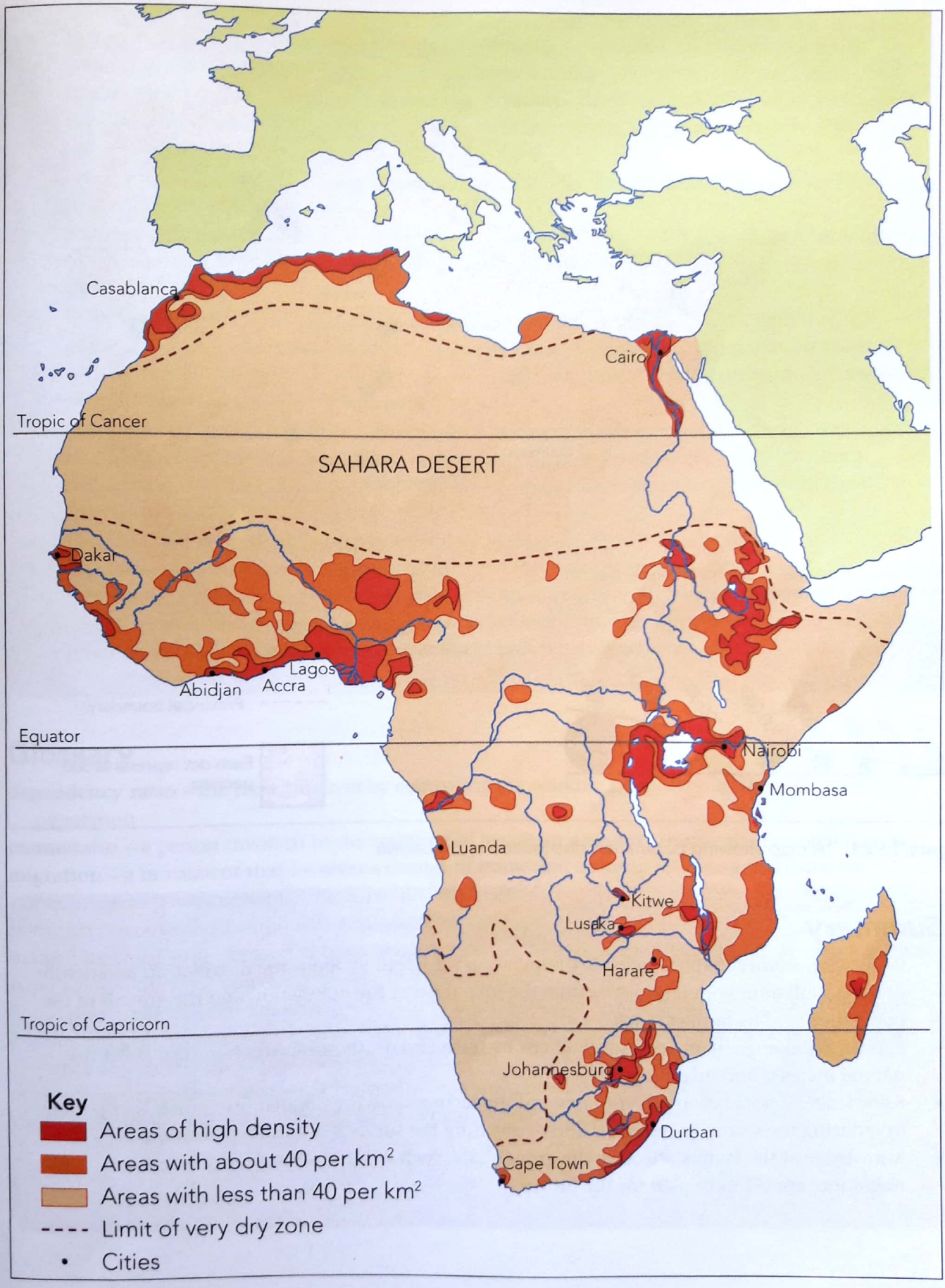


Figure 11.20 A map showing population clusters in Africa

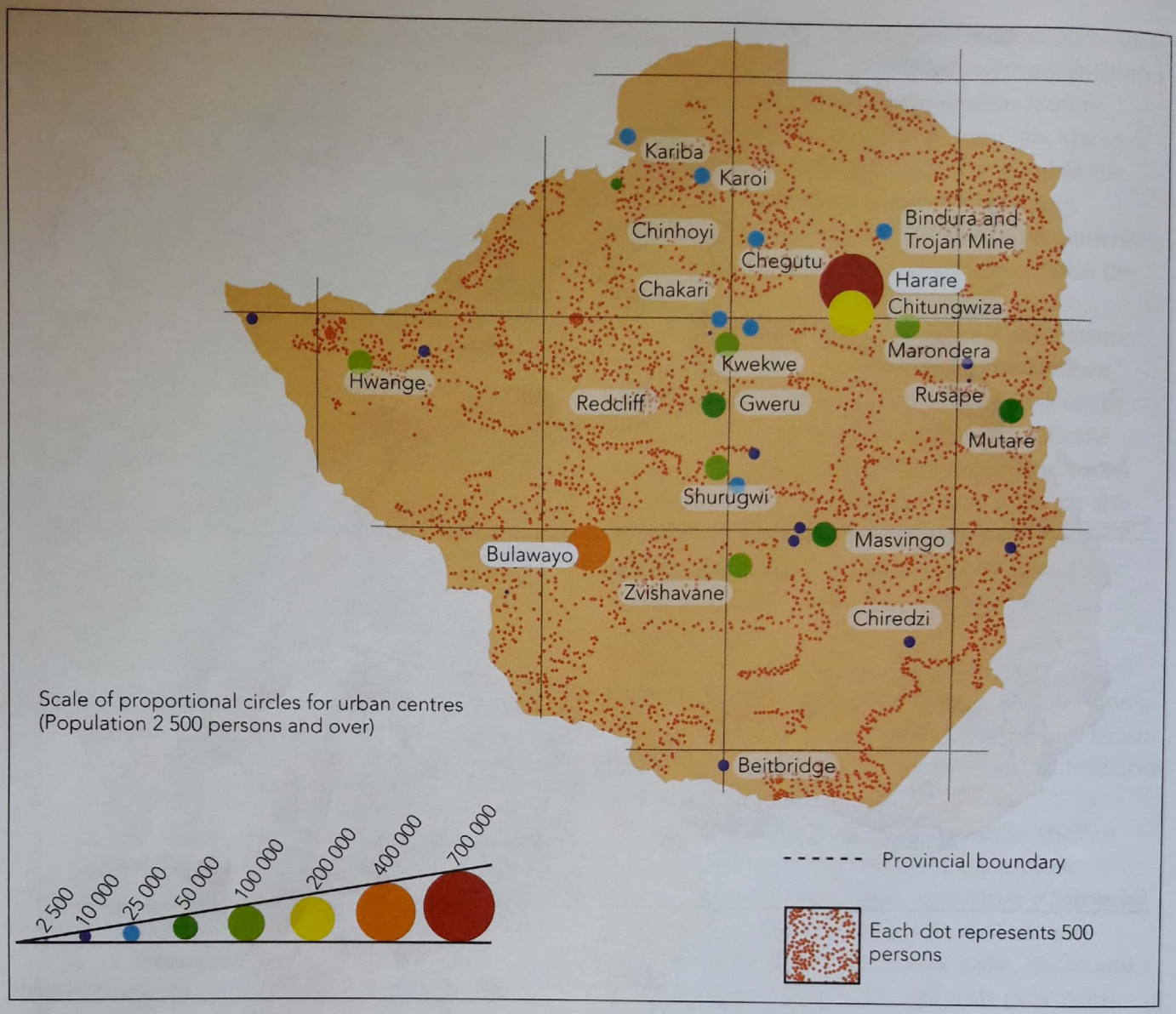


Figure 11.21 A map showing population distribution in Zimbabwe

Summary

- Population studies involve collecting population information about the distribution and density of the population, population structure, the migration of the population and the growth of the population and its implications.
- Population change in an area is influenced by birth and death rates, which in turn affect the natural increase and migration.
- Knowledge of population growth rates and the factors affecting population growth is important in reducing the strain on resources and in ensuring the survival of future generations.
- Knowledge of the factors affecting the growth rate, such as birth rates, death rates and migration, enable us to plan for the future.

- Factors that influence birth rates include the importance attached to children as a source of security in old age and as a source of labour. Early marriages, the preference for a male child, having many children being seen as a sign of greatness, the discouragement of abortion and contraception by some religions and family planning programmes, are other factors that influence birth rates.
- The death rate is influenced by the infant mortality rate, the availability of water and sanitation, food supply and wars.
- Population structure differs from area to area. Population pyramids tell us the characteristics of a population, whether it is made up of youthful people or elderly people and other factors that affect the structure.
- A population pyramid structure with a wide base and a narrow top shows a youthful population, associated with developing countries such as Zimbabwe. A population structure with a broader top shows an ageing population with a higher life expectancy and are associated with developed countries.
- Population information is collected using the census and vital registration, among other methods.
- The world distribution of population is such that there are more people in the northern hemisphere than in the southern hemisphere because there is more land surface in the north than in the south.
- Dots or shading are usually used to show the distribution of population on maps.
