Unit 1:
Natural resources and their importance

Introduction

When people use a piece of land to grow crops such as maize, sorghum or wheat, they are using soil and water to obtain food. A natural resource is a supply of something from the natural environment that people use because of its particular value to them. For centuries people have used the resources available in their immediate environment for food, shelter and clothing. Our planet has huge supplies of natural resources that we need in order to survive. However our biggest challenge is to use resources without destroying or degrading the environment. Our quality of life and survival depend on our ability to use, rather than abuse, the environment.

We start this unit by examining what natural resources are and continue by focusing on water, soil, biodiversity and energy as natural resources.

This unit consists of the following sections:

1.1 What are natural resources?
1.2 Water as a natural resource
1.3 Soil as a natural resource
1.4 Biodiversity as a natural resource
1.5 Natural energy resources
1.6 How nature works

Specific outcome and learning outcomes

The specific outcome for this unit is to assess what natural resources are available for human use.

Learning outcomes	Assessment Activities	Actual time spent
	Workbook activities	
1. What are natural resources? 2. Water as a natural resource 3. Soil as a natural resource 4. Biodiversity as a natural resource 5. Natural energy resources 6. How nature works	1.3 A simple model of the water cycle. (Ih) 1.5 Finding out about rainfall in your area. (2h) 1.6 Make your own terrarium. (1h) 1.8 Water use in your management area. (1.5h) 1.10 Considering aspects, ridges and valleys (Ih) 1.11 Identifying soil types. (2h) 1.12 Identifying soil texture, structure and depth. (5h) 1.13 Biodiversity as a resource (1h) 1.16 Your place in the cycle of nature. (30 min)	
	Assignment Assignment 1: Information for this assignment is contained in Tutorial Letter 101. (3h)	

Key concepts

Strategy
Natural resources
Renewable resources
Non-renewable resources
Habitat
Solar energy
Recycling
Water cycle
Evaporation
Evapotranspiration
Transpiration
Condensation
Precipitation
Infiltration
Groundwater
Water table
Water shed

Aquifers
Catchment
Drainage basin
Perspective
Fossil fuel
Indigenous
Organisms
Soil texture, stucture and type
Humus
Biodiversity
Cycle of nature
Food chain
Food web
Trophic (feeding) levels
System
Ecosystem

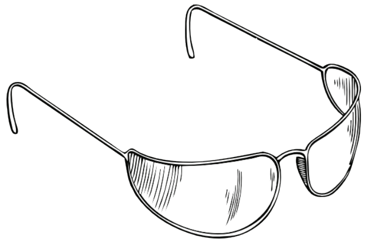
Start-up activity

Complete this activity on your own in this study guide

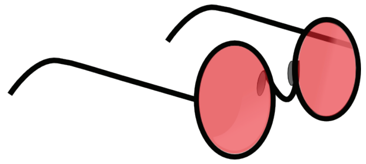
Thandi, whom you met in previous modules, was listening to a group of people arguing under the shade of a Marula tree. The argument was on whether soil, air, water, wild plants and animals are only for the benefit of people. What are your immediate thoughts on this issue?

When we think of this or any other issue, we need to think scientifically and look at the issue from different perspectives (ways of thinking) before coming to a conclusion. A man by the name of Edward De Bono developed a strategy, called the *Six Hat Thinking* strategy. According to this strategy, you put on different coloured hats that each represent a different perspective on the issue. When you wear a specific coloured hat you think of the issue only from that perspective. Only after you have worn all the different coloured hats will you be able to reach a scientific conclusion on the issue.

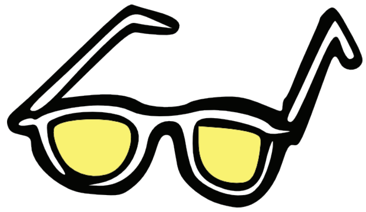
We have adapted De Bono’s strategy and will look at the issue not by putting on different coloured hats, but by looking at the issue through spectacles with different coloured lenses. What does each of the different coloured lenses represent?



White lenses: White is the colour of the paper in this study guide. This lens means that a person would look at the facts (just as books represent facts).

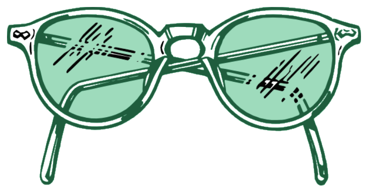


Red lenses: Red is the colour of blood and the heart, and the red lens in a similar way represents emotion. What are my feelings (emotions) on the issue?

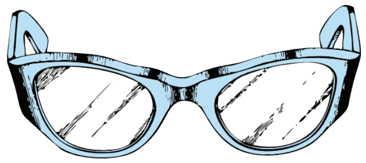


Yellow lenses: Yellow is a sunny and bright colour, and the yellow lens represents a view where one looks at the positive side of something. Think about the points in favour of the issue.

Purple lenses: Think critically about the issue, without allowing your emotions to dominate. What are the weaknesses in an issue? What are the problems associated with the issue?



Green lenses: Green is the colour of new growth in plants, and the green lens represents a creative look at things. Think creatively and suggest new solutions for the issue.



Blue lenses: Blue is the colour of the sky. The blue lens represents a big-picture view. Evaluate all the arguments and think about the bigger picture.

Figure 1.3 Looking at an issue from different perspectives
(Adapted from Edward de Bono's Six Hat Thinking Strategy)

Note: You may wish to use different coloured hats for the activity by using coloured sheets of A4 paper that you fold and staple to form the hat.

What you must do

1. Work in groups and discuss the issue specified in the block below to formulate your immediate thoughts.

Soil, air, water, wild plants and animals are only for the benefit of people.

2. Each group now looks at the issue from the perspective represented by the:

- white lenses
- red lenses
- yellow lenses
- purple lenses
- green lenses
- blue lenses

After your discussion, complete the following table:

Table 1.1 De Bono's lenses

White lenses/hats (facts)	**Purple lenses/hats** (positive arguments)
Red lenses/hats (emotions)	**Green lenses/hats** (problems or weak points)
Yellow lenses/hats (creative look)	**Blue lenses/hats** (big picture)

3. Discuss each perspective and write the group's ideas on the flipchart.

4. Come to a final decision on where *you* stand on the issue and write this down in the space below.

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You will gain a much better insight on this issue and other issues as you work through this unit and the other units in this module.

1.1 What are natural resources?

Almost everything that people use comes originally from nature. This includes cars, aeroplanes and computers. Most of these items have gone through many different manufacturing and industrial processes before we get to use them as resources. Have you ever thought that the money in your pocket is a resource that has its origin in nature? Today special paper is used to print notes and coins are made from various metals. Each country in the world has its own currency, which represents its trading unit. Did you know that in the past people in Africa used a variety of items from their environment to trade with, such as shells, ivory, gold and silver ingots and bracelets? In the late 1800's right up to 1918 people in Sierra Leone, Liberia and Guinea used thin twisted iron wires, known as Kissi twists, as money. The Kissis were 25 to 40 centimetres long and bundled in groups of 20 to 50 pieces. In those days you would have needed about 1000 Kissis to buy one bull. Money has always had a social and financial dimension and it is communities that decide on the value that their money represents.

When we refer to **natural resources** in this programme, we include those that come **directly from nature** or are still in a natural form. Wood to make fires and cook food is a natural resource, but paraffin is not. Paraffin and petrol are not natural resources as they are by-products of a refining process of the natural resource called crude oil. Vehicles, roads, and houses are also not natural resources as they are made by people and are referred to as **physical** resources.

There are two broad categories of natural resources: renewable and non-renewable.

1.1.1 What are renewable resources?

Renewable resources are resources that can grow again or replenish themselves. Trees, grass, other plants and animals are **organic** (living) resources. Water and certain gases like oxygen are **inorganic** (non-living). But are renewable resources always renewable? If renewable resources are used in an unsustained (unwise) way, will they continue to be renewable? Look at the following facts:

Table 1.2 Threats to renewable resources

Renewable resources	Possible threats to renewable resources that can make them non-renewable
Fresh water	We are only able to use ¼ of the Earth's groundwater as the rest depends on steady rainfall over long periods of time. People can use up the groundwater in an area because of drought and insufficient rainfall to restore it. Water can be polluted by humans through improper sewage management, and by chemical spills. This makes the water unsafe and unusable.

Land/soil	The land can be overgrazed or the nutrients in the soil can be used up through improper farming practices. Natural vegetation can also be removed to make way for building projects. In these cases the soil cannot renew itself and plants cannot grow. This makes it easy for the rain to wash away the soil and for the wind to blow it away. We refer to this as **soil erosion**.
Oxygen/clean air	The rainforests are often called the lungs of the world because the trees absorb carbon dioxide, which cannot be used by the human body, and release oxygen into the air. When forests are destroyed or die through pollution they are not able to carry out this important function. As a result the quality of the air decreases. When chemicals pollute rivers the oxygen in the water is depleted and living things in the water die.
Trees and other pants (vegetation)	Trees and other plants play a vital role in maintaining the balance in an environment. Where trees and other plants are cut down and not replanted, the soil and climate of the natural environment change. As a result plants may die and animals may lose their **habitat** (the natural conditions or environment in which living things live).

Activity 1.1 Renewable resources under threat

Complete this activity on your own in this study guide

1. What renewable resource in your area is under threat?

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2. Why do you think this renewable resource is in danger of becoming unusable or not renewable?

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……

3. Do you think something can be done to prevent this renewable resource from becoming unusable or not renewable? Give a reason for your answer.

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Comments on Activity 1.1

Human actions can have a positive or a negative effect on renewable resources. One of the resources under severe threat in many areas of South Africa is water. This is due to low rainfall and high water pollution levels in many places. Levels of pollution are often high in urban areas where there are factories and industries and where large numbers of people live together. This situation puts a lot of pressure on natural resources. We will discuss the impact of people and their actions on the environment in more detail in Unit 3.

Today we are beginning to realise that renewable resources cannot be taken for granted. We cannot afford to think that we can use as much as we like because a resource is renewable. Renewable resources are capable of being replaced **only** under the right circumstances and conditions and if we manage their use by respecting the laws of nature.

1.1.2 What are non-renewable resources?

Non-renewable natural resources are those that can be used up or finished and cannot be produced, re-grown or replenished in a reasonable amount of time. Examples include **fossil fuels** such as coal, crude oil, and natural gas. Minerals that are taken out of the Earth through mining such as diamonds, gold, silver and copper are also considered non-renewable. All these resources exist in a fixed amount in nature and they cannot be replaced as fast as they are being used up. The time will come in the near future when the world's oil reserves will be used up. It is for this reason that countries around the world are looking at alternative and renewable sources of energy. For example energy from the sun or solar power, wind power, and power from the movement of water (hydropower) are possible new sources of energy that are practically infinite and that cannot be used up.

The following pictures show the kind of natural resources people use in a rural and in an urban area.

Picture 1 - A household in a rural area

Picture 2 – A household in an urban area

Figure 1.4 Utilising land as a natural resource in rural and urban areas

Activity 1.2 – Renewable and non-renewable natural resources

Complete this activity on your own in this study guide

It is important to distinguish between renewable and non-renewable natural resources, since you will need to make this distinction when you investigate and assess the available resources in your area.

1. Look at the two pictures in Figure 1.4 and identify the resources used by a household in an urban and one in a rural area. Pick out the items that you consider to be renewable and non-renewable resources.
2. Write the items in the table below.

Natural resources			
Renewable resources (Urban area)	**Renewable resources (Rural area)**	**Non renewable resources (Urban area)**	**Non renewable resources (Rural area)**

Comments on Activity 1.2

Renewable resources do not only include **biological resources** such as plants and animals but also water, and solar (sun) energy. Energy from the sun is renewed daily and will continue in this way until the sun burns out millions of years from now. Soil is a very important resource for growing crops and it can be improved and renewed through good soil management and land use.

Most non-living resources such as metals and fossil fuels cannot be replaced when they are used up. People will have to learn to live without them or to improve techniques for **recycling** them.

The diagram below gives a helpful summary of the ideas discussed in this section.

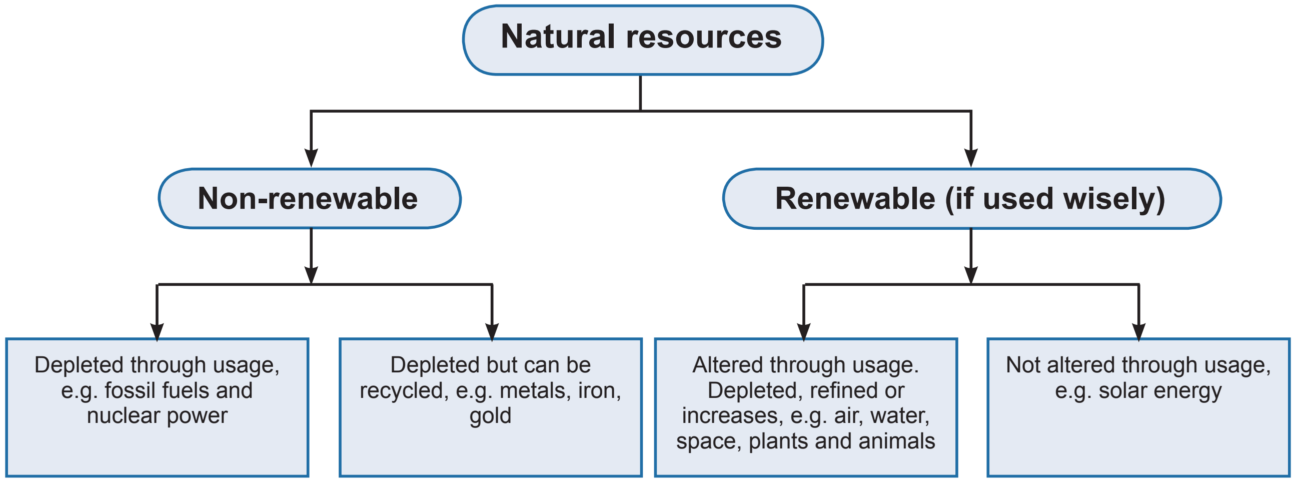


Figure 1.5 Classifying natural resources
(Adapted from Hugo, 2004)

1.2 Water as a natural resource

Without water no life is possible. Why is water so important to life? Most living things are primarily composed of water. The human body, for example, is made up of 70% water. All the chemical reactions of life, which happen inside the bodies of living things, take place in water. About 96% of the water on Earth is found in oceans, salt lakes and rivers. Less than 1% occurs in the atmosphere and about 3% is found as fresh water on land and in underground reservoirs (natural storage places). As most of this fresh water is locked up in the polar ice caps and as glaciers, only 0.3% of all fresh water is available for humans to use. What does this tell us about using water wisely?

What are polar ice caps and glaciers?

Ice caps are thick layers of ice and snow that permanently cover an area of land, usually the area around the North and South Poles.
A glacier is a huge mass of ice which moves very slowly, often down a mountain valley.

1.2.1 The water cycle

Where does the water on Earth come from? Water constantly circulates around our planet moving from the oceans to the skies to the land and back to the oceans again in a process called the **water cycle.** This cycle is driven by heat energy from the sun, as you can see in the figure below.

