Year 13

Geography

GEOGRAPHY

Year 13

GOVERNMENT OF SĀMOA
MINISTRY OF EDUCATION, SPORTS AND CULTURE

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Other sources of information are as follows:

D. Lambert and D. Balderstone *Learning to Teach Geography in Secondary School: A Companion to School Experience*, 2000, Routledge / Falmer, London.

T. Simkin and L. Siebert, *Volcanoes of the World: an Illustrated Catalog of Holocene Volcanoes and their Eruptions*, 1994, Smithsonian Institute, Global Volcanism Program Digital Information Series, GVP-3.

Wayne Ellwood, *The No-Nonesense Guide to Globalisation*, 2001, New Internationalist Publications.

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R. B. Johnson, *Environment*, International Edition, 1993, Sunders College Publishing.

Garth Rogers, *The Fire has Jumped. Eyewitness accounts of the eruption and evacuation of Niuafo'ou, Tonga*, 1986, IPS, USP, Suva, Fiji.

National Geographic, August, 1999.

Every attempt was made to contact the authors of the following articles. Please contact the publisher if you represent any of them.
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Climate change killing 150,000 a year, says WHO
The fight against the rising tide
Britain aims to cut emissions

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Table Of Contents

Part 1

Physical Environments

Overview

This section covers the Physical Environments strand. At the end of this section, you will be able to show your knowledge and understanding of the following:

Achievement Objectives:

1 Tectonic and atmospheric processes and patterns on a global scale

2 Volcanic eruptions and tropical cyclones as natural events and natural hazards.

The focusing questions that this section covers are:

1 What is the difference between a natural event and a natural hazard?

2 Where, on a global scale, can we find volcanic activity and tropical cyclones, and why?

3 How and why do volcanic eruptions occur? How and why do tropical cyclones occur? What is the sequence of events for each hazard?

4 How and why are volcanic eruptions and tropical cyclones a hazard?

5 How do people respond to these hazards? What are some strategies (both traditional and modern) that people have developed to reduce the impact of these hazards, and how effective are they?

Introduction

There are two chapters in this section. The first is about tropical cyclones. The second is about plate tectonics and volcanism. Before we begin studying these physical processes and the impact they have on people and their activities, we need to look very closely at these terms:

- ❑ natural processes
- ❑ elements
- ❑ interactions
- ❑ natural events
- ❑ natural hazards.

Key Words

Biogeographical
Climatological
Environment
Geomorphological
Hydrological
Natural
Pedological
Processes

Natural Processes

Key Ideas

- ❑ **Natural processes involve a series of related natural actions/events.**
- ❑ **These actions/events result in changes.**
- ❑ **These changes produce a state of equilibrium or disequilibrium.**
- ❑ **Processes vary in time and space, i.e. within, on and above the earth and span millions of years.**
- ❑ **Processes can be large or small. They may occur all the time or infrequently.**

Natural processes are natural events that occur in a sequence whereby one event causes another event to occur or change. Many of these sequences of natural events combine over time to sculpt and change the natural **environment**

The context of natural processes

In the broadest sense, processes that dominate the natural environment are found in three settings.

There are five high order natural processes that operate within these three settings:

Natural processes occur:
1 above the Earth
2 on the Earth
3 within the Earth.