- The factors influencing the density and distribution of the population are divided into physical, human and economic factors. Physical factors include climate, soil, relief, vegetation, water supply, pests and diseases. Human and economic factors include mineral resources, land resettlement, urban development, government policy, transport and defence.

Glossary

dependency ratio – the ratio obtained by comparing the working population to the non-working population

enumerator – a person involved in the counting of people in a country during the national census

migration – a movement that involves a change of home and crossing of some administrative boundaries on a temporary or more permanent basis

mortality – deaths as a component of population change

natural increase – the increase of population due to the difference in births and deaths in a given year

population – the total number of people living in a place

population change – the increase or decrease of population size due to births, deaths and migration

population growth rate – the rate of population increase or decrease in a given year due to natural causes and migration

population structure – the age-sex distribution usually shown by means of an age-sex pyramid

vital registration – population information obtained from registers of births and deaths

Topic test

1. The population information collected using a census includes all of the following except:
   - A people's ages
   - B people's gender
   - C people's heights
   - D people's cooking facilities
2. Low population densities in the Zambezi Valley and south-eastern lowveld of Zimbabwe are mainly a result of:
   - A deforestation and lack of minerals
   - B the hot and dry climate
   - C the low-lying relief
   - D the presence of thick vegetation cover
3. The natural increase of population is:
   - A the birth rate minus the death rate
   - B the death rate minus the birth rate
   - C the fertility rate minus the growth rate
   - D life expectancy minus the death rate
4. The birth rate of a country such as Zimbabwe can be reduced through:
   - A encouraging early marriages
   - B family planning programmes
   - C allowing men to marry more than one wife
   - D giving people more wages or salaries
5. Which country would have its age-sex structure represented by the pyramid in Figure 11.22?