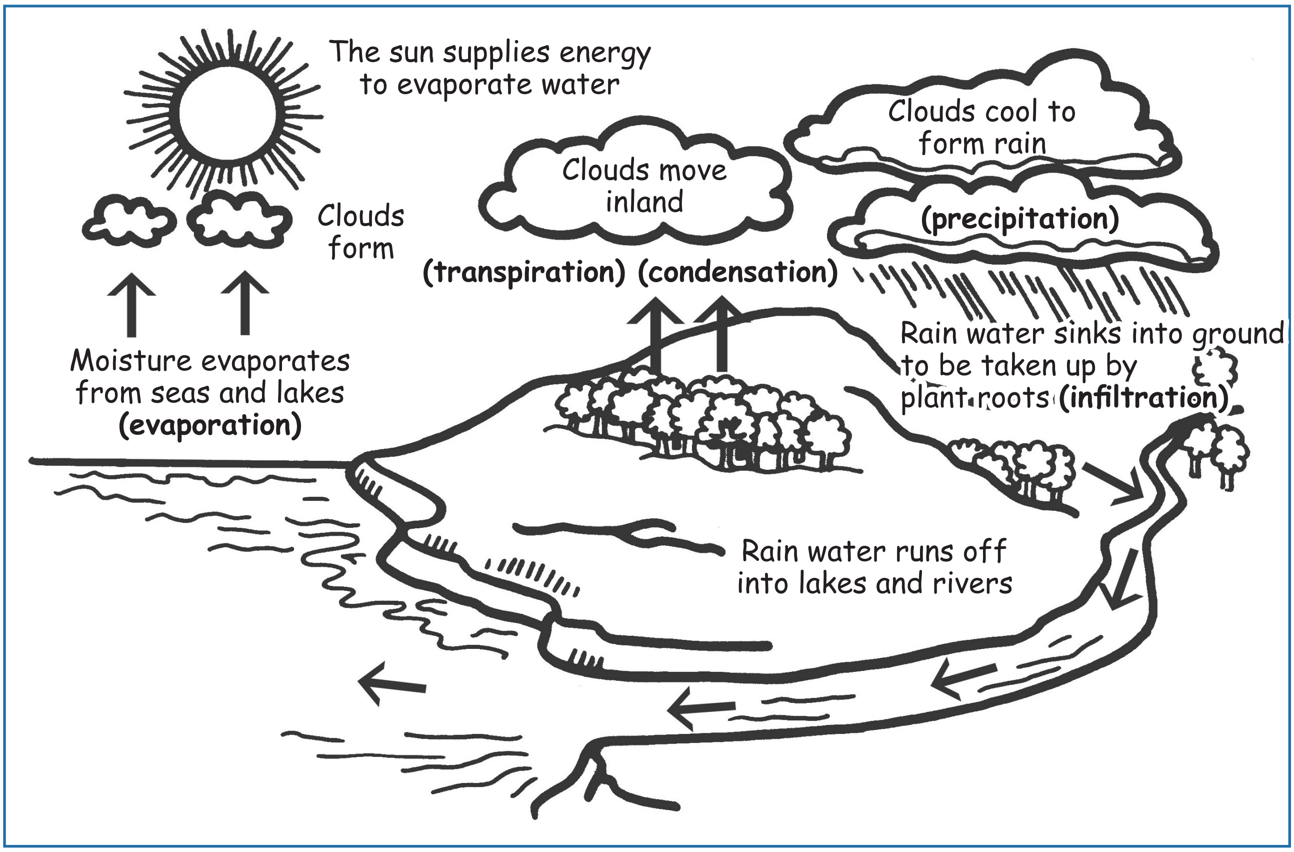


Figure 1.6 The water cycle.

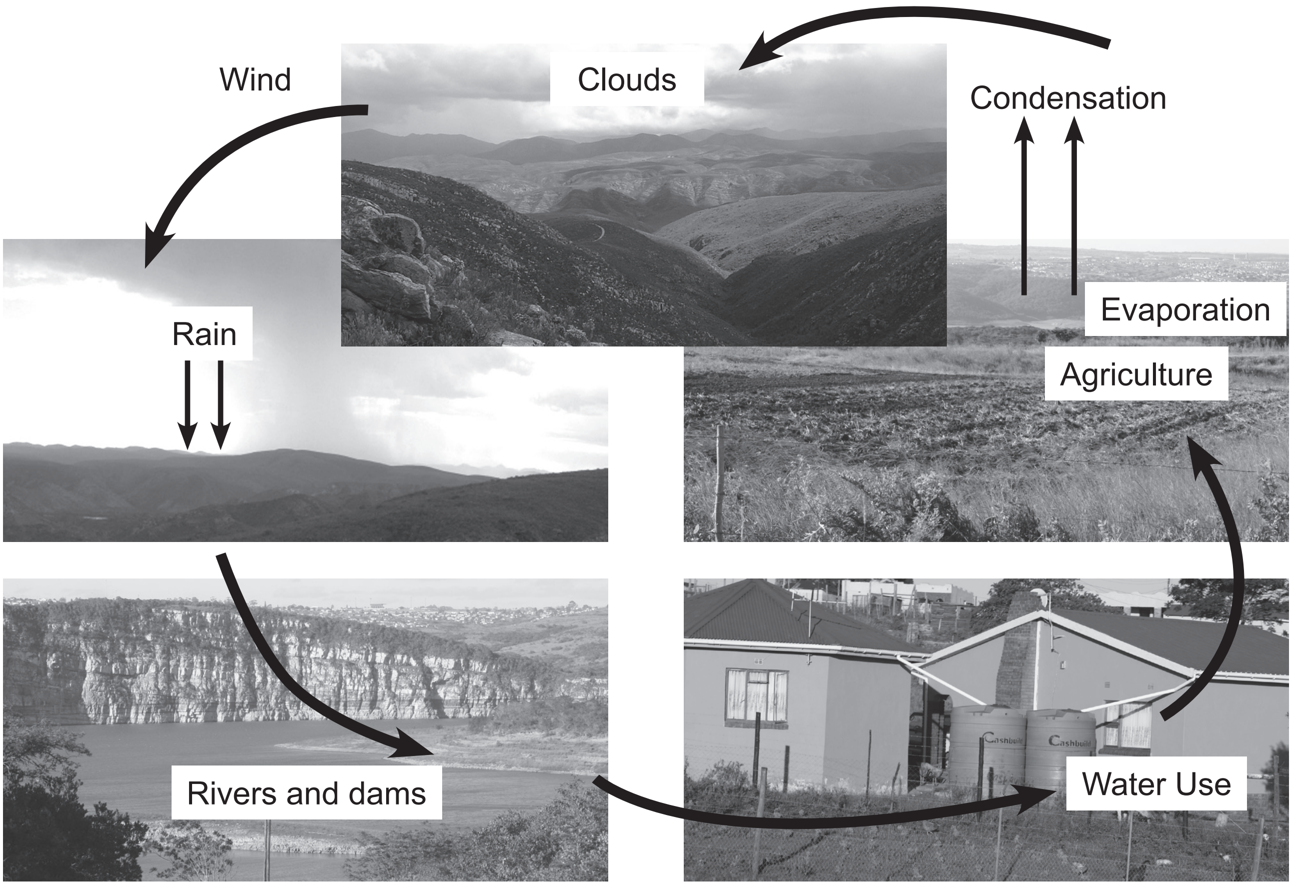


Figure 1.7 The water cycle in Kouga (Eastern Cape)

What happens in the water cycle? A number of inter-linked processes take place:

1. **Evaporation:** Heated by the sun, water evaporates into the atmosphere from the surfaces of any open body of water such as oceans, lakes, rivers and dams. Because oceans cover three quarters of the Earth's surface, evaporation from the oceans contributes most of the water to the atmosphere. On land, as much as 90% of the water that reaches the atmosphere, comes from plants as they release water vapour into the air during a process called *transpiration.* Find out more about this process in the next section.

2. **Condensation:** The water vapour in the air condenses back into water when it cools down there. Clouds are formed that consist of very small droplets of water.

Groundwater and pollution

Much of the groundwater in South Africa is polluted and the situation is getting worse. Pesticides are one reason for this. They are washed from the surface of plant leaves and the topsoil, to reach underground water. You will find out more about how human activities impact on the water cycle in Unit 3.

3. **Precipitation:** Water falls from the clouds back to Earth through rain, hail, sleet and snow. Dew, frost and mist are formed when water vapour condenses directly onto the land without first forming clouds.

4. **Infiltration:** Water falls on the land and infiltrates the soil until all the soil pores/openings are filled and the soil is saturated. The water that infiltrates the soil becomes groundwater. Further rainfall runs off into puddles, streams, rivers, lakes and finally into the ocean. Ultimately all water will end up back in the ocean to start the whole process again. No new water therefore enters the cycle and no water ever leaves the cycle.

Something to think about
In what ways is the water cycle important to people in communities, especially those who want to start a homestead garden? You need to start thinking about this question, but it will become clear to you as we progress through this module.

You will gain a much better understanding of how the water cycle functions by completing the next activity.

Activity 1.3 A simple model of the water cycle

Complete this activity on your own in your workbook

Aim: Build a simple model of the water cycle to gain an understanding of the interlinked processes that take place.

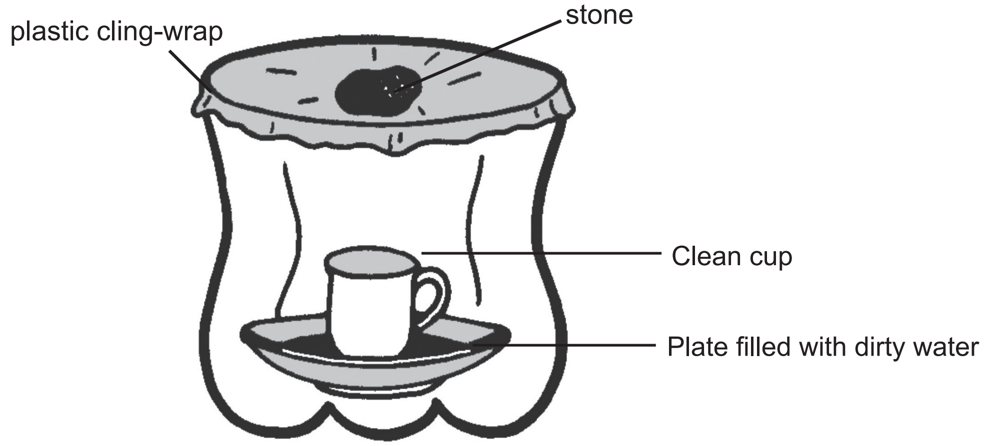
Time: 1 hour

What you will need

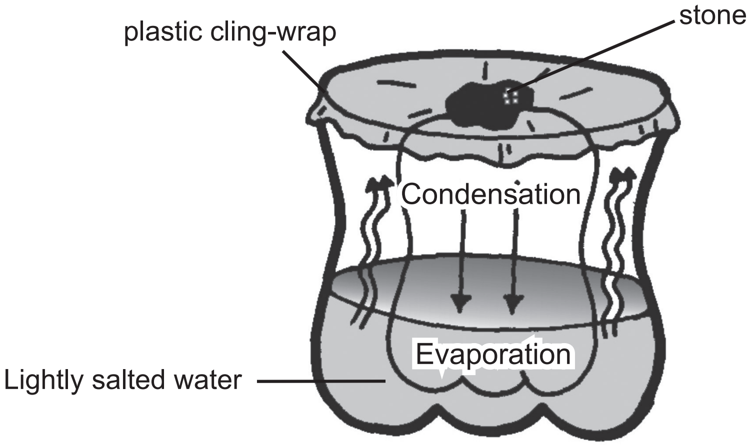
Transparent (see through) container, cup, plate, dirty water, plastic cling wrap, small stone.

What you must do

1. Build your model of the water cycle as shown in any one of the figures below. Make sure that the cling wrap seals tightly along the edge of the container.
2. Once your model is set up, place it outside in the sun and observe it over a period of a few days.
3. Answers the questions below in your workbook in the spaces provided.



A. An evaporation/condensation chamber to simulate the water cycle.



Taste the water that condenses and drops into the middle container

B. Another way of doing this experiment

Figure 1.8 Models of the water cycle

Questions

1. Describe your observations. (What did you see?)
2. How does your model represent the water cycle? Make a drawing of your model with arrows connecting the different processes that form part of the water cycle.
3. We have seen that most water is stored in the oceans. This water is saline (salty). Is rainwater saline or fresh? Give a reason for your answer.
4. Which human activities have a negative impact on the water cycle?
5. Reflect on how we can lessen our negative impact on the water cycle.

South Africa is a water-poor country and we are therefore very dependent on rainfall. What is the average rainfall for different parts of the country?

1.2.2 Rainfall in South Africa

You are aware that the amount of rain in your area varies from one year to the next. Rainfall may also be concentrated over a short rainy season or spread over a longer period. However, it is possible to get a general idea of the amount of rainfall in your area from maps that have been developed for this purpose. These maps show the *mean annual rainfall*. The amount of rain which falls in a year is measured for a number of years and then an average is taken which gives the mean annual rainfall.

The two maps below will help you determine:

- the average annual rainfall
- the season in which the rain falls
- the months of the year when there is the most rain.

For example, the eastern parts of the country, have an annual rainfall ranging from 600 to 800 millimeters (mm), concentrated in the midsummer months. The northern areas average 400 to 600 mm, concentrated again in the midsummer, while in the West the rainfall averages 200 to 400 mm and peaks later, namely in March to May.

What does mm stand for?
Rain is measured in millimeters (mm).
There are 10 millimeters in a centimeter.
There are 100 centimeters in a meter.
Use a school ruler to determine the size of one mm and one cm.

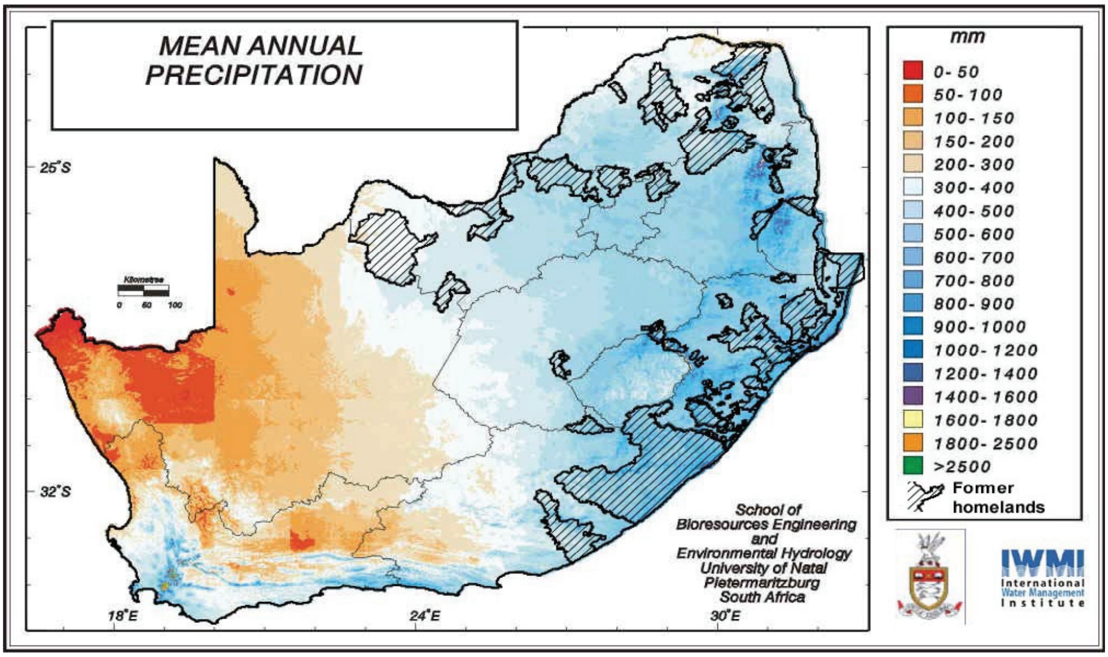


Figure 1.9 Average annual rainfall for South Africa (see Annexure A for colour maps)

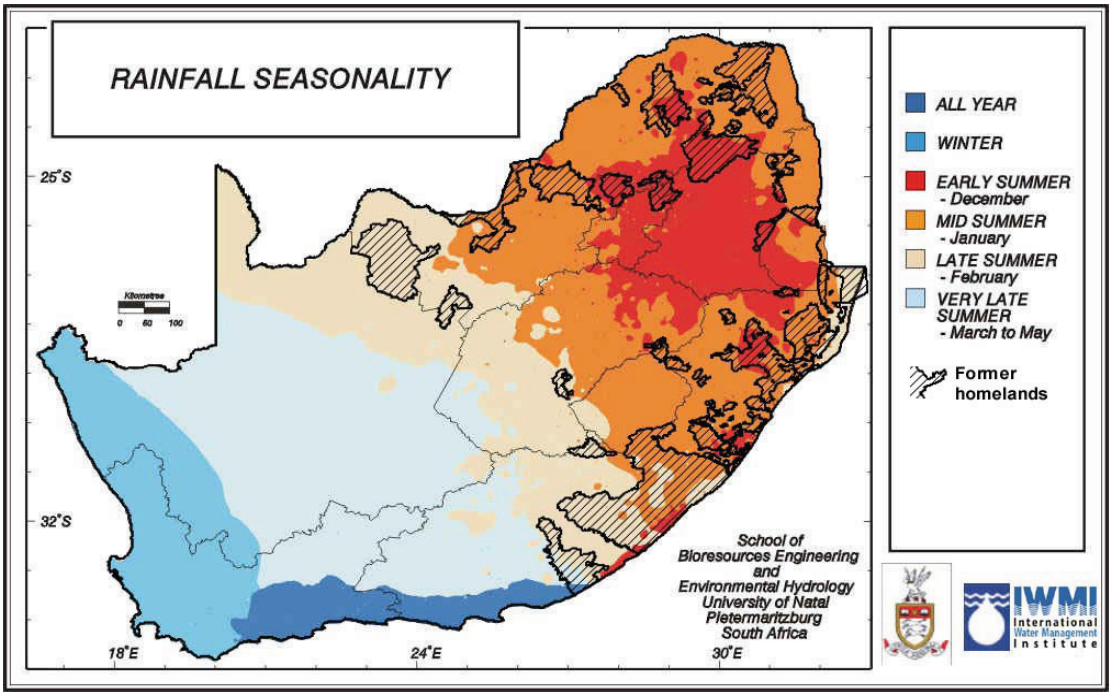


Figure 1.10 Seasonality of rainfall in South Africa (see Annexure A for colour maps)

Activity 1.4 Finding out about rainfall from maps.