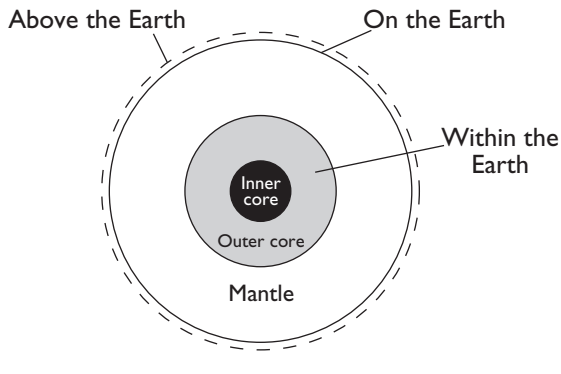


Figure 1.0.1 The Earth

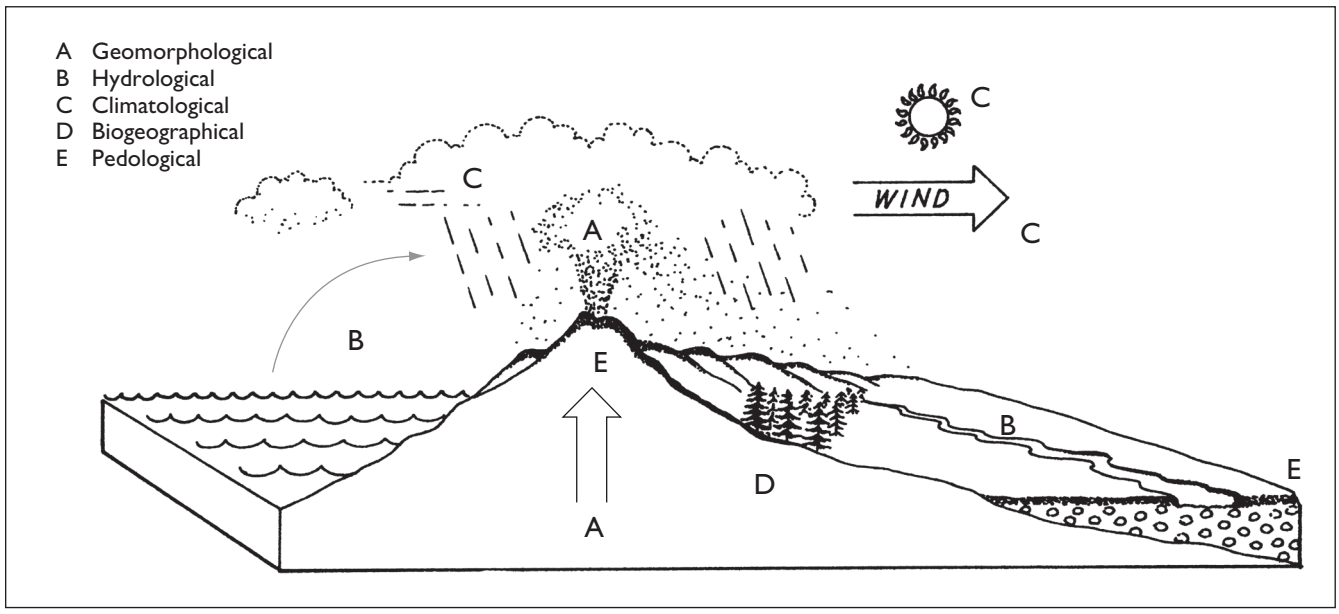


Figure 1.0.2 High order processes

The five high order processes can be defined in the following way.