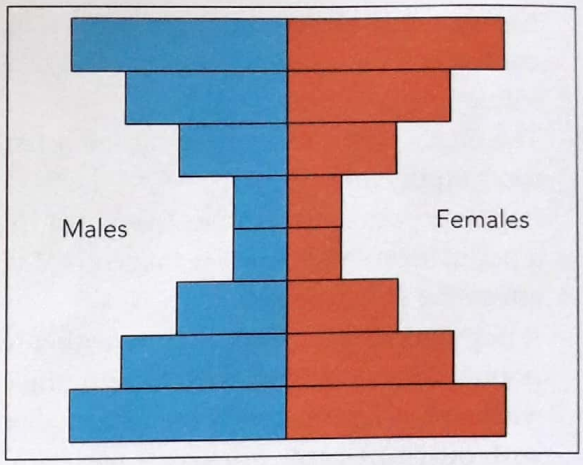


Figure 11.22 An age-sex pyramid

   - A Japan
   - B Zimbabwe
   - C Kenya
   - D Nigeria
6. Figure 11.23 shows the population structure of a small town.
   Which one of the following would have a population structure like the one shown in Figure 11.17 on page 131?
   - A an agricultural market town
   - B a coastal resort town
   - C a university town
   - D a gold mining town

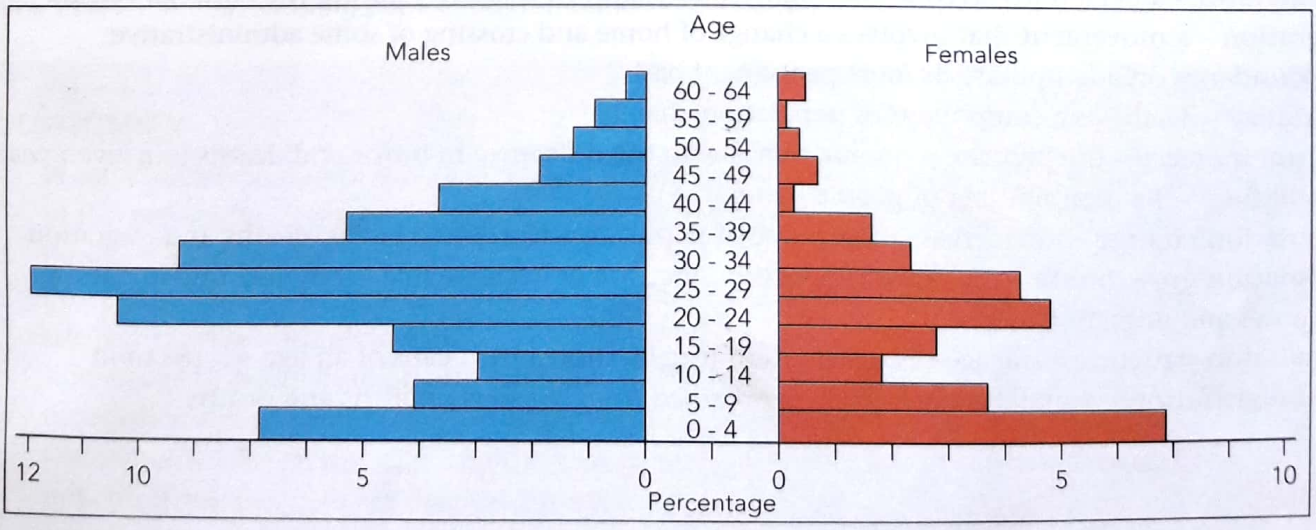


Figure 11.23 The population structure of a small town

7. The shaded areas on the diagram in Figure 11.24 below shows
   - **A** mortality rate
   - **B** life expectancy
   - **C** natural increase
   - **D** net migration

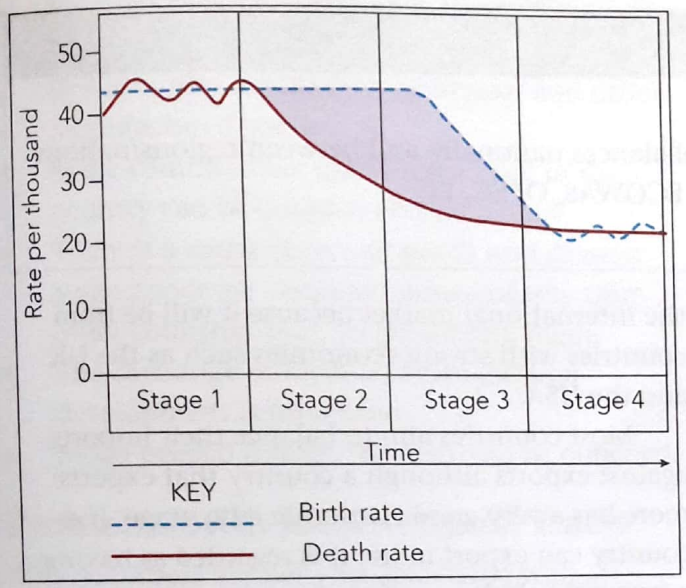


Figure 11.24

8. **a)** Why is population information important to a country such as Zimbabwe?
   b) Describe the population information that is collected using the following methods:
   - **i)** census
   - **ii)** vital registration

   c) What are the problems associated with these methods of collection of population data/information?