Complete this activity in groups in this study guide

1. In groups of three to five people, look at the two maps in Figures 1.9 and 1.10. (See Annexure A)
2. Use the maps to identify where your group members are from and what the mean annual rainfall is for your area. (You can use another more general map of South Africa to pinpoint your position if it is difficult from this map)

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……

3. Which months have rain and when does the rainy season occur in your area?

……

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4. Discuss in your group whether the values given on the maps are similar to what you have experienced in the past few years. Does it rain more or less at the times suggested?

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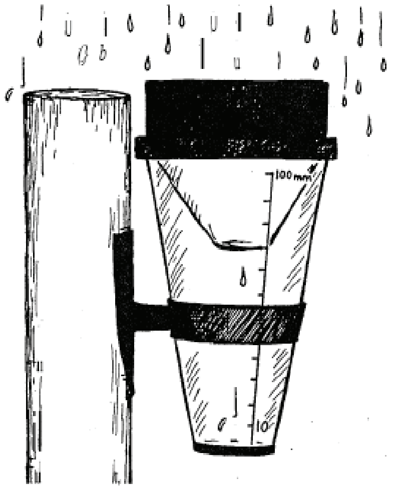
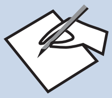


> **Note:** *It is also possible to use information from agricultural extension staff, local people in your area or to even measure the rain for yourself. You can measure rainfall for your area by using a* **rain-gauge** *and keeping a record of it.*

Figure 1.11 Rainfall is measured in millimetres in a rain-gauge

Activity 1.5 Finding out about rainfall in your area



Complete this activity in groups in your workbook

Aim: Get rainfall data in specific areas using local sources.

Time: 2 hours

What you must do

1. Find out from knowledgeable people in your area:
   - what the average rainfall for the area is.
   - what the seasonality of the rainfall is (which months of the year have rain and which month has the most rain).
   - the average minimum and maximum temperatures for your area. (You need to know whether there is frost, or you have very high temperatures and how long these conditions last)

> *Temperature is measured in degrees centigrade (also known as Celsius). We use the symbol ° for degrees. We use the symbol C for centigrade or Celsius.*
>
> *0°C is freezing point*
> *20°C is mild*
> *35°C is very warm*

Who are knowledgeable people whom you can consult about rainfall?
You can speak to older farmers who have been living in the area for a long time.
You can speak to the local agricultural extension officer in your area.
You can consult books or the Internet (Here you may need help from your tutor).

2. Once you have spoken to people and looked at other sources, you need to write a short report, which includes the following information:
   - Who you spoke to.
   - What each person said about average and seasonal rainfall and minimum and maximum temperatures. Present this information in a small table).

- Compare this information with the general rainfall data you worked out in Activity 1.4.
- Comment on similarities and differences.
- Specify why it is important for an HFS facilitator to be aware of average rainfall and seasonality of rainfall.

1.2.3 What is evapotranspiration?

You may have read about, or have heard people talk about, **evapotranspiration**. But what does this mean?

Evaporation on the ground surface + transpiration by plants = evapotranspiration from a given piece of land

You know what evaporation is but what is transpiration? Plant roots take up water which slowly moves through the soil. The plant loses part of this water as vapour which is emitted into the air through pores (small holes) in the leaves by means of a process called **transpiration.** Plants and in particular forests and grasslands play an important role in contributing to water vapour in the air and thus in maintaining rain in the landscape. This is one more good reason to protect our trees and other plants, especially our **indigenous plants**! Evapotranspirated water in the air accounts for about 90% of our atmospheric water from land. The water vapour forms clouds and these, in turn, form rain.

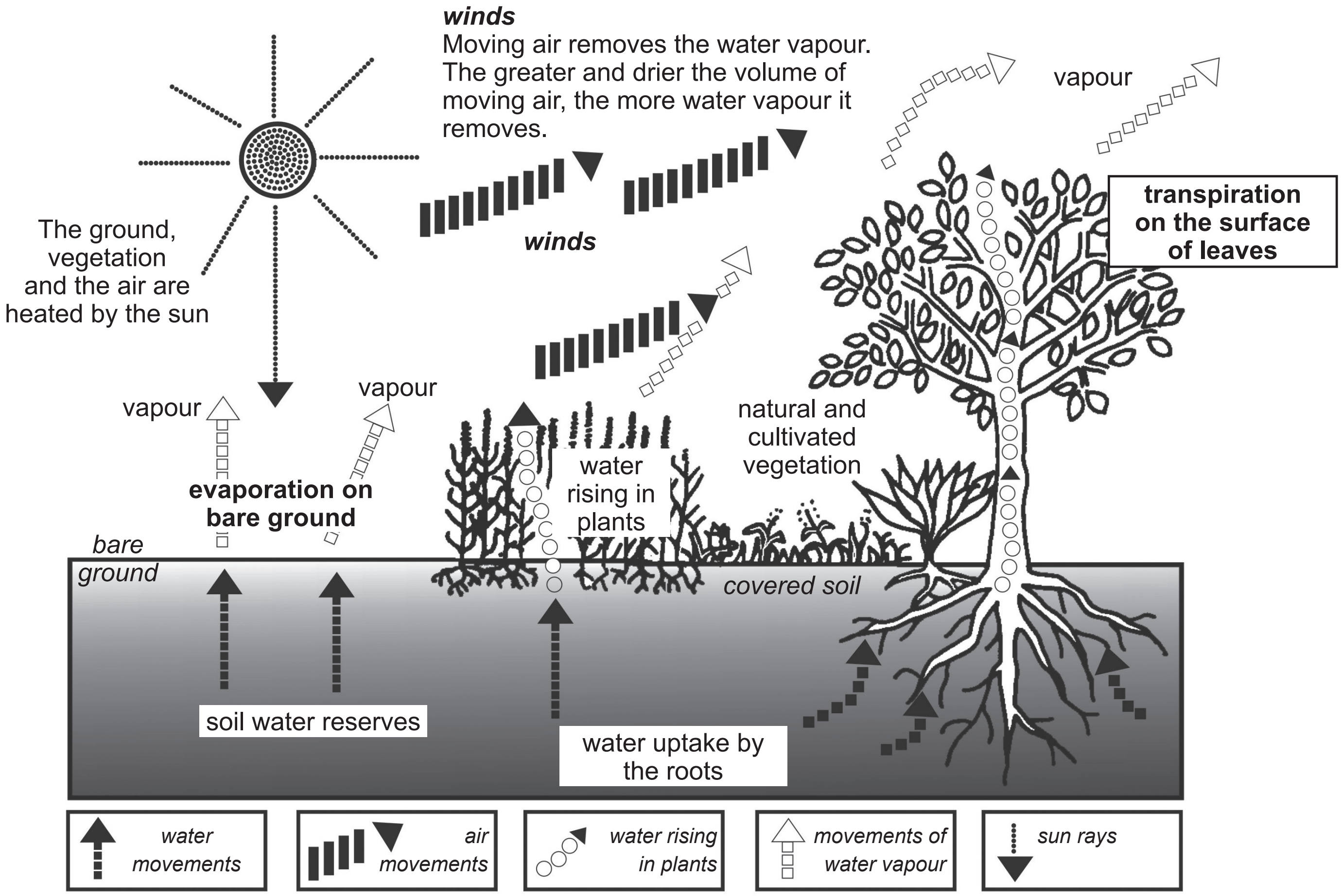


Figure 1.12 How evapotranspiration works

Carry out the experiment in the next activity to find out how evapotranspiration takes place.

Activity 1.6 Make your own terrarium

Complete this activity in groups or on your own in your workbook

Aim: Build a terrarium to gain an understanding of evapotranspiration

What you will need

A large glass or clear plastic container (spray bottle) with a lid, soil, sand, pebbles, compost, seeds, small plants, a small dish or cup, spray bottle.

Time: 1hour

What you must do

1. Build the terrarium (a very small garden inside a container) as follows:
    - Place the sand and pebbles at the bottom of the container which has been tipped on its side
    - Place about 3 to 4 cm of soil and compost on top of the sand and pebbles..
    - Plant the small dish firmly in the ground and fill it with water.
    - Create a small landscape by building small hills and valleys.
    - Plant the seeds and the small plants in the soill.
    - Moisten the soil and plants, using a spray bottle.
    - Seal tightly and place the terrarium in indirect sunlight, for example on the veranda (stoep) away from the sun.

2. Look at your terrarium (small world) every day for one to two weeks and write your observations in your workbook.
    - What is happening inside the terrarium?
    - What has changed over time? (Give the date and the event)
    - Why do you think the changes have happened? (Give the reason for the changes.)

3. Try some of the following experiments:
    - Add other life forms, for example, insects.
    - Plant some more seeds or small plants of your choice.

7. In what way does this model represent the water cycle? Make a drawing with arrows connecting the different elements of your terrarium in the space provided in your workbook.

8. Explain why is it important to know about evapotranspiration.

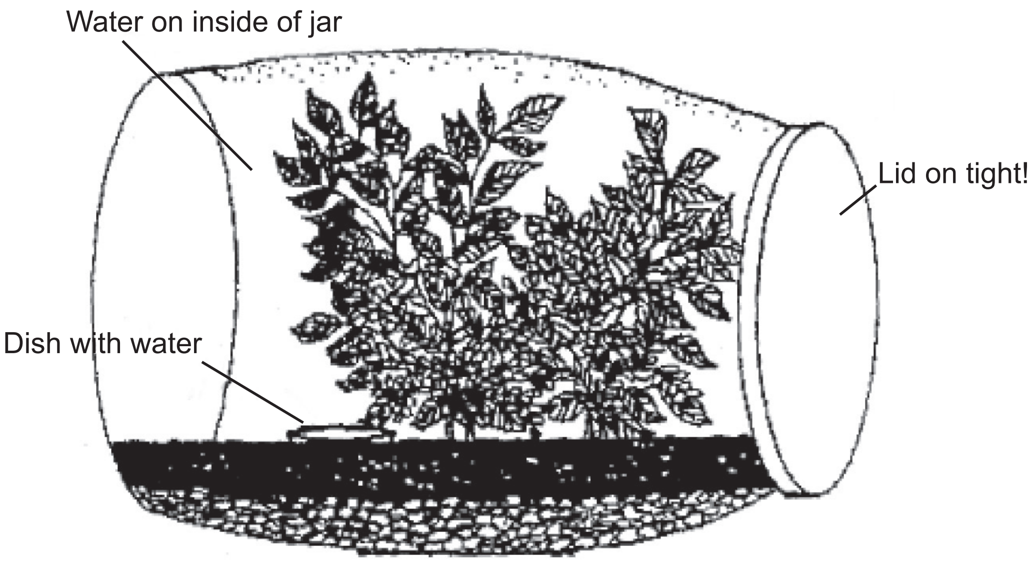


Figure 1.13 A terrarium to demonstrate evapotranspiration

Comments on Activity 1.6

> **What is stress?**
>
> *Plants suffer from stress when conditions are difficult (e.g. a lack of water or light), just as when people do when facing difficult situations.*

Understanding evapotranspiration is an important concept in growing vegetables and other crops. Plants wilt and become stressed if they transpire more water from their leaves than they can draw from the soil.

Something to think about

- How can a gardener limit the rate of transpiration by plants and evaporation from the soil, i.e. how can evapotranspiration be inhibited?
- Why should a person be selective regarding the type of crop or vegetables he or she plants in a garden?
- Which factors would determine what plants are cultivated in a garden?

You need to start thinking about these questions. The answers will become clear to you as we progress through this module.

Activity 1.7 Reading maps on evapotranspiration

Complete this activity on your own in this study guide

Look at the two maps below (also see Annexure A for coloured maps) and answer the questions that follow.

- The **first map** shows you the *potential evapotranspiration* (written in mm) during December, the peak rainfall month in the summer rainfall areas of South Africa.

- The **second map** shows you the potential *evapotranspiration* for July, which is mid-winter.

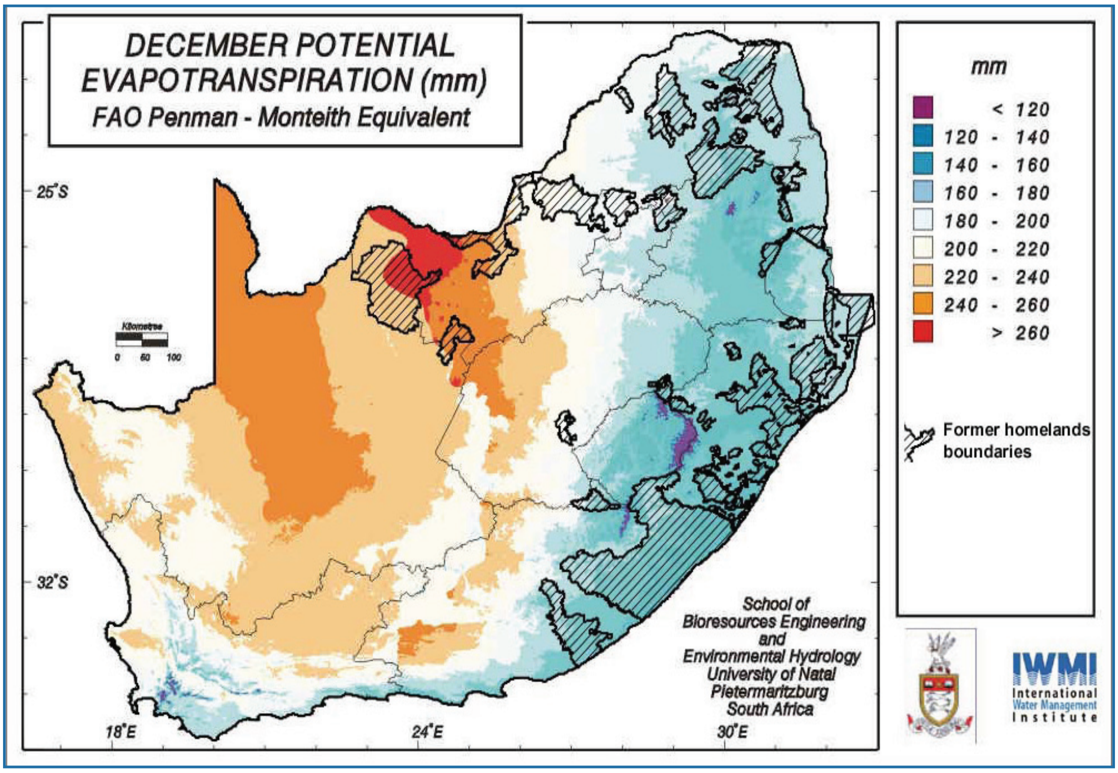


Figure 1.14 Map showing December evapotranspiration potential in South Africa
(See Annexure A for coloured map)

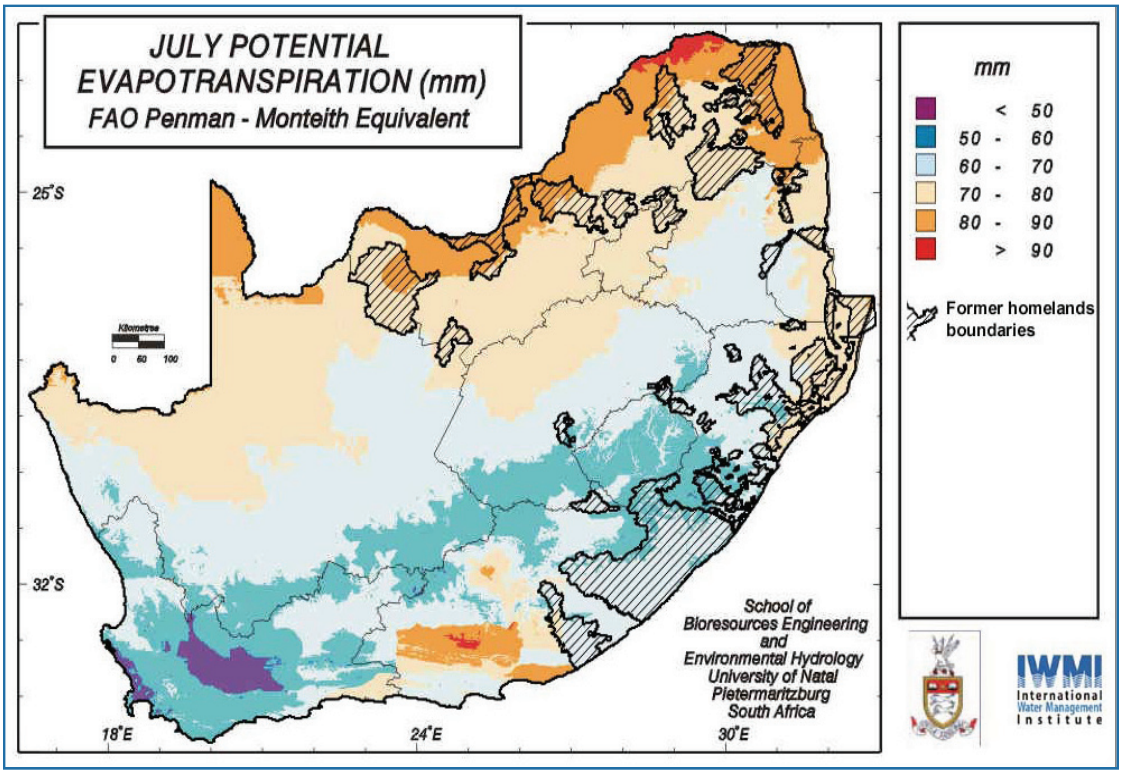


Figure 1.15 Map showing the July evapotranspiration potential in South Africa
(See Annexure A for coloured map)

Questions

1. What does the symbol >, and the symbol < on the maps mean?

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2. Why do you think the reference evapotranspiration for the area shown in red is so high for December? See Annexure A for coloured map.