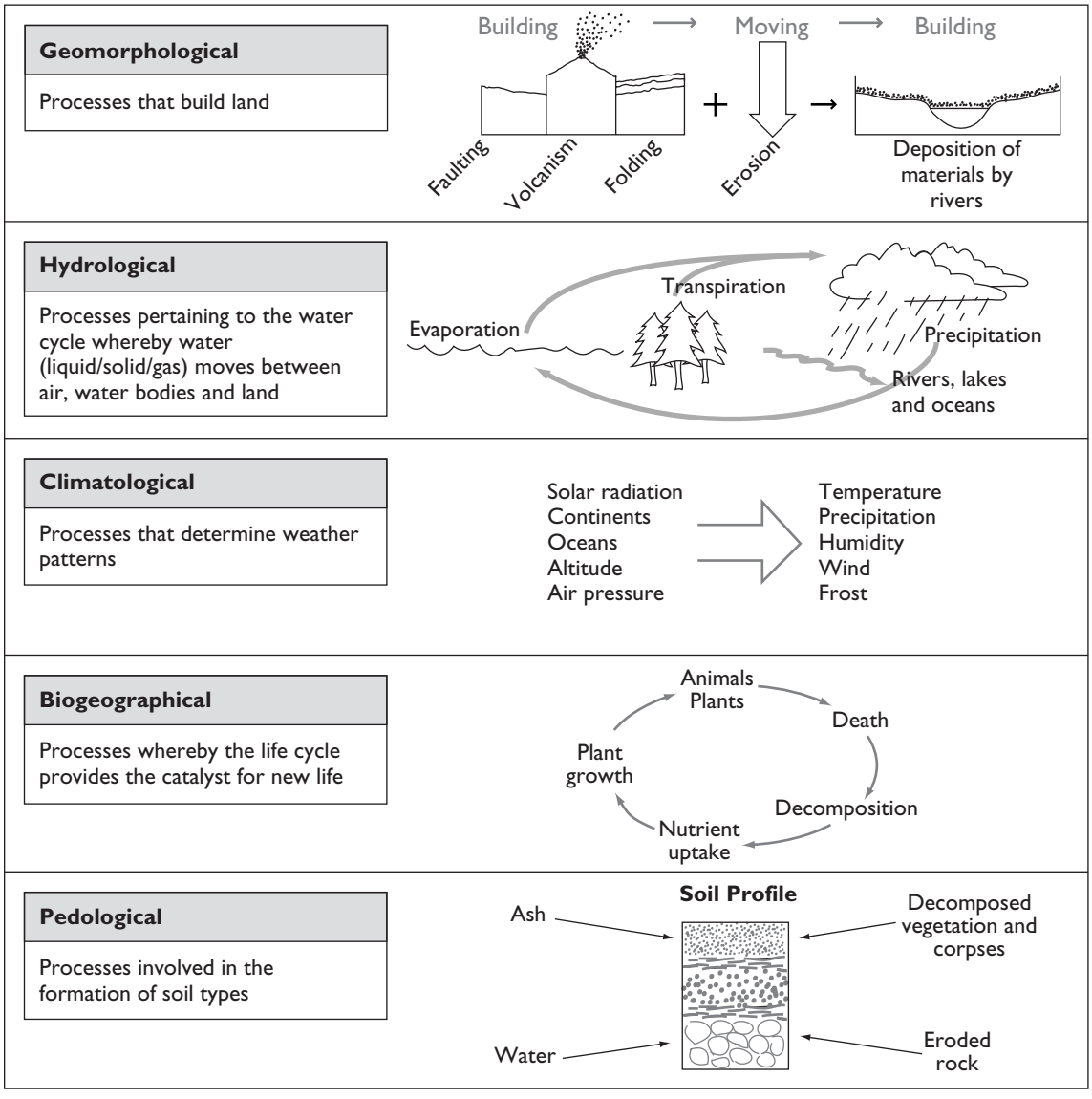


Figure 1.0.3 High order processes

The variables affecting natural processes

The high order natural processes combine differently in different locations to produce unique natural environments. Four variables operate to generate these differences in the way the processes combine.

Table 1.0.1 Time and space

	Long time	**Short time**
Large area	*example:* erosion of a mountain range	*example:* a volcanic eruption
Small area	*example:* the erosion of a peninsula until it becomes an island	*example:* a landslip