9. Study the map of population distribution in Zimbabwe in Figure 11.21. Why is population not evenly distributed in Zimbabwe?
10. Explain the following terms
    - **a)** birth rate
    - **b)** death rate
    - **c)** life expectancy
    - **d)** age-sex pyramid
    - **e)** dependency ratio
11. Figure 11.25 shows a population pyramid for a country.

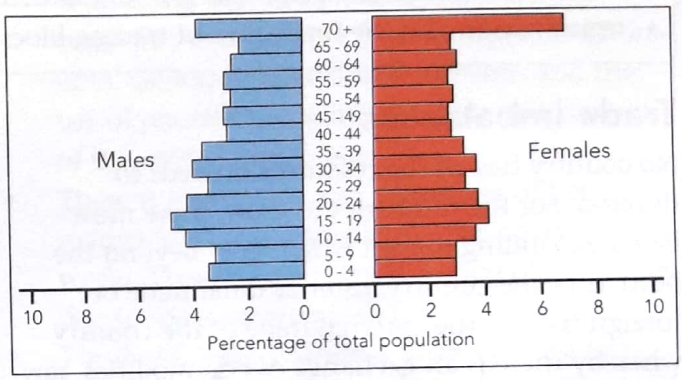


Figure 11.25 Population pyramid for a country

   a) Name the type of the population pyramid.
   b) State the stage in which this country is according to the demographic transition graph and give reasons for your answer.
   c) Describe and explain the population problems likely to be faced by this country.

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BEATRICE

Topic 12 Transport and trade

Objectives

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

- demonstrate how trading patterns may create imbalances nationally and between regions/nations
- name economic groupings like SADC, COMESA, ECOWAS, OPEC, EU
- give reasons for the formation of trading blocs

Trade imbalances

No country has all the resources it needs to develop. For the industries to grow, there must be an expanding market which goes beyond the borders of the country. International trade or foreign trade is the external trade of the country whereby there is an exchange of commodities, raw materials and manufactured goods between one country and another.

International trade has two aspects, which are import trade and export trade. Import trade is the bringing in of goods from other countries into the home country and export trade is the sending of goods to other countries and external markets. The export trade brings foreign currency into the country. The foreign currency has more value on the international market because it will be from countries with strong economies such as the UK and the USA.

Most countries aim to balance their imports against exports although a country that exports more has a very good economic advantage. If a country can export more, it is regarded as having a favourable **balance of trade**. Any country must live within its income. A country should not spend more than it can earn or else it will become bankrupt. **A balance of trade** is a situation in which a country balances off its earnings from exports and its expenditure on imports. If more is earned than is spent, a favourable (positive) balance of trade exists and if more is spent than is earned, then there is an unfavourable (negative) balance of trade.

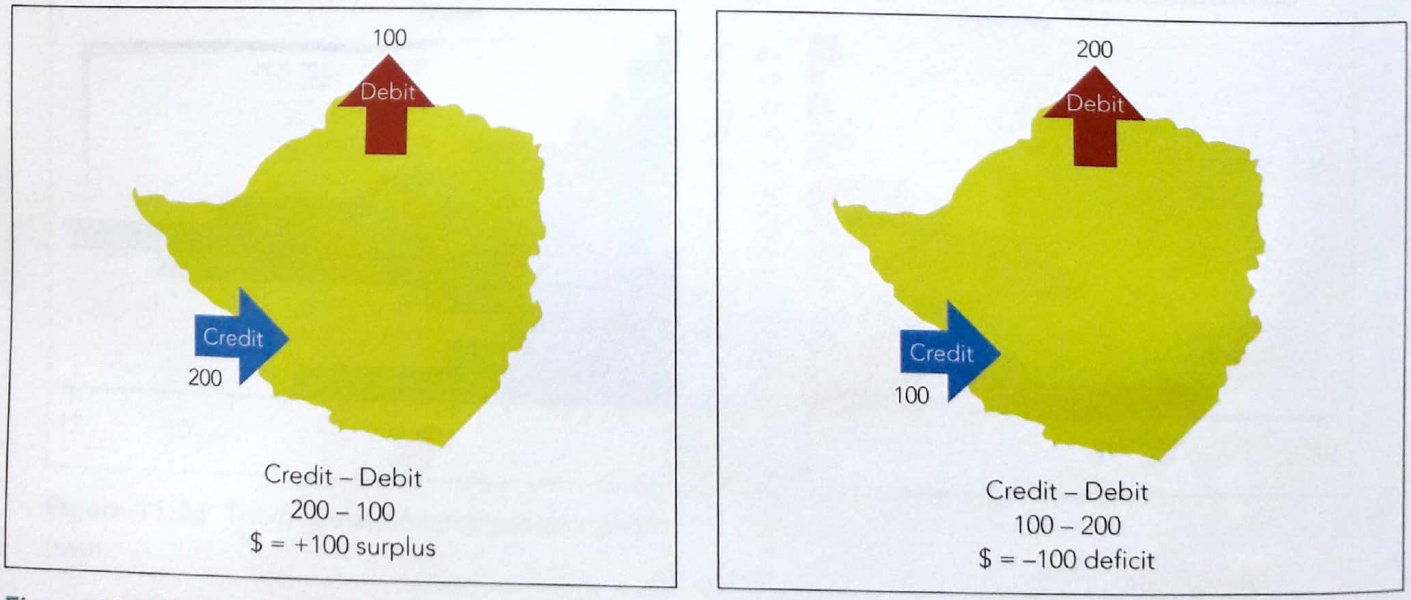


Figure 12.1 The balance of payments can be positive or negative. This can change from year to year.