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3. Why is it useful to know about the reference evaporation for the area where you are living if you are a farmer or gardener?

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4. Identify on the map where you are from. What is the evapotranspiration in December and July in your area?

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Comments on Activity 1.7

The symbol >, means more than. Example; the evapotranspiration is more than (>) 500mm.
The symbol <, means less than. Example; the evapotranspiration is less than (<) 500mm.
The area shown in red (see Annexure A) is in the interior with a very hot and dry climate, which causes the evapotranspiration to be very high.

Why is it useful to know the evaporation for the area where you are living and farming? This information will give you an idea of the amount of water you will require to grow crops. The agricultural planning sector in your area can work out the evapotranspiration of any crop that you may want to grow. This is then compared with the amount of rainfall expected, which, in turn, indicates the amount of water that you will need to provide for your crops through irrigation or rainwater harvesting.

The annual reference evaporation ranges from 1300 mm (1,3 metres) on the east coast, and 1500 mm (1,5 metres) in the North and interior, to 1800 mm (1,8 metres) in the West. Annual means for a period of one year.

Remember that the evapotranspiration values are higher than the rainfall values. Therefore the main function of irrigation and rain harvesting is to close the gap between low rainfall and high evapotranspiration. Crops need to get at least as much water as they lose in evapotranspiration in order to produce high yields.

1.2.4 What happens to water in the soil?

As you are aware, infiltration is one of the inter-inked processes that take place during the water cycle. With enough rainfall the water that falls on the ground will infiltrate (move deeper into the earth) to become groundwater that is stored in aquifers. These aquifers could be in cracks inside other rocks or in huge caves or channels. The upper boundary of the underground water is called the **water table**. About 98% of all fresh water in the world is stored as groundwater. Figure 1.16 shows you what happens to water beneath the ground.

What is an aquifer?

Aquifers are cracks in rocks or huge caves under the ground that are usually filled with water.

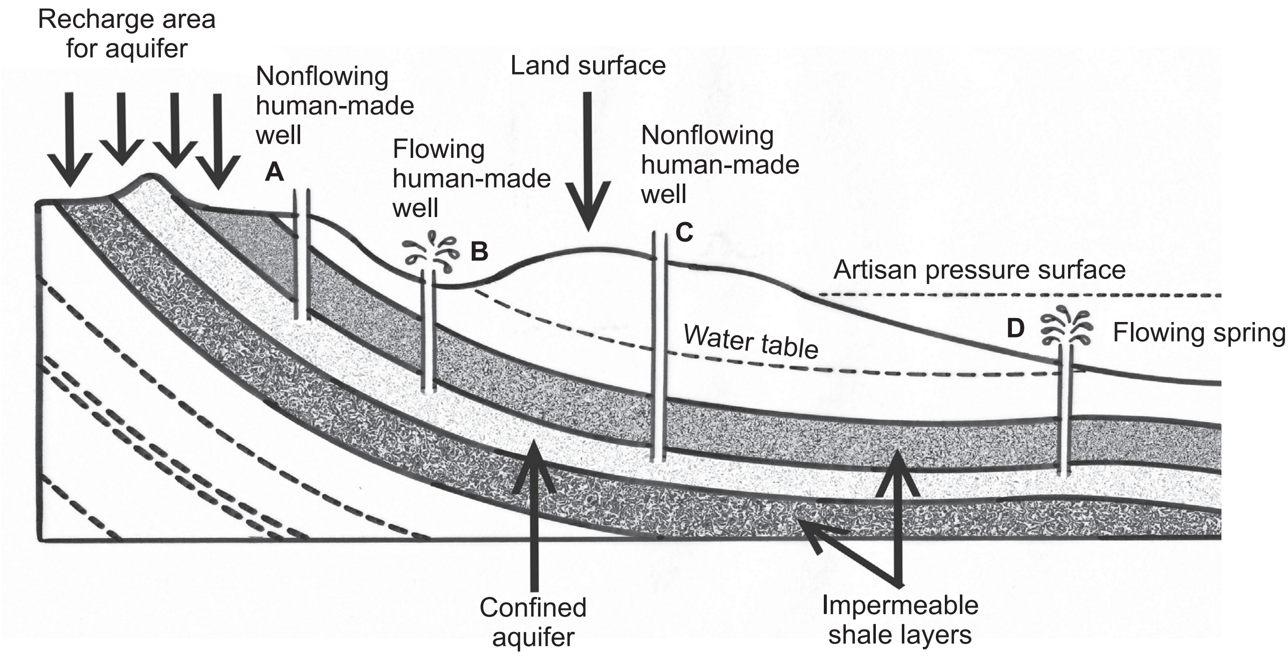


Figure 1.16 What happens to underground water?

When water that seeps into the soil reaches an **impermeable** layer of rock such as shale/mud stone, which is a layer of rock that doesn't let water through, it will follow the slope and can eventually emerge on the surface as a spring or the source of a stream or river. Rivers have a sustained flow, because most of the water is actually stored in the soil, where it slowly releases into the drainage basin or stream.

1.2.5 What are watersheds and catchments?

A watershed is an area of higher elevation (such as the top of a mountain) that separates two **catchment areas** from each other, so that water flows down from the watershed into one or the other catchment area. All the streams in one catchment flow into one river and those in the other catchment flow into a different river.

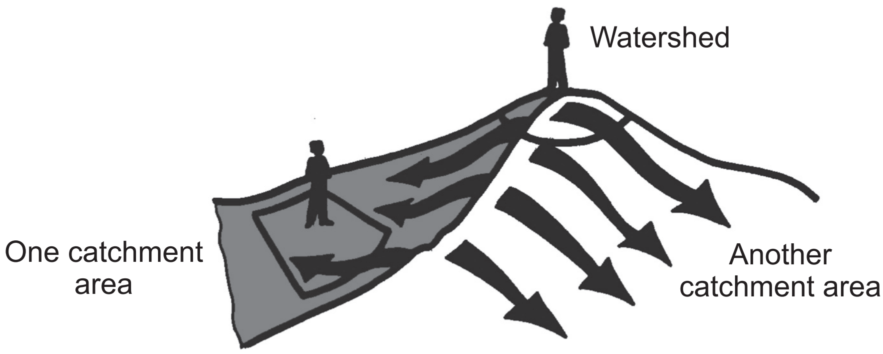


Figure 1.17 The top of a watershed with two catchment areas

Plants in catchments

Indigenous vegetation (plants) are very important in catchment areas (catchments) for the following reasons:

- Plants slow down water as it flows over the land (runoff) allowing much of the rain to soak into the soil and replenish underground water (aquifers). Water seeps from these aquifers into rivers.
- Plants prevent soil erosion as their roots hold soil in position, preventing it from being washed away.

In disturbed ***watersheds****, the slow and sustained release of water is disrupted. Water runs rapidly off the ground's surface, rather than soaking in. This process creates floods followed by drought.*

- Vegetation (plants) in wetlands and on the banks of rivers is of particular importance. The roots of the reeds, sedges, shrubs and grasses growing in wetlands and next to rivers bind the soil and prevent erosion. At the same time these plants clean the water by filtering impurities and regulating water flow.

Something to think about
Why are watersheds and catchments important to communities and people who want to start gardening projects?

It is of the utmost importance that our catchments are well managed because if this does not happen, all the people in the community will suffer. Reflect on how you can contribute to good management of catchments.

1.2.6 Water management areas in South Africa

On a larger scale your land (your local government/ local municipal area) will almost surely be part of a larger watershed or catchment. These are combined for local areas to form **regional drainage basins/catchments** that drain thousands of square kilometres of land, creating streams and rivers. In South Africa the **quarternary catchment** (about 100 square kms) is the smallest unit at which national planning is done. These quarternary catchments make up the units of even larger areas known as **water management areas,** of which there are 19 in South Africa.

These water management areas contain the larger rivers and dams in the various regions of South Africa and provide the basis for regional planning. This planning includes water requirements and allocations for various uses such as irrigation, mining, cities, industry and rural areas.

Where are the 19 water management areas in South Africa and what are the water requirements for these areas?

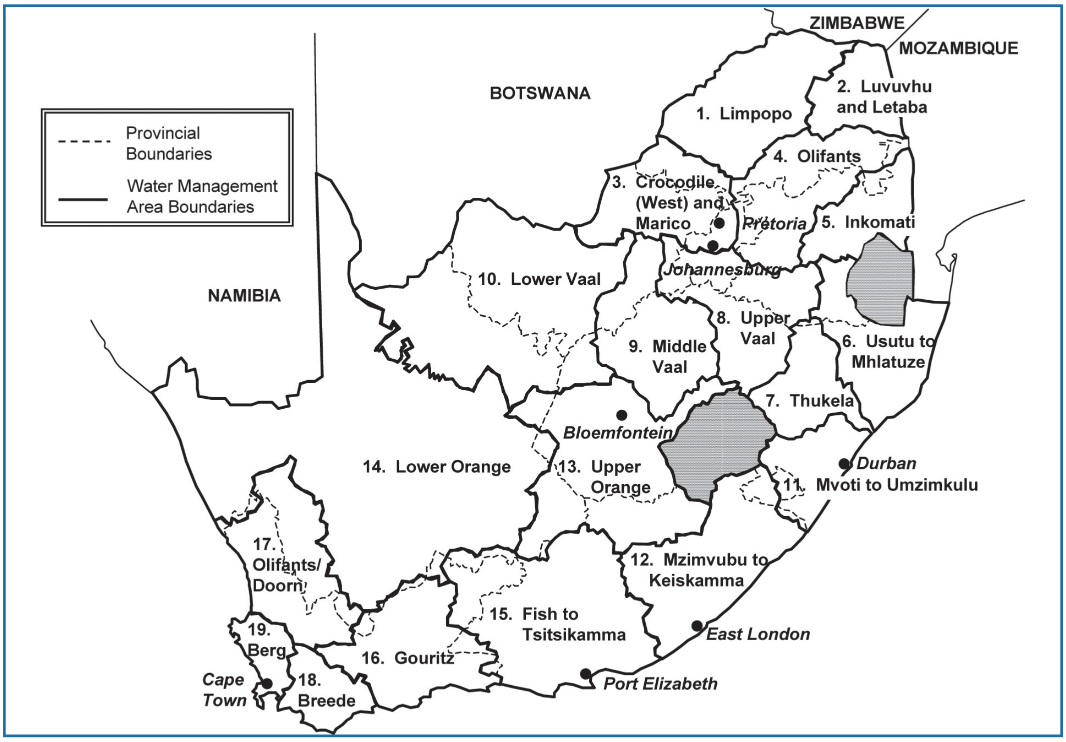


Figure 1.18 The 19 water management areas in South Africa
(Adapted from Oosthuizen, 2004)

Do each of the 19 water management areas use water for the same purpose? Do they use different amounts of water? Table 1.3 below gives you an overview of how water is used in each water management area.

Table 1.3: Water requirements for the 19 water management areas based on statistics for the year 2000 (million m³/ year)

Water Management Area	Irrigation	Urban	Rural	Mining and Bulk Industrial	Power generation	Aforrest-ation	Available balance in 2000	Potential water require-ments in 2025	Total local requirements
Limpopo	238	37	28	14	7	1	(24)	8	325
Luvuvhu/Letaba	248	11	31	1	0	43	(37)	102	334
Crocodile west and Marico	445	691	38	127	27	0	11	0	1 328
Olifants	557	92	44	94	181	3	(196)	239	971
Inkomati	737	65	24	24	0	198	(253)	114	1 048
Usutu to Mhlathuze	404	54	40	91	0	104	235	110	693
Thukela	204	56	31	46	1	0	(97)	598	338
Upper Vaal	114	795	42	173	80	0	481	50	1 204
Middle Vaal	159	112	32	86	0	0	(2)	0	389
Lower Vaal	525	78	44	6	0	0	48	0	653
Mvoti to Umzimkulu	207	438	44	74	0	65	(267)	1 018	828
Mzimvubu to Keiskamma	190	100	39	0	0	46	480	1 500	375
Upper Orange	777	129	60	2	0	0	486	900	968
Lower Orange	780	28	17	9	0	0	(9)	150	834
Fish to Tsitsikamma	763	116	16	0	0	7	106	85	902
Gouritz	254	57	11	6	0	14	(66)	110	342
Olifants/Doring	356	7	6	3	0	1	(35)	185	373
Breede	577	43	11	0	0	6	29	197	637
Berg	301	423	14	0	0	0	(34)	210	738
Total for Country	**7 836**	**3 332**	**572**	**756**	**296**	**488**	**504**	**5 576**	**13 280**

Activity 1.8 Water use in your management area

Complete this activity in groups or on your own in your workbook

Aim: Interpret information on water management in your area.

Time: 1.5 hours

What you must do

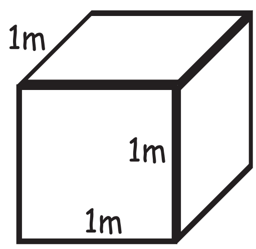
1. Look at the map in Figure 1.18 above.
2. Identify on the map where you live. You may want to look at another more general map of South Africa to help you situate where you are and what the names of the major rivers are that are close to you.
3. Find out the name of the water management area where you are and list the names of the major rivers.
4. Now look at Table 1.3. Look under your water management area and summarise the water requirements information by answering the following questions:

Questions

1. What does million m^3/ year mean?
2. Which water user, uses the most water in your water management area? Look at the headings across the top of the table to help you find this information.
3. Which water user uses the least water in your water management area?
4. Why are the water requirements for rural users much lower than for the *urban* users? Think of at least three possible reasons.
5. Is the "Available balance in 2000" for your water management area in brackets? What do you think this means?
6. Compare the "Available balance" in your water management area with the "Potential water requirements in 2025". What do these figures mean to you?
7. Suggest at least three potential options of how to solve the problem of too little water.

Comments on Activity 1.8

The metric unit **m³** indicates cubic meters. A cubic meter is a measurement of volume which is 1m x 1m x 1m in size.



The million m^3/ year in the heading of Table 1.3 therefore means that a million cubic meters of water is used every year.

Water use will depend on where you live. For example in the Mzimvubu – Keiskamma region: Irrigation uses the most; mining and power generation uses the least water.

We can summarise by saying that the main consumption of water is for:

- **agricultural use.** Agriculture is the largest user of water in South Africa where water is mainly used for irrigation. Irrigation in our country leads to a tremendous waste of water. Unwise irrigation, the choice of crops and inefficient management techniques are mainly responsible for this wastage. In the next unit we will examine how water should be managed.
- **industrial use.** In developed countries almost as much water is used for industrial purposes as it is for agriculture. However, in industry a large part of this water is used over and over again.
- **domestic use.** Unfortunately a tremendous amount of valuable purified water for domestic purposes is wasted every day. The people of South Africa will have to be made aware of the necessity to conserve water.

You are now aware of the importance of catchments and their management, but is it important to also consider the shape of the land when you plan a homestead garden? This is the topic for our next section.