Magnitude and frequency

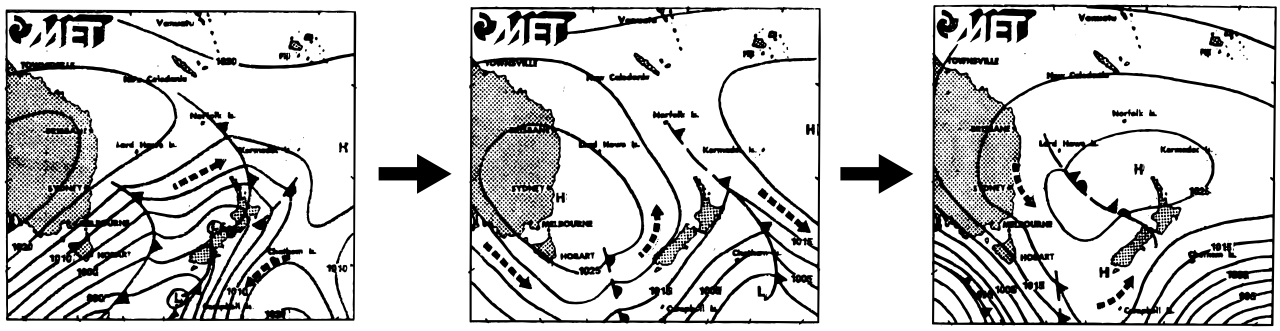


Figure 1.0.4 An anticyclone passing over New Zealand

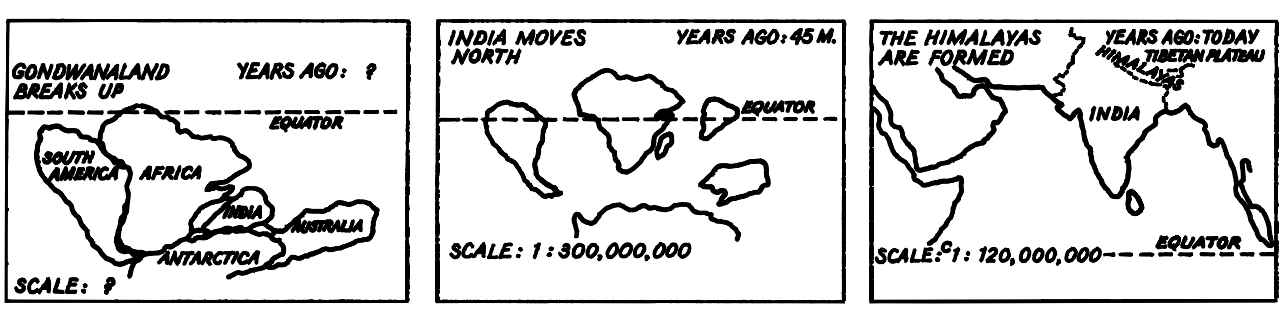


Figure 1.0.5 The break-up of Gondwanaland

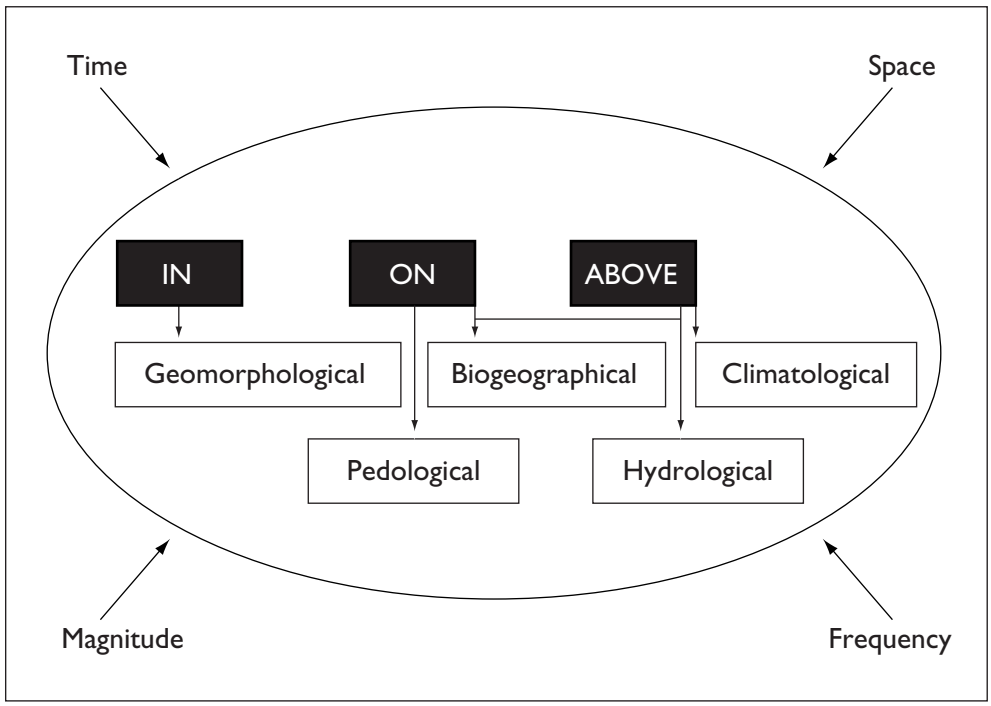


Figure 1.0.6 Natural processes and their context

Guidelines For Studying A Geographic Environment

Elements and interactions

Definition

Identify the parts or components that affect each other in the sequence of events operating in the chosen geographic environment.