The benefits of trade

In the modern world, a country has to trade with other countries, not only to gain foreign currency but for the general development of the country.

The benefits of international trade can be highlighted as follows:

- Products that a country cannot produce become available. In the case of Zimbabwe, this is mostly machinery, chemicals and other manufactured goods.
- Some commodities that are seasonal in the country can be enjoyed all year round.
- There is a wider choice of goods and designs.
- Some goods are obtained more cheaply from other countries than by producing them.
- The exchange of ideas and also cultural development is promoted.
- Much needed foreign currency can be obtained.

Problems with international trade

Although there are benefits associated with international trade, problems also arise from the selfish nature of some countries and in some cases from the need to protect their own industries from competition. The problems of international trade can be highlighted as follows:

- International trade is dominated by the developed countries.
- The developed countries determine the type of goods and the prices for the goods, such as tobacco, tea, coffee, rubber and other products from the developing countries.
- The colonial past affects international trade in a negative way. Most developed countries restricted the development of manufacturing industries in their former colonies and promoted the exploitation of raw materials. Most developing countries are still relying on the colonial type of international trade.
- Countries in the developing world largely export low value unprocessed raw materials in the form of crops and minerals. These are then processed by the developed countries and sold back to the developing countries as high value manufactured goods. The developing countries do not determine the prices of the goods.
- Most of the prices of raw materials fluctuate and in most cases decline, putting the developing countries at a disadvantage. On the other hand, the prices of manufactured goods from the developed world always seem to be rising.
- Developing countries often buy manufactured goods from the developed world using loans from the developed countries. They are charged very high interest rates for the loans.
- When there is a decline in raw materials for the developed countries, they try other sources, for example, the substitution of copper by optical fibre (commonly called fibre-optic cables) in telecommunications and the use of plastics and synthetic materials instead of the original materials.
- There is sometimes also a flooding of the market with raw materials by the developing world. This results in the lowering of the prices due to the increase in supply.
- The developing countries do not have a fair share of the wealth created by international trade since raw materials are priced low.
- Improved technology and recycling techniques have also reduced the demand for traditional metals from the developing world.

Case study

IMF's decision on Zim sensible

The country is fully committed to applying home-grown solutions to addressing macro-economic challenges, which are reflected in rising inflation, foreign exchange shortages, unemployment and the decline in overall output.

Surely, a country which has shown total commitment to reducing its arrears to the International Monetary Fund (IMF) and turning around its economy using its own resources does not deserve to be thrown out of the IMF community?

We believe the IMF appreciated the fact that Zimbabwe's payments have been consistent and increased from the initial US$1,5 million a quarter to the current US$9 million.

Pledges have also been made to further increase the payments to US$15 million a quarter before the end of the year and to US$40 million a quarter from next year.
The Government, represented by a team led by the Reserve Bank of Zimbabwe Governor, Dr Gideon Gono, made a succinct and clear-cut presentation of the country's case before the IMF board last Friday and won the hearts of the majority. They were convinced that Zimbabwe deserved to be given another chance.
In his presentation to the board, Dr Gono also pledged that the government would continue to commit its own resources and work tirelessly to clear the outstanding IMF arrears of about US$175 million by November next year. We all believe that the Governor will live up to his word.
[Source: The Herald, 12 September 2005]

Activity 1

1. Which problem relating to international trade is being illustrated in the article?
2. What problems are likely to be faced by Zimbabwe in trying to meet the demand of the IMF?

Possible solutions to the problems of international trade

Tariffs
A country can use tariffs on imported goods. Tariffs are taxes. The tariffs could be made so high that it would discourage the importation of goods into the country and therefore reduce the loss of foreign currency and also encourage the development of local industries.

Quotas
The allocation of **quotas** can also control the quantities of imports coming into a country.

Subsidies
Tax concessions or offers of subsidies can be given to companies in the country to encourage exports. For example, in Zimbabwe, manufacturers who earn foreign currency are given a higher allocation of foreign currency to buy inputs.

Export processing zones
The setting up of Export Processing Zones (EPZs) to help the local manufacturing companies wishing to export can be done.

Luxury goods
Discouraging the importation of expensive luxury goods is needed. For example, cars imported from outside with foreign currency not obtained through the Reserve Bank are heavily taxed.

The export of processed or manufactured goods
A country can increase the production and sale of manufactured goods instead of raw materials.

Building up stocks
The export of raw materials should, whenever possible, be withheld when prices are low.
A country should build up its stocks and only release them when prices are up again.