1.2.7 What is topography?

Topography tells you about the shape of the land. It is important to take the shape of your land into consideration, as this will affect your farming/ gardening and how you use the land.

For example:

- If you cultivate steep **slopes,** you could cause soil erosion.
- Valley bottoms are often not suitable for farming as there may be a problem with frost or there may be a wetland. **Wetlands** are lowlands that are seasonally or permanently waterlogged (wet).
- If your crops are planted in a flood plain, they can wash away during heavy rainfall.
- If you are at a high altitude you may have cold winter temperatures.

What is a slope?

A slope tells us how steep or flat our land is. Steep slopes are vulnerable to erosion when used for cropping and grazing. Bare soil is easily washed away on slopes. Slope is measured or estimated, so that it is possible to work out how far apart to make **contours** or erosion control structures on the slope or hillside so that slopes may be cultivated without being eroded.

What are contours?

Contours are imaginary lines that are on the same level (at the same height or elevation), across a slope as indicated on the picture below.

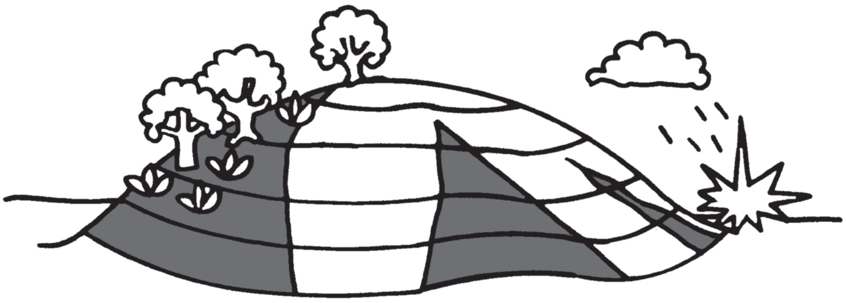
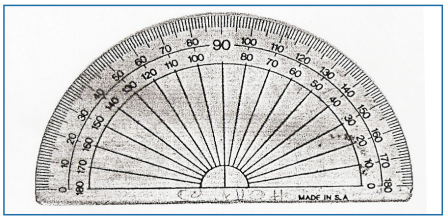
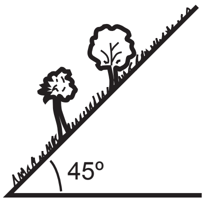


Figure 1.19 Contour lines drawn on a hill to show the areas that are level

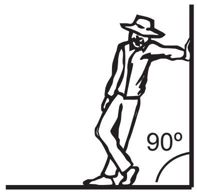
To measure the angle of a slope, professional people use an instrument called a **theodolite**. However, as we do not have such an instrument available, we can practise measuring the angle of the slope by using a small instrument called a **protractor** which measures in degrees (°). The small sketches on the right give you an idea of the angles of three different slopes.



Flat land is 0º



This slope is 45º



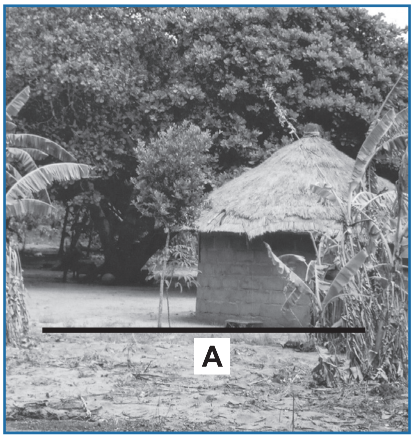
A vertical wall is 90º

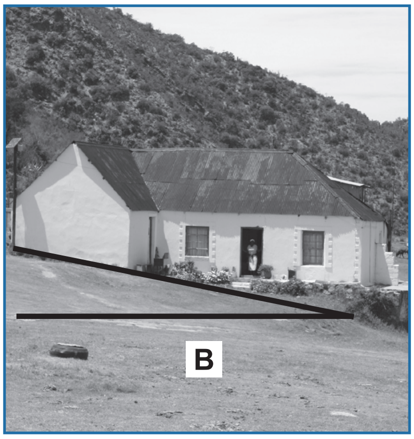
Figure 1.20 A protractor

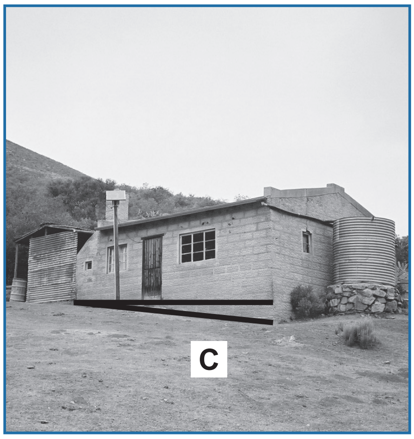
Activity 1.9 Measuring angles using a protractor

Complete this activity on your own in this study guide

1. Measure the following angles with a protractor.







A ....The ideal is to have no slope and the soil is level.

B .... Note the filling added to improve the slope forming part of the foundation.

C .... Note the filling to add if you want to level the soil for a garden.

2. Look at Table 1.4 below that provides recommendations for land use, depending on the slope. Go outside and look at the land. Guess the degrees (steepness) of three different slopes you notice in the environment.

Table 1.4 Recommendations for land use, depending on slope

Slope º	*Description of slope*	*Recommendations for land use*
Less than 12º	Gentle slope	Can be ploughed and used for commercial cropping
12º - 20º	Moderate slope	* Can be ploughed and used for commercial cropping. * Include contour plantings and structures. In areas including Eshowe in KZN and Alexandra, Albany, Bathurst, Komga and East London in the Eastern Cape ploughing of slopes more than 12º is not recommended, because the soil is likely to erode. * Home gardens also need contour plantings, structures or terraces. It is better to plant crops that cover the ground such as sweet potatoes and cowpeas. * It is best to plough and plant perennial (long living) plants such as trees, pasture, sugarcane, etc.
20º - 30º	Moderately steep slope	Plough for perennials (plants that carry on growing for years and years and do not die after one season).
30º - 50º	Steep slope	This slope is too steep for crops. You can plant fruit or timber trees. However you will need to dig holes by hand.
> 50º	Very steep slope	Not recommended for planting,

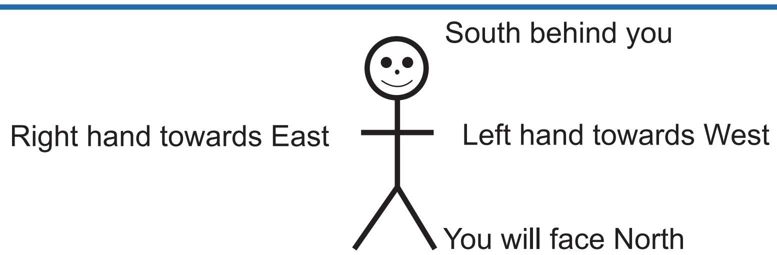
In Unit 3 you will measure the actual slope of your land, using a line level.

1.2.8 What are aspect, ridges and valleys?

Aspect tells you whether your land faces North (N), South (S), East (E) or West (W). In South Africa, north-facing slopes tend to get the most sun. They are sunny and can often be hot and dry. You may find aloes on these slopes. The South-facing slopes are cooler and wetter. This is where you would find indigenous forests.

Do you know how to find out where N, S, E and W are? If you are confused; just think where the sun comes up – that will be East. Where the sun goes down – is West.

Something to do
Go outside and stand with your left hand towards the West and your right hand towards East. You will be facing North and South will be behind you. If it is Midday (12 o'clock) your face should be facing the sun to estimate north.



You can also use the direction of N, E, S, and W and the sun to tell the time as the shadow of the pole moves from one point to the other corresponding with time on a watch.

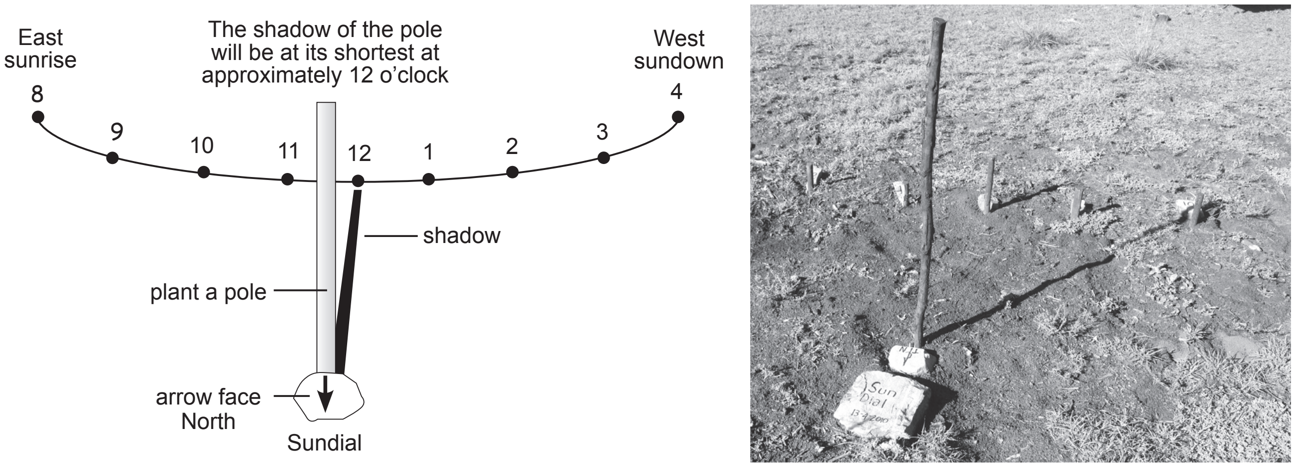


Figure 1.21   A sundial (sun clock)

> Plant a pole and measure the end of the shadow at every hour and mark with a stone. The position of the shadow will be different in summer and winter.

Ridges are at the tops of hills or slopes. **Valleys** are at the bottom of hills or slopes. There can be a large difference in temperature between ridges and valleys. Valleys can become very cold at night and hot during the daytime. Frost is often found in the valleys. Ridges can be cold and windy.

The best places for cultivating plants are generally on the mid- and lower slopes, but not on top of ridges or in valley bottoms, as you can see from the figure below.

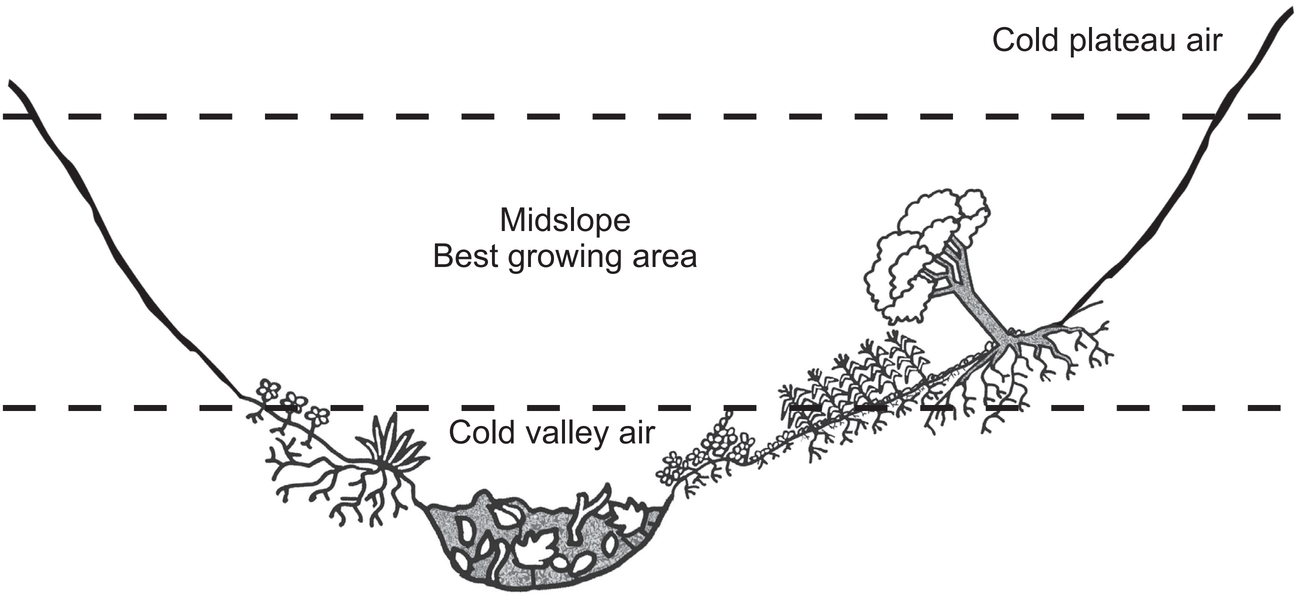


Figure 1.22 Ridges and valleys in a part of your catchment showing the mid-slope area that is best for farming.

Activity 1.10 Considering aspects, ridges and valleys

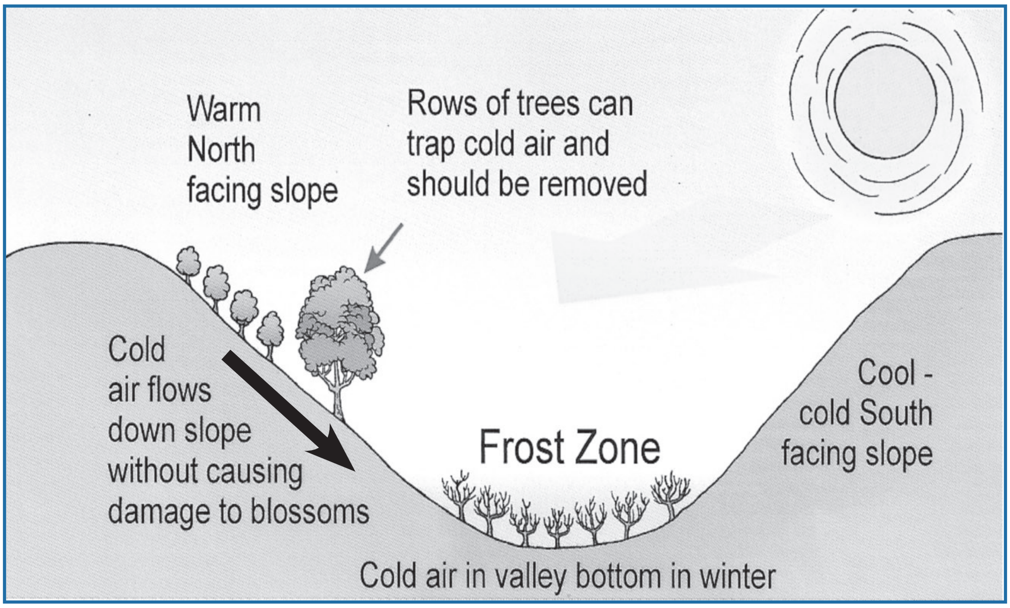
Complete this activity in groups or on your own in your workbook

Aim: Analyse a figure on aspect, ridges and valleys for land use options.

Time: 1 hour

What you must do

1 Look at the figure below. It gives an indication of where to plant fruit trees taking the aspect, ridges and valleys into consideration.



Note the aspect and the movement of air as shown in the drawing. Then answer the following questions.

Questions

1. Where it the best place to plant trees and crops? Give two reasons for your answer.
2. Why have no fruit trees or other trees been planted on the cool, cold south-facing slope?
3. What is the difference between the fruit trees planted on the north-facing slope and the fruit trees planted in the valley bottom?
4. A comment on the drawing states: *Rows of trees can trap cold air and should be removed*. Discuss what this statement means.
5. Where is the cold air coming from and where is it going?
6. Where will the cold air be trapped?
7. If you would want to plant rows of trees to protect your fruit trees from cold air where would you plant them?

1.3 Soil as a natural resource

Soil together with temperature and the availability of water is one of the most important resources in the environment.

1.3.1 What is soil?

Soil is the growth medium that supports almost all plant and animal life on land. Soil can be defined as the uppermost weathered (broken down) layer of the Earth's surface that contains gases, water, mineral salts, living organisms and their remains (organic matter). Soils begin with the weathering of rocks and their minerals. What do we find when we examine each component in soil?

Soil air and soil water

In a good soil, about two thirds of the spaces between the soil particles contain air after the excess (extra) water has drained.

The air in these spaces, provides oxygen for plant roots. Water occupies the remaining soil space. The relation between the amount of air and water is, however, not fixed.

After heavy rain all the spaces may be filled with water. If some of the excess water does not drain from the soil, plant roots may die from lack of oxygen.

On the other hand, if there is not enough soil moisture, plants wilt from lack of water. Soil moisture and air are also important in determining the numbers and kinds of organisms present in the soil.