The five high order **natural processes** operate in geographic **environments**. Within each process there are parts or features called **elements** that **interact** with each other to give the geographic environment its own distinct characteristics (see Figure 1.0.7).

Key Words

Elements
Phenomena
Environment
Processes
Equilibrium
Spatial
Interact
Throughflows
Modify
Transformations
Natural

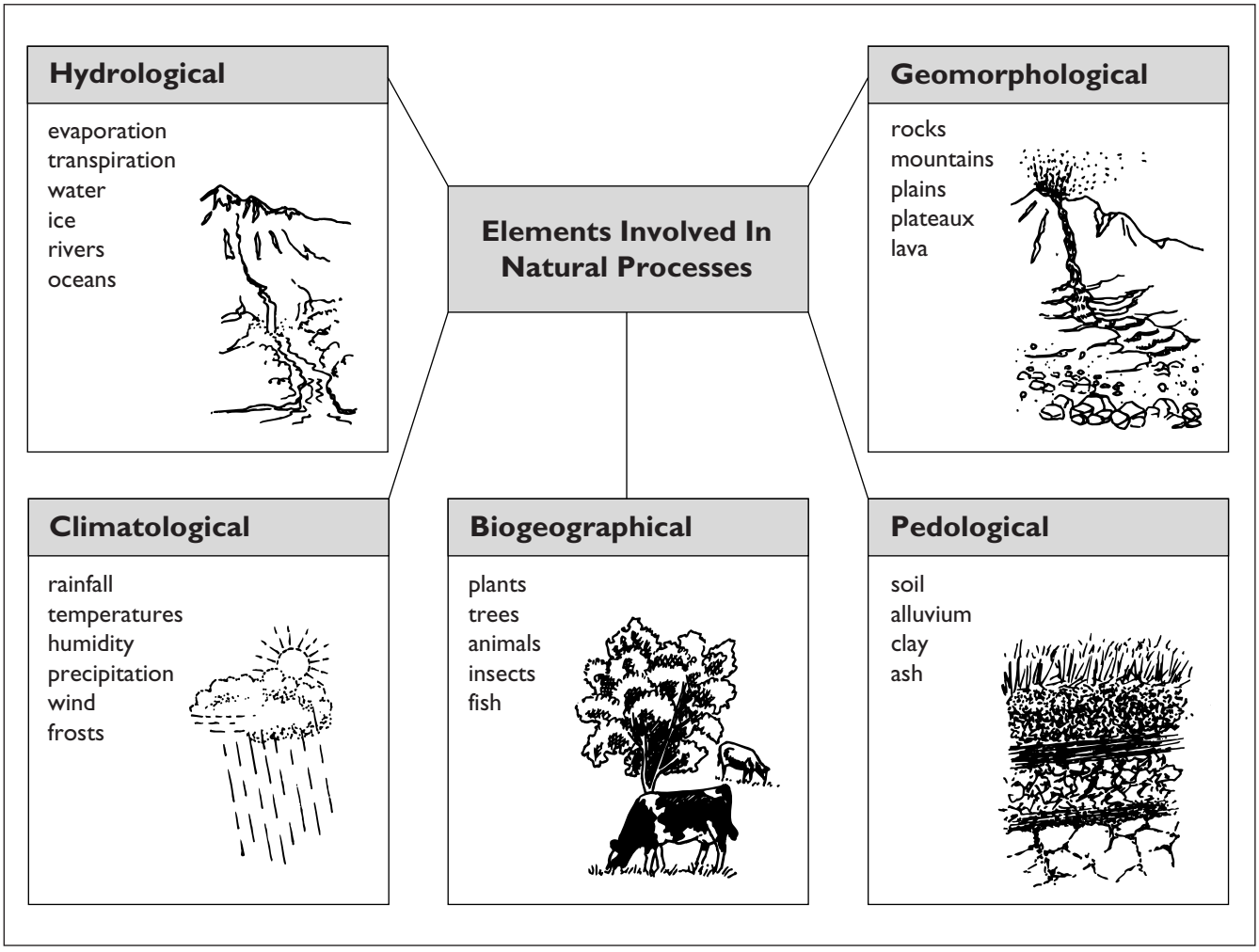


Figure 1.0.7 Elements in geographical environments

As the high order processes interact, the elements within them interact also, as demonstrated by Figure 1.0.8.