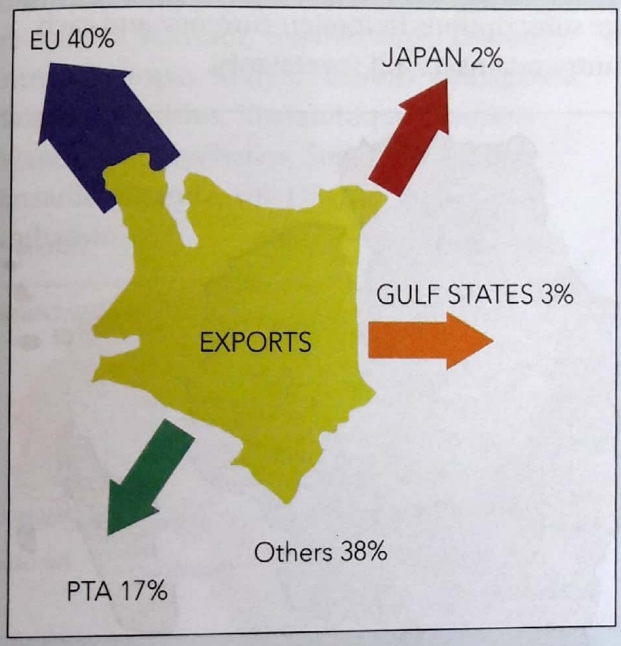
Transnational corporations
Some control of transnational corporations (TNCs) or multinational corporations is needed because these may end up exploiting the resources of the developing countries for the benefit of their mother countries only.

Changing the international monetary system
The developing world should work together to change the current monetary systems where trade and polices are determined by major currencies such as the US dollar and the British pound.

Trading groups
Trading groups should be formed to fight the injustices in international trade. In 1975, the developed countries were shocked when the Organisation of Petroleum Exporting Countries (OPEC), made up of developing countries, withheld the supply of oil to force up the price.

Activity 2

1. Figure 12.4 shows trade between Kenya and four trading partners in 1992. With which trading partners did Kenya have its most favourable trade?
   - **A** The European Union (EU)
   - **B** The Gulf States
   - **C** Japan
   - **D** The Preferential Trade Area (PTA)



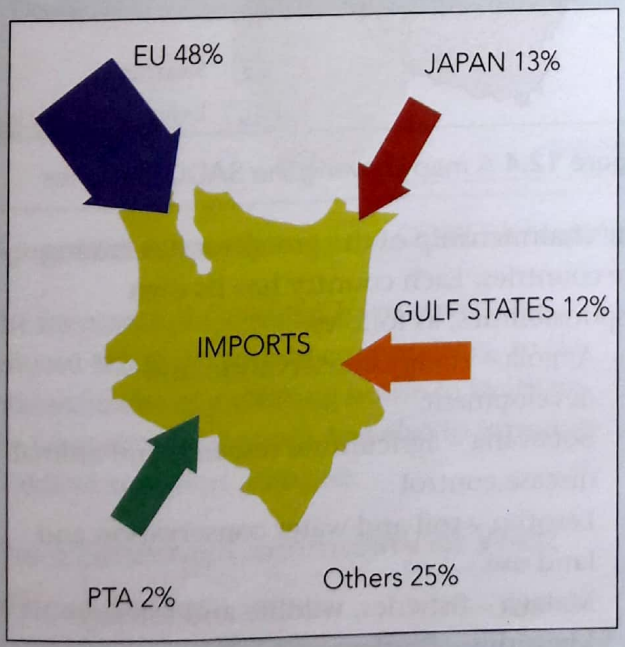


Figure 12.2 Map showing trade between Kenya and four trading partners

2. Study Figure 12.3 which shows the nature of the export trade for country A and B.

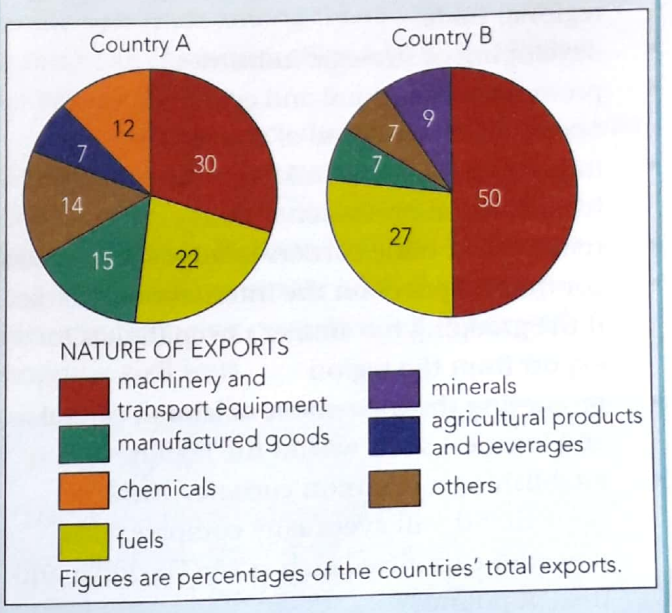


Figure 12.3 Export trade

   - **a)** Which one of countries A or B could be a developed country? Give reasons for your answer.
   - **b)** What problems are likely to be faced by each country in its international trade?

Trading blocs

The imbalances in the international world and the need to control trade have resulted in the formation of economic groups or **trading blocs**. The aims of the groupings are the same generally. Neighbouring countries often join together to promote regional growth, self-sufficiency and general security.

Reasons for the formation of trading blocs

The general aims of such groups are as follow:

- improving the living conditions of the people in the region
- reducing economic dependence of members on other countries outside the region
- establishing links to form a true and equitable regional integration
- pulling resources together for the implementation of national, inter-state and regional policies

- transforming of the structure of production in the region
- liberalising trade in the region or promoting regional trade
- developing of strategic industries
- promoting of cultural and economic co-operation for the good of the region
- improving transport links and the sharing of technical and professional skills
- removing of trade barriers to all member states
- controlling prices on the international market if the grouping has similar raw materials for export from the region
- promoting the movement of labour, capital and business skills within the region
- establishing a common currency with the hope that it will eventually compete with powerful currencies such as the US dollar and the UK pound.