Soil organisms

Healthy soil is living soil, with many different organisms living and working in it.

Protozoa, nematodes, earthworms, insects, bacteria and fungi are typically found in soil. What are the functions of these organisms in soil?

What are organisms and organic matter?

Any living thing is an organism. For example, bacteria, protozoa, fungi (mushrooms), plants and animals, including humans are all organisms. Bacteria are very small organisms and are therefore called microorganisms.

Dead organic matter in soil, is the remains of plants (leaves, fruits or grass), and animals (manure or dead organisms)

Organisms present in healthy soil

Protozoa are very small organisms who act as parasites on other soil organisms. They therefore help to regulate the population size of the other soil organisms

Nematodes are often called roundworms. They may help with the break down (decay) of dead organic matter

Insects contribute to soil properties by forming burrows (passages) and recycling organic material. Some are also major crop pests

Bacteria and fungi are microorganisms and very important in the decay and recycling of organic materials. They can for example change *nitrogen* in the dead material into *ammonia* or *nitrate* that can be utilised by plants

Figure 1.23 Organisms present in soil

Mineral salts in soil

Mineral salts can be visible (in the form of crystals, powder or granules) or invisible (dissolved in the water). They can also be combined with organic matter. Ashes spread on the ground are visible salts, as are fertiliser granules or crushed shells. When they are dry these salts remain on the surface of the ground. As soon as it rains some of these salts dissolve and are carried away between the soil particles. We use the word **leaching** to describe water moving through the soil which dissolves and removes the salts to layers lower down.

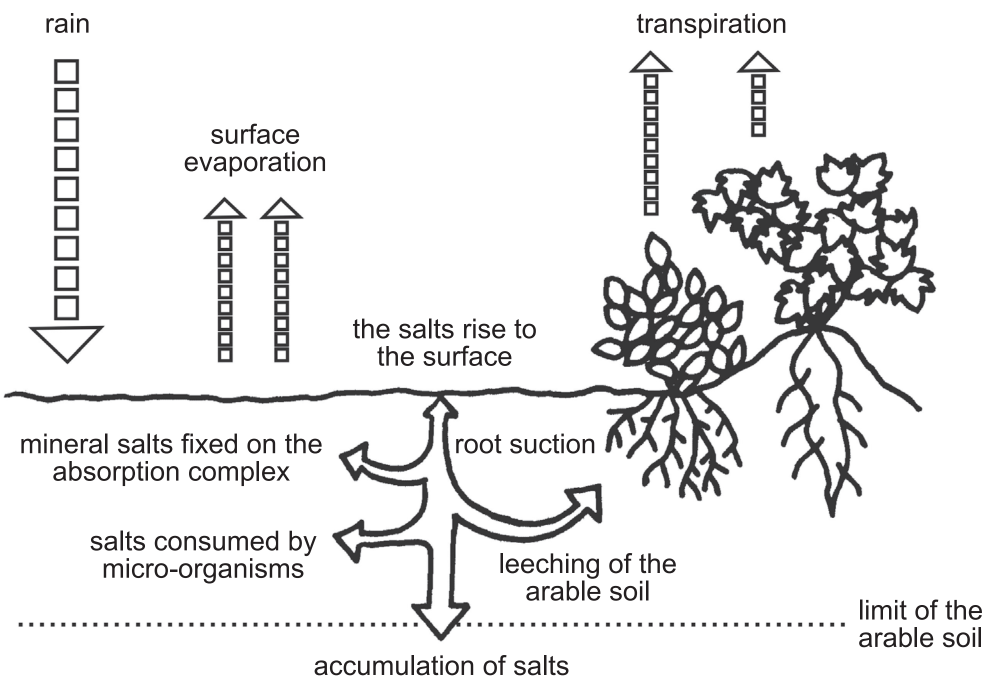


Figure 1.24 The movement of water and minerals in the soil
(Adapted from Du Preez *et al.* 1992)

1.3.2 What is soil texture?

Soil is made up of individual particles or clusters of particles, with small spaces (pores) between them that contain air and water. A good soil has pores of many different sizes, large and small. The texture of soil is determined by the size of the rock particles (pieces) in the soil. The following table shows you how soil is classified, based on the size of the particles.

Table 1.5 Soils classified on the basis of particle size

Soil type	Particle size
Gravel	Between 0.05 and 2.0 mm
Sand	Between 0.05 and 2.0 mm
Silt	Between 0.002 and 0.5 mm
Clay	Less than 0.02 mm

Gravel and sand

Large particles like gravel and sand feel rough between the fingers. Water and air easily infiltrate this kind of soil because of the spaces between the particles. Water drains from this kind of soil very rapidly, often carrying valuable **soil nutrients** out of the soil where they cannot be reached by plant roots**.**

Silt

Silt is a fine sandy soil. Silt holds water and **plant nutrients** better than a coarser sandy soil. Silt is easily washed out of the soil into rivers and dams.

Clay

Clay consists of very tiny particles. They are so small that you cannot feel them with your fingers. That is why clay feels slippery and sticky. There are very small pores or spaces between the particles. The particles stick together in lumps or clods. Clay holds onto water and nutrients in the soil. Certain types of clay will swell when they are wet and shrink and crack when they are dry. They can be difficult to work with.

Which type of soil is the best? The best soils are called **loams,** which combines the good aeration and drainage properties of large particles with the ability of clay particles to retain **nutrients**. Loams contain more or less equal mixtures of sand, silt and clay.

How can you tell your soil type?

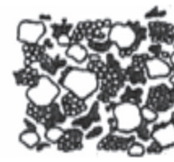
We need to touch, see and smell soils so that we can use our knowledge to discuss different soil types. We want to use peoples' own ways of distinguishing between soils and their own management practices as the basis for our discussions. We can use the bottle and soil sausage tests below to guide a discussion on soil types, soil characteristics and good and bad soil management practices.

Soil Structure Examples

SAND - light soil, no water-holding capacity

CLAY - heavy soil, holds water, difficult for root penetration

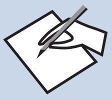
SANDY CLAY - holds water, easy for root penetration



LOAM - optimum water holding capacity, optimum for root penetration, contains organic matter

Something to think about
When you start a homestead garden, why is it important to determine what kind of soil you have available?

Group Activity 1.11 Identifying soil types



Complete this activity in groups or on your own in your workbook

Aim: Identifying different soil types by touch and observation

Time: 2 hours

What you need

For the sausage test: At least three types of soil (about a handful of each) and some water. These can be collected from the river (sand), low lying wet areas (clay) and good cropping fields (silt). Look for soils that have a different colour and texture so that you can compare them.

For the bottle test: Three clear plastic or glass bottles (for each small group), such as 1-litre coke bottles, with caps. Handfuls of three different types of soil from the area or of the three main soil types there are.

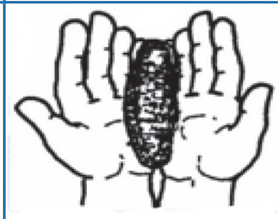
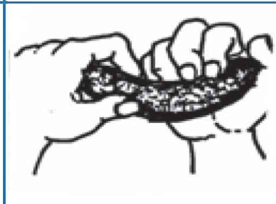
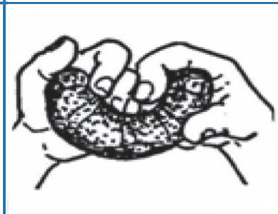
Use the space provided in the workbook to complete this activity.

What you must do

Tell by touch: You can tell how much sand, silt or clay is in your soil by how it feels.

1. Wet some soil and roll it into a ball between your hands.
2. Now roll this ball into a sausage.
3. Use the table below to identify your soil type.

Table 1.6 Identify soil type by touch

What soil looks like	What soil feels like	When rolled into a sausage		The soil is
Very Sandy	Very rough	Cannot be rolled into a sausage		Very Sandy 0-5% clay
Quite Sandy	Rough	Can be rolled into a sausage but it cannot bend		Sandy 5 - 10% clay
Half Sandy & half smooth	Rough	Sausage can bend a little		Sandy Loam 10 - 15% clay
Mostly smooth	A little sandy, quite smooth but not sticky	Sausage can bend about half way around		Loam or Silt Loam 15 - 35% clay
Mostly smooth	A little sandy, quite smooth and sticky	Sausage can be bent more than half way round		Clay Loam or Sandy Clay 35 - 55% clay
Smooth	Smooth and sticky	Sausage can bend into a ring		Clay More than 55%

(Adapted from Stimie, *et al*. 2010)

Tell by observation.

1. Fill a bottle one third full of soil.
2. Almost fill the bottle with water and shake vigorously for several minutes to separate the soil grains.
3. Leave the bottle with its contents to settle and observe what takes place.
4. Make a labelled drawing and write a description next to it in the space provided in your workbooks.
5. Use the examples below to guide your comments.

Examples

- The substances settle in layers, the heaviest at the bottom and the lightest at the top. Others remain suspended (float) in the water. Some substances are lighter than water and float on its surface. These are pieces of organic matter such as leaves, seeds, fruit or insect litter and fungus spores. Other heavy substances such as gravel, pebbles and sand quickly fall to the bottom.
- The finer substances then accumulate (stick together); first the silt, followed by the fine and very fine clay. These layers vary in consistency and colour. The layer of water above the settled material remains cloudy for a long time. It contains clay particles so fine that they stay suspended in the water.
- If some salt crystals were added to the soil before the bottle was shaken, we notice that they have now disappeared. They have dissolved in the water and can no longer be seen. Some soil components are visible and others are invisible, because they are dissolved in the water.

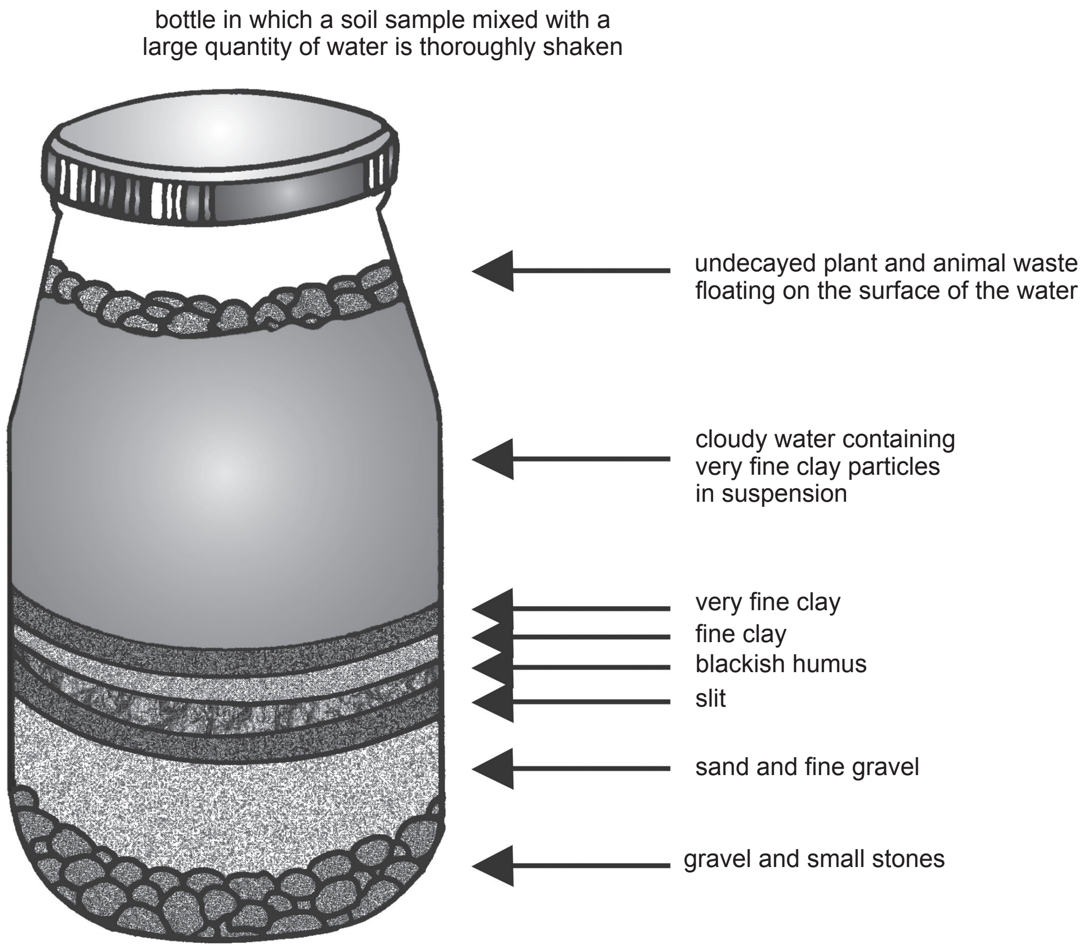


Figure 1.25 Soil sample mixed with water to show layers

6. Once you have decided on your soil types, use Table 1.6 below which gives an indication of good soil management practices for each of your soil types.

1.3.3 What is soil structure?

Soil structure tells us how the soil particles are mixed or grouped together. It also tells us how well the smaller particles stick together in clusters. This influences how easily water and air (and plant roots) can move through the soil.

The structure of soil depends on the following:

- The type and proportion of the different materials that make up the soil
- The way in which the soil was worked by tillage implements, water and microorganisms.

Table 1.7 Characteristics of soil types

SANDY SOILS	
Good things about this type of soil	Bad things about this type of soil
• It is easy to dig and work with	• It gets dry quickly
• It warms up quickly in spring after winter	• It does not keep much fertility
• It is good for root crops	• It does not hold water well
• Water and air can get into the soil easily	
LOAM SOIL (Mixture of sand and clay)	
Good things about this type of soil	Bad things about this type of soil
• It holds water well	• It is hard when dry
• It is best for root growth	
• It contains organic matter	
CLAY SOIL	
Good things about this type of soil	Bad things about this type of soil
• It holds water well and for a long time	• Its hard to work; heavy
• It holds fertility well and for a long time	• It is slow to warm up in spring
	• It is sticky when wet
	• It is hard when dry

Why is it important to know about soil structure? Soil structure plays a critical role in soil water management. The fact that organic materials and minerals are mixed together creates a balance:

- In a sandy soil where water will quickly run through, the addition of organic matter and humus promotes water retention (holding onto water). The soil will then not dry out so quickly,
- In a clay soil the addition of organic matter is good for drainage because it creates water channels in the soil.

Note: If you want to identify soil structure when you are in the field, you do so by means of observation and by touch. Below is information which you can use for this identification.

Structureless soils

Here the grains of sand or silt are not bound together. A dry, structureless soil will slip through your fingers like sorghum grains when they are poured into a container. These soils are infertile unless they are rich in **humus**. They are unable to hold water and are easily leached as the water flowing through carries away mineral salts in large quantities. These soils are susceptible (at risk) to water and wind erosion as there is no sticky matter to keep them in place.

> **What is humus?**
>
> *Humus is dead organic, decomposed material which enriches the soil and enables plants to grow well*

Compact soils

These soils contain a lot of clay. They are sticky when wet. Neither people nor plants work compact soils easily. The plants must use a lot of energy to allow their roots to penetrate this type of soil. When these soils dry out, they harden so much that neither roots nor farm implements can penetrate them. They contract and cracks appear.

Granular or aggregate soils

These soils are composed of a mixture of well-proportioned (good balance of the different kinds) elements**.** They are divided into little clods of Earth. These clods are divided into crumbs in which clay, humus and minerals stick the coarse granules of sand and gravel together. Between the crumbs there are spaces (pores) openings (gaps) and free spaces where water and air can circulate.

The crumbs are formed by everything that works the soil, including farm implements, plant roots, micro-organisms, earthworms, moles, ants and termites. These soil organisms are constantly moving, decomposing and producing material in the soil.

Activity 1.12 Identifying soil texture, structure and depth

Complete this activity in groups or on your own in your workbook

Aim: Digging a soil pit to tell different soil textures, structures and depth.

Time: Five hours

What you will need

Tools to dig a hole, a tape measure or ruler to measure depth and paper to record your results on.

What you must do

Complete this exercise in your home garden or in the garden of a member of the community. Make drawings and, if at all possible, take a few photographs.

> **Note:** Digging a soil pit is quite hard work. You may want to dig this pit in a spot in a garden where other activities will take place later. For example this pit can form the beginnings of a trench bed which you will use in Module 5, or it can become the planting hole for a fruit tree.

1. First look at the general environment. Are the plants growing there doing well? Are all the plants of the same kind, growing the same? If not, describe the differences.

2. What does the soil look like? Is it cloddy (lumpy), sandy or granular? What colour is it? Can you see any organic matter or humus in or on the soil?