Advantages and disadvantages of economic groups

Economic groupings have their fair share of advantages and disadvantages. There are more advantages than disadvantages.

The main disadvantage is that these groupings are further widening the trade imbalances and creating economic and political tension in the world. The other disadvantages are peculiar to certain regional groupings and these can be analysed as one looks at each economic group.

Activity 3

Work with a partner to use what you have learnt about economic groupings to list the possible advantages of a trading bloc.

Economic groupings

The Southern African Development Community

The predecessor to the Southern African Development Community (SADC) was the Southern African Development Corporation Conference (SADCC), formed in 1980 and consisting of nine member states. These were Angola, Tanzania, Zambia, Malawi, Mozambique, Botswana, Swaziland, Lesotho and Zimbabwe. With the joining of South Africa and Namibia and other states, it changed to a community, namely the SADC. All the southern African countries are members and these are Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Swaziland, South Africa, the Seychelles, Tanzania, Zambia, Zimbabwe and the DRC. The countries assigned each other special responsibilities. Countries are not required to pay large subscriptions in foreign currency and each country retains its full sovereignty.

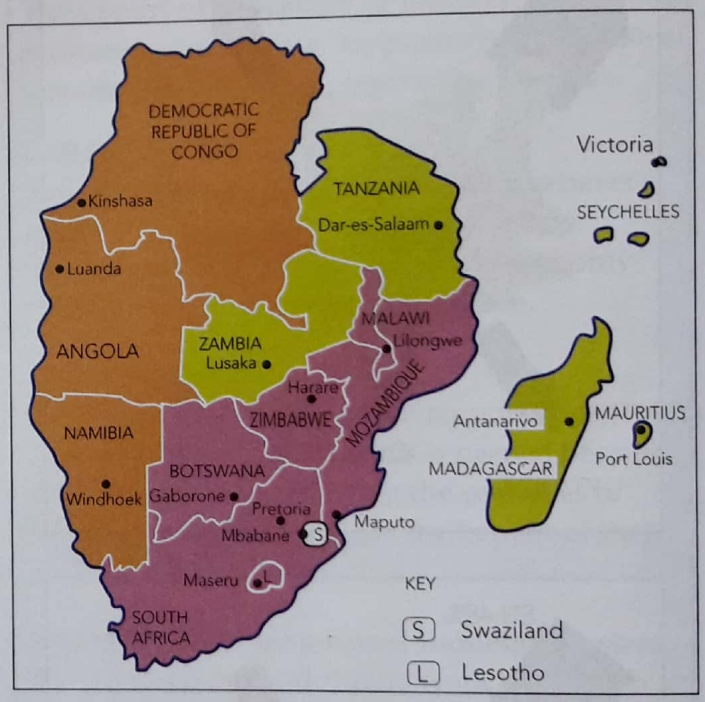


Figure 12.4 A map showing the SADC countries

The chairmanship of the group rotates among the countries. Each country has its own responsibilities, as follows:

- Angola – energy conservation and development
- Botswana – agricultural research and animal disease control
- Lesotho – soil and water conservation and land use
- Malawi – fisheries, wildlife and forestry
- Mauritius – tourism
- Mozambique – transport and communication
- Namibia – sea fisheries
- Tanzania – trade and industry

- Swaziland – manpower development and trade
- South Africa – finance and investment
- Zambia – the Southern African Development Fund and mining
- Zimbabwe – food security

The Common Market for Eastern and Southern Africa (COMESA)

The Common Market for Eastern and Southern Africa (COMESA) is made up of a good number of countries, some of which are in the SADC. These are Angola, Burundi, the Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, the Seychelles, Sudan, Swaziland, Tanzania, Uganda, the DRC, Zambia and Zimbabwe.

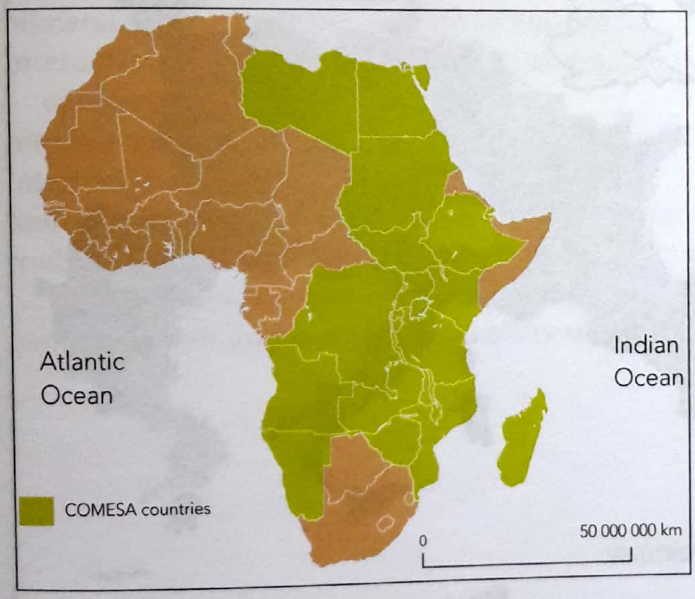


Figure 12.5 A map showing the COMESA countries

The members of COMESA have agreed to reduced tariffs on certain commodities, to the establishment of a clearing house to facilitate the transactions of goods and also to introduce COMESA travellers' cheques.