3. What life forms can you find that are working the soil? Describe them and give an idea of what you think they are doing in the soil in terms of moving material, decomposition and production. Make drawings of your life forms (or take some pictures, if possible).

4. Dig a pit about 40 to 50 cm wide and 40 to 50 cm deep. Keep on digging until there is a change in soil colour and consistency (that is, when you move from the top-soil into the sub-soil).

Now carry out the following activities:

- Check and record how deep the topsoil is.
- Check for root growth and comment on the kinds of root you find and how they are growing.
- Are there any impermeable layers in between the topsoil and subsoil? Describe what they look and feel like.

5. Make a drawing of the soil profile, or take a photograph.

6. Use the *Telling by Touch Table* (see Activity 1.11 above) to assess the texture of your topsoil and subsoil. Record the percentage of clay in each.

7. Describe the structure of your top- and subsoil. Does your soil come out in clods (lumps) or is it crumbly?

8. Will the topsoil support plant growth? What effect will the subsoil have on plant growth? Give reasons for your answers. What could be done to overcome some of the restrictions?

9. What can be done to overcome some of the negative effects of soils on plant growth?

1.4 Biodiversity as a natural resource

What is biodiversity? The word "*biodiversity*" is made up of two words, *bio* and *diversity.*

Bio means **living**
Diversity means a **large number of different things.**
Biodiversity therefore means the large number of different organisms (living things) on Earth.

There are millions and millions of different kinds of organisms on Earth. Organisms that are similar are placed into groups, such as the bacteria group, the fungi group, the plant group and the animal group.

Did you know that humans are also included in the animal group? Each one of these groups has members called *species* that are different from other species in the group. Each species has a

relationship with other species. Each one of these species has a role to play.
Here are some of the roles they play in nature:

- Some species of bacteria clean the water, while other species of bacteria change substances in the soil to other forms, which can be utilised by other organisms. However, some bacteria are less useful and cause crop diseases.
- Some species of fungi break down waste materials to form humus in the soil. Other species of fungi can be used as food by other organisms. Some fungi cause plant diseases.
- All plant species clean the air. How do they do this? They use up the carbon dioxide which humans and other animals breath out as a waste gas, and in the process put oxygen into the air. Plants also cover the soil and prevent erosion and floods.
- Some species of insects pollinate plants, including crop plants. Other insect species control pest populations. Some insects are pests, and can destroy crops.
- Animals like jackals and vultures are called scavengers and clean the environment of dead organisms.

The list of roles can go on and on. Nobody in the world knows how many roles are carried out by the species that live on Earth. However we do know, that if we destroy biodiversity, natural systems will not be able to work properly. Without biodiversity, we would have no air to breathe, no clean water to drink, no crops to eat and we would be buried under a huge pile of waste material!

People have depended on the Earth's biodiversity as a natural resource since the very beginning. They have hunted animals and caught fish for food. They have harvested plants for food, medicine and building materials. Even today people in rural areas rely on thousands of different species of plants and animals, to secure their food and keep them healthy.

Modern society has become separated from biodiversity as a resource. People in cities eat food that is grown with modern farming techniques. Farmers and scientists have taken plants and animals from the wild and bred them to become agricultural crops. Most things that we use in our lives are made in factories. However, even factories require raw materials from plants and animals. Many modern medicines are synthetic (man-made) but they are often copies of medicines from plants that are found in the wild.

Activity 1.13 Using biodiversity as a resource

Complete this activity in groups or on your own in your workbook

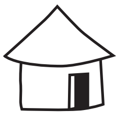
Aim: Interpret information in a case study on the use of biodiversity as a resource.

Time: 2 hours

Do you remember Lesedi, the son of the local business man, whom you met in Module 1? Lesedi's uncle, Jan Baadjies, lives in Calvinia in the Northern Cape, where he practises as a traditional healer. During the last school holidays, Lesedi went to visit his uncle, and was surprised by how different this community is compared to the one that he comes from.

What you must do

1 Read the following case study of the Hantam community in the Northern Cape, and follow the instructions.



Lesedi is walking in the foothills of the Hantam mountains with his uncle, Jan. He is very interested in the plants that are able to grow the very dry and quite harsh conditions of the Northern Cape. He is also very impressed with his uncle's knowledge of the plants, and how they are used. His uncle encourages him to collect small samples of the plants, and Lesedi makes notes on all the different plants his uncle tells him about. He also takes photos with a new camera that his mother brought him from money she got by selling produce from her homestead garden. Jan explains to Lesedi that, as a traditional healer, he needs to harvest the plants very carefully and not to take too many at once. The veld offers a variety of foods and medicines, but we should use these resources responsibly, Jan tells his nephew. That evening, Lesedi records all the plants he collected that day in a table like Table 1.8 below:

Table 1.8 Indigenous plants used by the Hantam community

Key: S=Scientific name; E=English name; A=Afrikaans name

Name of plant	What it looks like	What it is used for
Rhus lancea (S) Karee (A)		Fruit is eaten by people in Calvinia
Hydnora africana (S) Jakkalskos (A)		Edible fungus

Sutherlandia frutescens (S) Cancer bush (E) Kankerbossie (A)		Medicinal uses- boosts the immune system, used to build an immune system amongst people suffering from cancer and HIV/AIDS
Hyobanche sp (S) Soetprop (A)		Plant's nectar (syrup) is drunk by people
Galenia africana (S) Geelbos (A)		Medicinal plant used for toothache, skin infections and inflamed eyes.
Aloe spp (S)		Put in drinking water of chickens, to ensure their good health; placed on human wounds

Questions

1. Which plants that Lesedi recorded are used as food?
2. Which plants that he recorded are used for medicine and other purposes?
3. Do any of the plants Lesedi collected grow in your area? What does this tell you about the climate (temperature and rainfall) in your area? Refer to the rainfall maps in Figure 1.9.
4. If you do recognise the plants that Lesedi collected, what are they used for, or what other plants that you know are used for similar purposes?
5. Why did Lesedi's uncle tell him to harvest the plants carefully and not to take too many?
5. In these modern times, why should we consider using plants from the wild to plant in homestead gardens?

Commenting on Activity 1.13

The climate in the western regions of our country where the Hantam is located, is generally drier than the climate in the eastern regions of our country. Climate has an influence on the kinds of plants and animals found in an area. Therefore, if you live in an area with more rain, you may not recognise the plants collected by Lesedi.It is therefore very important to plant the plants and keep animals that are best suited to the climate of an area. We will explore this topic in depth in Unit 3.

1.5 Natural energy resources

Everything we do on earth depends on energy. We use a lot of energy without really thinking of where it comes from. We get food from the shop or garden, petrol from the petrol station, and electricity through power lines. But where does the energy in these things come from in the first place? Green plants store the energy received from sunlight as food, during a process called **photosynthesis.** (Refer to the last section of this unit). Animals which eat these plants use most of the energy for their body activities and store the rest. Animals which eat plants and other animals are therefore using stored energy that came originally from the sun.

Most of our electricity comes from power stations, which burn coal to produce steam. This steam is then used to turn turbo-generators, which produce the electricity. The petrol which we use in our cars, buses and lorries is produced by the distillation of crude oil. Some people also use natural gas for heating. Coal, oil and natural gas are called **fossil fuels**, which formed from plant and animal remains millions of years ago.

What is distillation?

Distillation is a process, which involves evaporating a liquid; then condensing the vapour in a separate container

1.5.1 Non-renewable energy sources

There is a major problem in using fossil fuels as a source of energy. They are non-renewable. They take millions of years to form from energy that originally came from the sun. However, once they are burnt in our cars, buses and other vehicles or in power stations, or homes they are gone forever. This is why we say they are non-renewable. The process of obtaining energy from fossil fuel is also not very efficient. More energy reaches the Earth in ten days of sunlight than is locked up in all the fossil fuels on Earth! This makes the sun an important source of energy that we can use.

1.5.2 Renewable energy sources

Instead of using non-renewable energy sources it makes better sense to use renewable energy sources that can be replaced as they are used. What are some sources of renewable energy that we can use to our advantage?

Table 1.8 Renewable energy sources

Source of energy	Comments	Advantages	Disadvantages
Solar (sun) energy	We now have the technology to capture (catch) the sun's energy directly for our use.	The largest potential source of renewable energy at present as we have abundant sun in South Africa.	The technology to capture the rays of the sun is expensive at present but it will be cheaper soon.
Wind energy	Windmills to extract water from boreholes are well known. New technology uses wind turbines which generate electricity	Holds promise for large parts of the interior of South Africa as well as along the coast	Cost of wind turbines very expensive at present.
Water energy	Electricity generated by water is known as *hydro-electricity* and requires the building of dams	We get electricity generated at Cahorra Bassa dam in Mozambique, at the Lesotho Highlands project and Tugela-Vaal scheme in South Africa.	Building of dams means many people must be relocated and natural ecosystems are destroyed.
Burning of organic resources	Organic resources include wood, animal droppings, agricultural waste such as sugar cane and charcoal from wood.	Most rural households in South Africa rely on firewood as an energy source, which is collected free from natural woodlands.	Causes large scale environmental degradation by destroying woodlands and causing major pollution.

Something to do
Under what circumstances is a renewable resource such as wood no longer renewable? Reflect on this question and write a paragraph on your thoughts in the space below.

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There are a number of creative ways in which natural resources can be used for energy. Figure 1.26 below gives some examples of how this can be done.

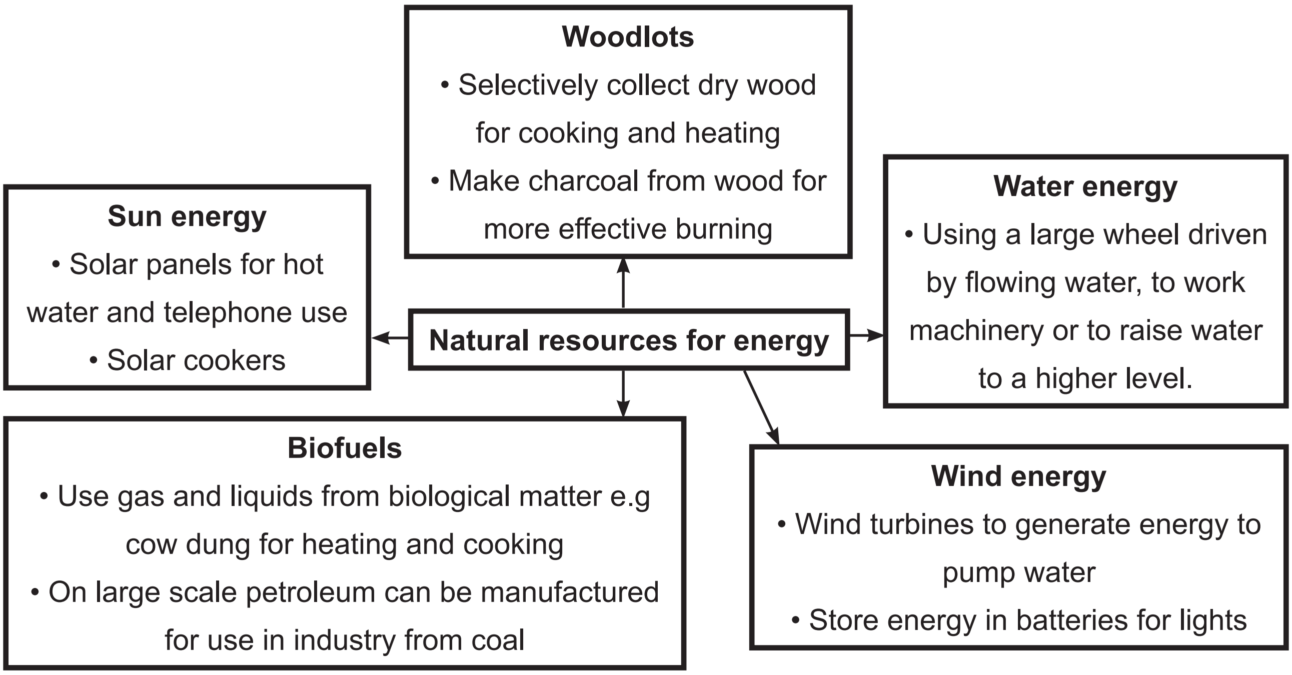
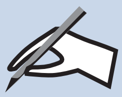


Figure 1.26 Creative ways of using natural resources for energy

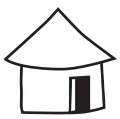
Conclude this section on water, soil, biodiversity and natural energy resources by doing the next activity.

Activity 1.14 Making choices regarding natural resources



Complete this activity on your own in this study guide

1. Read the following case study on the children, Peace and Sarah, whom you met in the previous modules.



Sarah's household tried to make a homestead garden, but found the water too expensive to use. They planted vegetables that were not suitable for their area, since they required a lot of water. All the members of Peace's household use their water sparingly, and make use of their used household water for their garden. They have also saved money to buy a good second-hand water tank, to collect rainwater. They plant traditional beans and other vegetables that do not need a lot of water. Peace's household also uses all kitchen leftovers as well as leaves from trees in the garden, to make a compost heap. This provides them with organic matter that they work into the soil of the homestead garden to improve its fertility and water holding capacity.

Sarah's household throws all the kitchen waste away, and every day, sweeps the area that can be used as a homestead garden. This compacts the soil to such an extent, that the soil cannot be used for gardening because it is to hard.

Peace's household made a fence from branches collected in the veld to protect the vegetable garden. Sarah's household did not build a fence, so the chickens and rabbits started to eat the vegetables.

Sarah's household uses non-renewable fossil fuels to cook their food. She has to collect firewood from the nearby forest every day and as dry branches are becoming scarce, she takes live branches from the trees. Peace's grandmother saved enough money from selling her produce from the homestead garden to buy a solar cooker, which uses energy from the sun to cook their food.

Questions

1. Which of the two households show best practices regarding the use of natural resources?

Practices	Peace's household	Sarah's household
Best planting practices		
Bad planting practices		
Best soil practices		
Bad soil practices		
Best energy choices		
Bad energy choices		
Best water practices		
Bad water practices		
Best gardening practices		
Bad gardening practices		

2. Suggest other ways in which households can manage soil, water and living resources, which will contribute to food security.

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3. Discuss the best and bad practices of the two households in your groups and write a paragraph explaining how natural resources should be used wisely to enhance food security.

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1.6 How nature works

When we look at the bigger picture, we see that the sun and the Earth provide us with all the natural resources, as well as important processes that we need for survival.

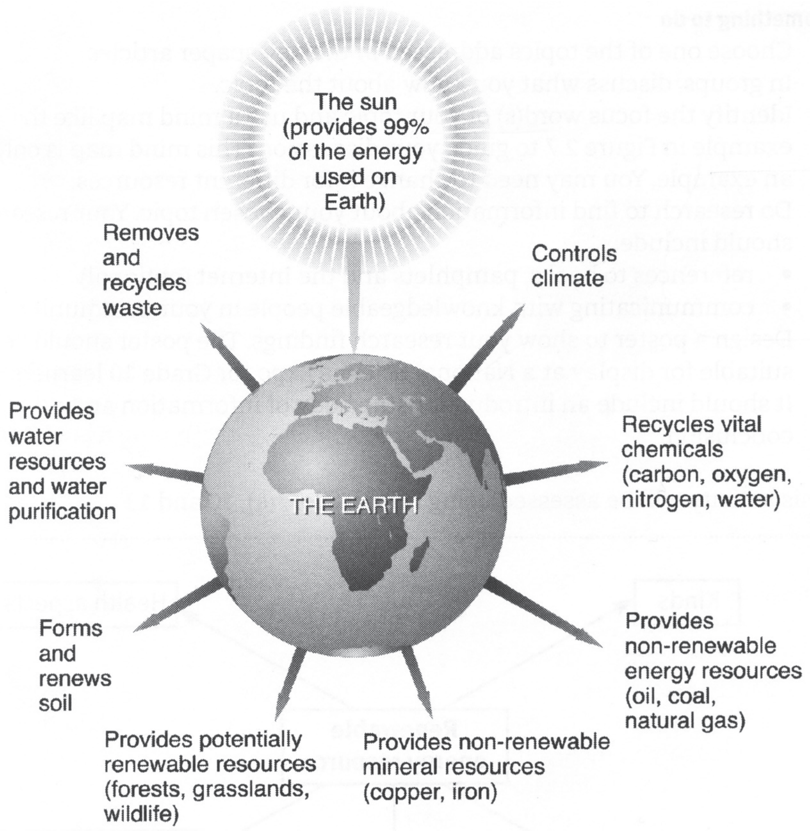


Figure 1.27 The sun and the Earth as providers
(Adapted from Bowen, *et al*. 2005)

Activity 1.15 Natural resources and processes provided by the sun and the Earth

Complete this activity on your own in this study guide

Look at the figure above and answer the following questions:

Questions

1. What natural resources does the Earth provide us with?

....