The Economic Community of West African States

The formation of The Economic Community of West African States (ECOWAS) was spearheaded by Nigeria and it has 15 members. The group aims to reduce political, economic and language differences among west African countries.

Like most other economic groups, they aim to increase trade among the member states, to improve communication and to establish a common currency.

The members include Mali, Niger, Mauritania, Gambia, Senegal, Guinea Bissau, Sierra Leone, Liberia, the Cote d'Ivoire, Ghana, Togo, Benin, Nigeria, Guinea, Burkina Faso and Cameroon.

The group has scored a lot of successes including bringing peace to West Africa and stopping civil wars.

Activity 4

Using a general outline map of Africa showing the countries, draw in and shade members of SADC, COMESA and ECOWAS separately on three outlines.

The Organisation of Petroleum Exporting Countries

The Organisation of Petroleum Exporting Countries (OPEC) was founded in 1960 to co-ordinate the petroleum policies of its members, and to provide member states with technical and economic aid. As of July 2016, OPEC's members are Algeria, Angola, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia (the de facto leader), the United Arab Emirates and Venezuela. Two-thirds of OPEC's oil production and reserves are in its six Middle Eastern countries that surround the oil-rich Persian Gulf. OPEC has a major influence on global oil prices.

European Union

The European Union (EU) is an economic and political union consisting of twenty seven states mostly found in Europe. Figure 12.6 shows most of the member states of the EU. It was founded on 1 November 1993 though this had been preceded by other forms of associations such as the European Coal and Steel Community (ECSC) of 1951 and the European Economic Community

(EEC) of 1958. The EU parliament seats in Brussels, which is effectively the EU capital.

The EU is the largest economic and political union of its kind. It has a population of over 500 million, which is just over 7% of the world population.

The group operates a common market and is removing trade barriers, promoting free trade, free movement of labour and capital and has established a common currency known as the euro.

Figure 12.6 A map showing EU countries

Summary

- Trade is the exchange of goods or commodities. Trade can be internal or international.
- Trading blocs are associations between groups of countries for the purpose of promoting free trade.
- Trade can be classified into national and international types. International trade is currently very important but problems have arisen due to lack of resources and skills in the developing world and the selfish behaviour of the developed world. Most developing countries have debts which they are paying back and consequently they remain poor.
- As a result of the need to promote trade and the existence of international problems, countries have formed economic groupings to solve some of the problems of international trade. Most of these groups have scored a lot of successes.

Glossary

balance of trade – the relationship between export earnings and import expenditure. A positive balance of trade is when a country has trade surplus. A negative trade balance is the opposite

bilateral trade – trade between two countries

International Monetary Fund – (IMF) an international organisation working to foster global monetary co-operation

internal trade – trade within a country

international trade – trade between countries

multilateral trade – trade between many countries

trading blocs – economic trading groups set up by more than two countries in order to promote favourable trading terms among themselves

quotas – a limit imposed on the quantity of goods produced or purchased

Topic test

1. Which of the following countries is a member of the SADC but is not a member of the PTA?
   - A Zimbabwe
   - B Tanzania
   - C Malawi
   - D Kenya
2. Table 12.1 shows trade figures (in $million) for Zimbabwe and its major trading partners in 1986.

   Table 12.1 Trade figures

Country	Exports	Imports
South Africa	184,0	217,4
USA	79,7	65,1
United Kingdom	175,7	127,5
West Germany	101,6	109,5

   With which two countries did Zimbabwe have a favourable balance of trade?
   - A The USA and the United Kingdom
   - B West Germany and South Africa
   - C South Africa and the United Kingdom
   - D West Germany and the USA
3. An unfavourable balance of trade is
   - A more imports than exports
   - B more exports than imports
   - C imports of manufactured goods
   - D export of raw materials

4. a) (i) Explain the terms 'tariffs' and 'quotas' as used in trade.
   (ii) Describe and explain the problems faced in international trade.
   (iii) Suggest four possible ways for a country in the developing world to solve the problems of international trade.
5. a) (i) Describe the causes of trade imbalances in international trade.
   (ii) Name three economic groups you have studied.
   (iii) Suggest possible advantages of a country being a member of an economic group.

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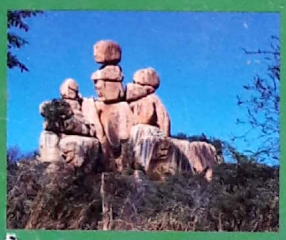
step ahead

Geography

FORM 3



Step Ahead Geography Form 3 is part of a new course especially developed to meet the needs of the 2015–2022 Zimbabwe Education Curriculum Framework.

The course seeks to develop learners who:

- are keenly aware of the values, ethos and attitudes necessary for the growth and development of our country
- realise that they already have natural talents and skills which they can build on, so that they are able to function beyond the classroom as effective citizens of Zimbabwe.

The *Learner's Book* addresses all aims and specific outcomes of the Geography syllabus. It contains:

- carefully drawn artwork and colour photographs
- varied activities and exercises designed to foster key skills, like critical thinking, problem-solving, leadership, ICT, communication and team-building.

The *Teacher's Guide* contains:

- useful background information for the teacher
- hints on how to teach concepts well
- answers to activities, exercises and assessments.

This course has been approved for use in schools by the Ministry of Primary and Secondary Education.

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