....

2. What important processes are we provided with by the sun and the Earth?

....

....

3. Reflect on why we should understand and respect nature.

....

....

1.6.1 The cycle of nature

Are the natural resources and processes provided by the sun and Earth just for our direct benefit as humans, or do they also play a vital role in nature? Before we can give attention to producing and eating healthy food, we need to understand the role of natural resources, such as water, soil, air, plants, animals, including insects and other living things such as fungi and bacteria, in nature. Even though we use all of them as resources for our own well being, they work in a system in nature where they interact with each other to form a cycle, which plays a very important role in keeping nature in balance.

See figure 1.28 on page 49.

Why is it important for us to understand and respect the interactions in nature? Let's use a simple example. Many flowers need pollinators such as bees to produce seed. We need seeds to grow crops that provide us with food. What would happen if the bees died in large numbers because of pollution, in the environment? Understanding how natural systems and cycles work helps us to live and work in a natural environment without disturbing the balance in the system. Then it is possible for us to have continued access to the resources that we need to stay alive.

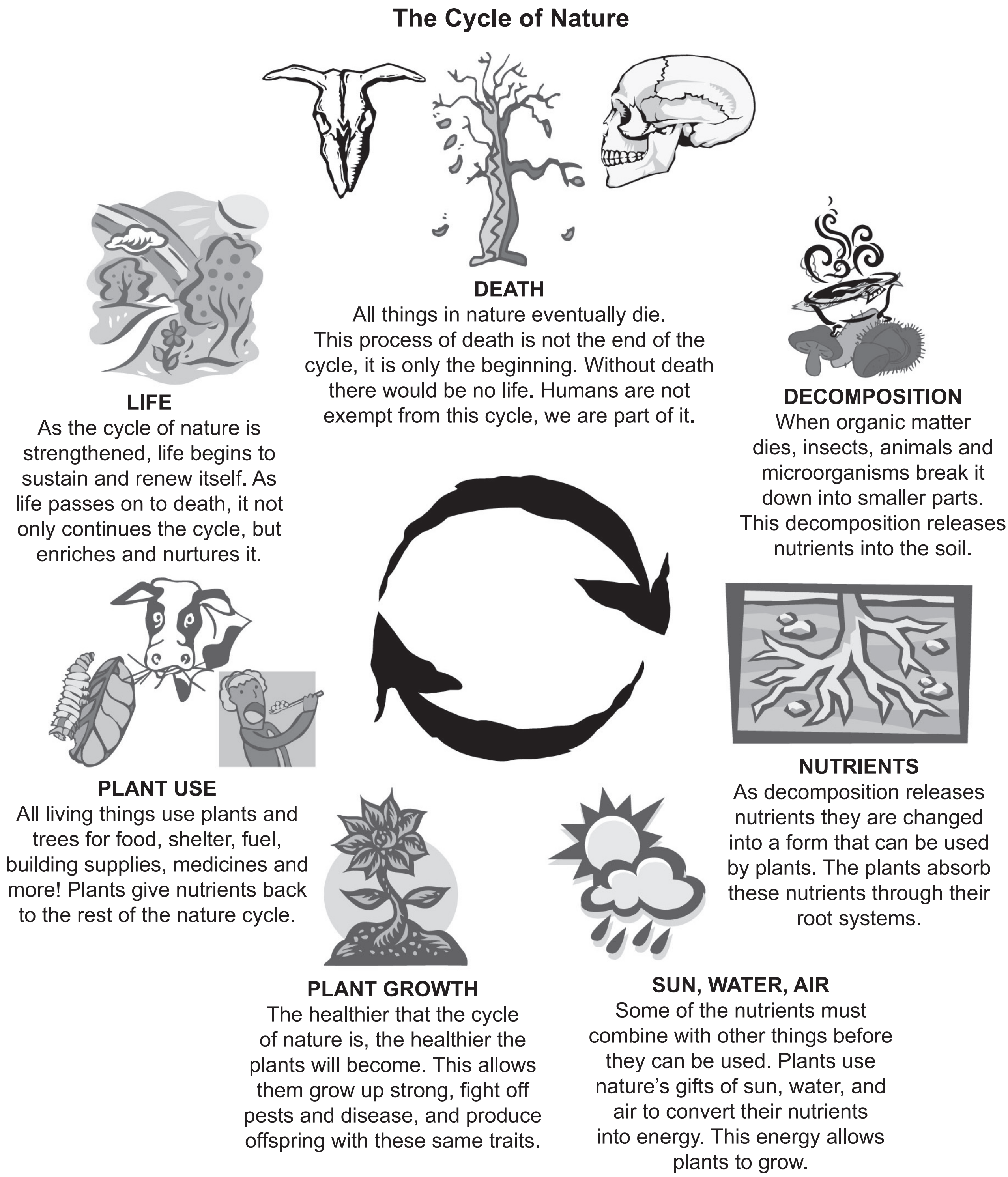


Figure 1.28 The cycle of nature
Adapted from Nordin, 2005

Activity 1.16 Your place in the cycle of nature

Complete this activity on your own in your workbook

Aim: Understanding the place of humans in the cycle of nature.

Time: 30 minutes

What you must do

1. Draw yourself in the centre of an A4 sheet of paper. Draw or write on the paper:
    - all the different foods you eat.
    - where your food comes from.
2. How do these things (that have become your food) get their own food? Use arrows to show the links between the different elements.
3. What will happen if one of these links is broken or damaged?

Comments on Activity 1.16

Your drawing will have made you more aware of how humans, plants, animals and other organisms of the Earth depend on each other to stay alive. In a natural system all the elements such as soil, water, plants, animals, wind and rocks interact to create the system. The system gets *inputs* such as energy from the sun, gases such as carbon dioxide and nitrogen from the air, water from rain and minerals from broken-down rocks. A natural system does not need artificial (human-made) inputs from the outside, such as chemical fertilisers or pesticides. The system produces waste material but recycles and reuses most of its own *outputs*. Although the system releases water, carbon and energy, these will be taken up by other systems in nature.

What is an ecosystem?

All the living things such as plants, animals and bacteria in a certain area in nature and the non-living things such as soil, water and air interact, through a flow of energy and a cycling of materials, to form a system called an ecosystem.

A natural system is called an **ecosystem.** According to Starr & Taggart 1987, an ecosystem can be defined as follows:

"An ecosystem is a community of organisms functioning together and interacting with the physical environment (soil, air, water) through a flow of energy and a cycling of materials."

1.6.2 Feeding relationships in ecosystems

What did you eat for breakfast this morning? The food you eat supplies you with material for growth, and energy for your daily activities. Let's find out where your breakfast food might have come from. Let's take eggs as an example. Eggs are made by chickens (hens), which eat grains. The grains come from plants such as mealies, sorghum or wheat.

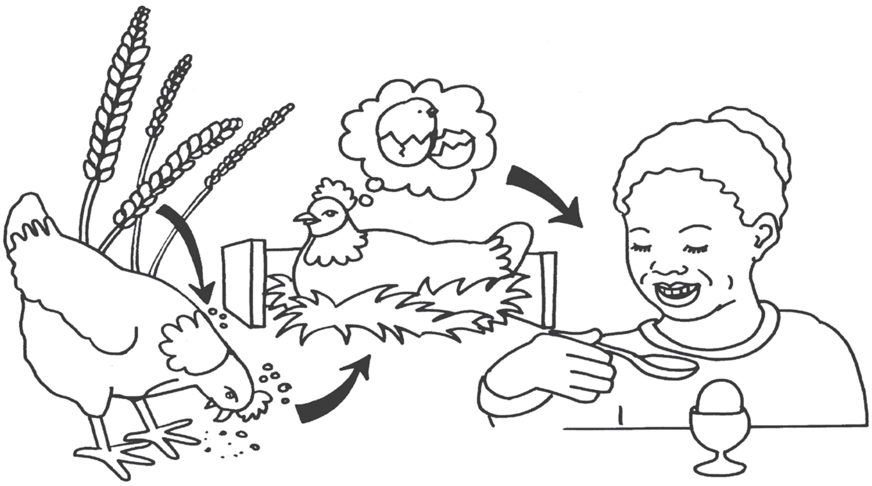


Figure 1.29 A simple food chain

The figure above gives a **food chain**, which shows you the feeding relationships among organisms. One organism provides the food for the second. The second organism provides the food for the third, and so on. The food chain can be written simply as:

Grain (from plants) → Egg (from hen) → Human

The arrows show the direction in which the food passes.

In an ecosystem organisms feed on one another transferring energy and nutrients. How does this work?

What are herbivores and carnivores?

Plant eaters are called **herbivores.**
Meat eaters are called **carnivores.**

- Green plants are able to capture the energy from the sun that falls on their leaves and to change it into a form of energy that can build the plant body. Together with the energy from the sun they also need carbon dioxide gas from the air, water and nutrients from the soil. No other organism on Earth can do this and that is why green plants are called **producers.** The crops in our example above (sorghum, mealies and wheat) are therefore producers.
- Animals that feed directly on plants get some of the energy from these plants to build their own bodies. Plant eaters are called **primary consumers.** Chickens, as indicated in our example, are therefore primary consumers.
- Animals that eat primary consumers get energy from these animals to build their own bodies. These animals that feed on primary consumers are called **secondary consumers.** If you were to eat the chicken in our example, you would be an example of a secondary consumer.
- Animals that eat secondary consumers get energy from these animals to build their own bodies. These animals that feed on secondary consumers are called **tertiary consumers.** If a jackal were to eat the chicken who fed on small worms, the jackal would be a tertiary consumer.
- Living things produce waste and eventually die, but why is the Earth not piled high with waste material and dead organisms? Organisms called **decomposers** break down the dead material into smaller and smaller bits, releasing nutrients into the soil, which can again be used by the plant. If any of the organisms in our example of a food chain were to die, decomposers such as small insects, fungi and bacteria would break down their bodies.

All these feeding levels (producer, primary, secondary and tertiary levels) are called **trophic levels**. Organisms from each trophic level, feeding on one another in a linear series, make up a food chain.

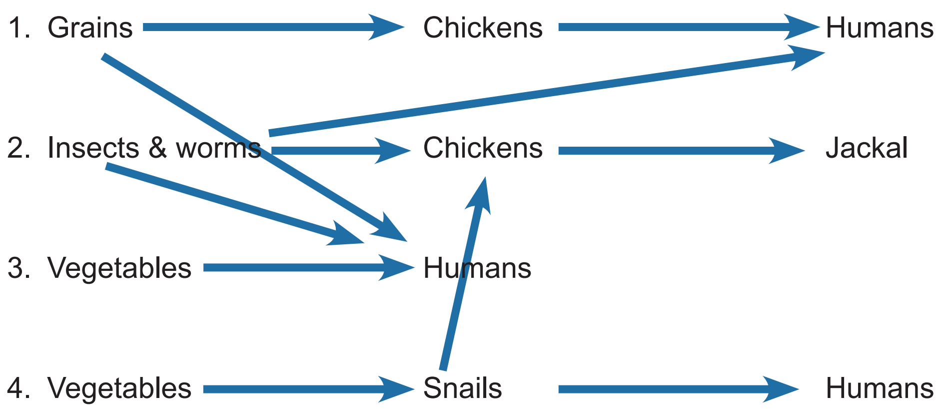
Living in a food web

Let us take a look at the household of Peace. Her household has a vegetable garden, as we have seen in Module 1. A family member also surprised them with a lovely gift; a goat, and a few chickens. Peace was given a project from school, in which she had to draw a food chain that she had observed in her community, and one that she had observed in the natural environment. She observed that the chickens did not only eat grain, but also worms and other small insects. Peace's grandmother was very upset when two of the chickens got into the vegetable garden, and fed on some seedlings. Disaster struck when a jackal caught one of the chickens.

We can show these events as a number of food chains:

1. Grains (Producers) → Chickens (Primary consumers) → Humans (Secondary consumers)
2. Insects & worms (Primary consumers) → Chickens (Secondary consumers) → Jackal (Tertiary consumers)
3. Vegetables (Producers) → Humans (Primary consumers)

Peace then realised that there are connections between these food chains. She made the following connections:



To get a more complete picture of the feeding relationships, Peace observed that the food chains can be combined. In the natural environment we do not find single food chains but interconnected food chains which form a **food web**.

Activity 1.17 Feeding relationships in a dam

Complete this activity on your own in this study guide

Peace observed the feeding relationships between the organisms in a dam and her grandmother's vegetable garden.

She identified the following organisms:

Dam: Fish, frogs, snails, tadpoles (baby frogs), water insects, water plants

Garden: Plants, earthworms, snails, termites, birds and chickens, humans, water

1. Draw a food web, of either the dam or the garden, using the organisms Peace observed.
2. Use arrows to show what eats what, just as we have done in the example above.
3. Also identify which organisms are producers, and which are primary, secondary and tertiary consumers.

Draw your food web in the space below.

Questions

1. Which organisms in the dam or garden will be decomposers and on which trophic levels will we find them?

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2. What will happen when human actions remove all the producers from an ecosystem?

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3. What will happen when human actions remove all the consumers from an ecosystem

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4. How do healthy feeding relationships in ecosystems benefit humans?

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Comments on Activity 1.17

Below is an example of the relationships between organisms that are present in and around an Acacia tree (thorn tree). These relationships keep the ecosystem in balance. The interaction between organisms in a dam is similar to those that occur in the Acacia tree.

The *Acacia sieberana* (umKhamba or paperbark tree)

Acacia sieberana is an indigenous African tree that is found in bushveld and grassland. Let us take a look at some of the relationships that exist around this tree.

- Cattle herders and cattle rest under these shady trees.
- Humans use dry branches for firewood.
- Many animals feed upon the tree:

  The flowers attract beetles, bees, wasps and butterflies. These animals provide food for birds and lizards.

  Buck, cattle and even elephants love to eat the seed pods, which are rich in nitrogen.
- When a browsing animal moves away the seeds are carried away from the parent tree to where there is more space to grow
- The seed is dropped on the ground in a pile of dung. The stomach acids of the animal that ate the pods have broken down the hard seed coat of the seed. Now it can germinate. And the seed has plenty of nutrients in the pile of dung to enable it to germinate. Dung beetles roll the dung into balls. They lay their eggs in the dung balls. The young beetles hatch and feed on the dung balls. Baboons and honey badgers dig up the dung balls to eat the larvae of the beetles. Guinea fowl also search the dung for seeds and insects.
- The dung is decomposed by decomposers and becomes part of the soil nutrients. Micro-organisms also feed on the dead leaves that fall off the tree. The roots of the tree obtain nitrogen in a form it can use with the help of certain bacteria that live in association with the tree roots. This nitrogen is released into the soil when the tree dies.
- The tree provides nesting holes for birds such as barbets.
- The tree also provides oxygen (clean air) for people and other organisms.

There are probably many more relationships that we do not even know about.

Humans can upset the fine balance that exists between all the organisms in and around the tree, when they:

- remove live branches from the tree
- remove or kill any of the animals that feed directly on the tree or on other animals
- pollute the environment in which the tree lives by using poisonous chemicals to kill pests and weeds
- cut down the tree.

Concluding remarks

So far you have become aware that soil, water and air form the basic building blocks of our ecology. We need healthy soil, clean water and clean air to produce the next level of building blocks; healthy plants and animals. With water, soil, air, plants and animals, people can live a good life.

If the soil is damaged or washed away, if the water or air is polluted, then plants and animals become weak and diseased. Their numbers in the ecosystem will no longer be balanced. Since people depend on the natural environment, they too can become weak and diseased. If nothing is done to restore the balance it will just be a matter of time before the whole ecological pyramid collapses. The cholera epidemic which swept through Zimbabwe at the end of 2008, and which is still claiming the lives of hundreds of people, shows what can happen if people do not have access to safe water. Where water is contaminated, due to waste that is not treated and managed properly, bacteria such as the *Vibria cholerae* bacteria can grow and multiply. This bacterium causes cholera, by infecting people's intestines and causing diarrhea, vomiting and leg cramps.

When we as people live, garden and farm in an environment, we change it to suit ourselves and make use of the resources available to us. When we are managing a resource, we are consciously looking at, thinking about and caring for that resource. We need to find the warning and danger signs of overuse or incorrect use. In Unit 3 we will explore the topic of using resources wisely in more detail. However, we first need to zoom in to the link between natural resources and food security which is the topic for Unit 2.