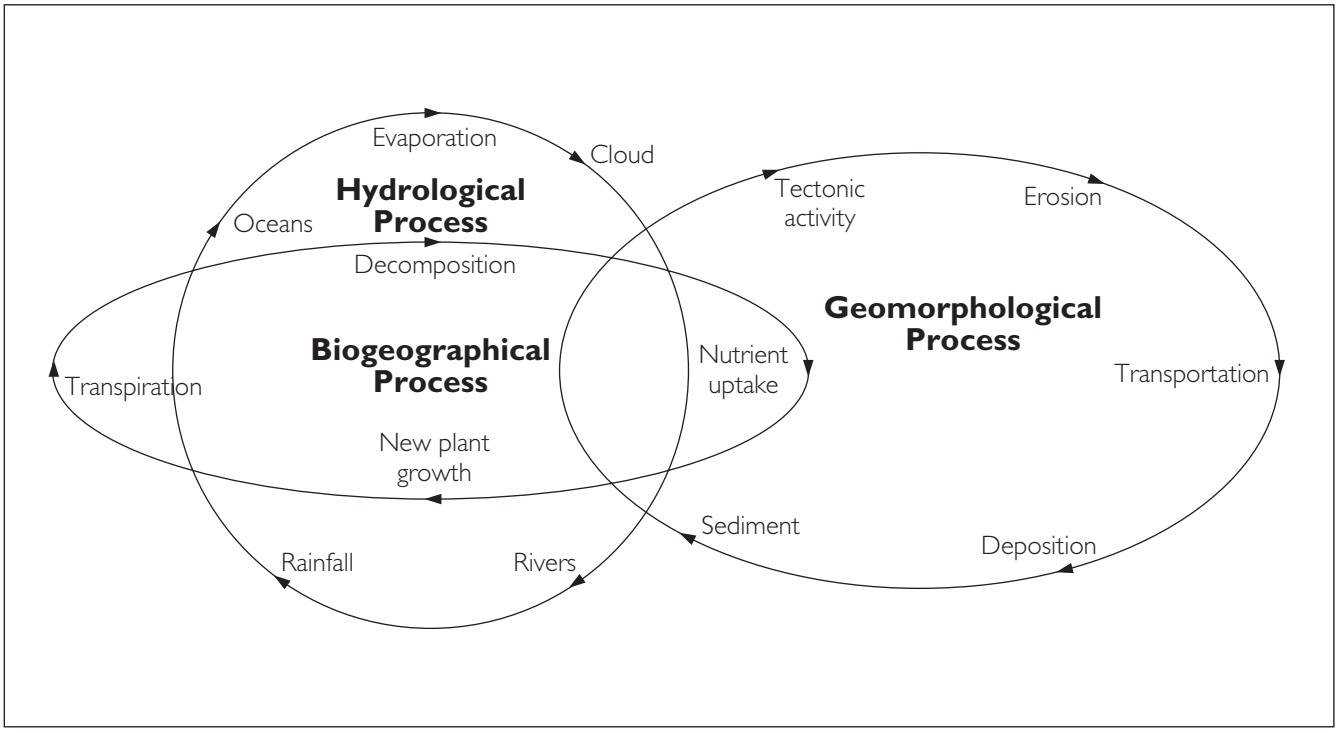


Figure 1.0.8 Interactions in geographic environments

The ways that processes work

Explain how each sequence of events is acting or working (as part of a system).

Natural processes are process-response systems. The **elements** of process systems are inputs, which have **throughflows** or **transformations** where interaction occurs (see Figure 1.0.9). From these interactions come outputs of matter and/or energy which feed back again as inputs. The processes operate and produce a response in the form of features in the environment. The whole process is always working towards a state of **equilibrium.**

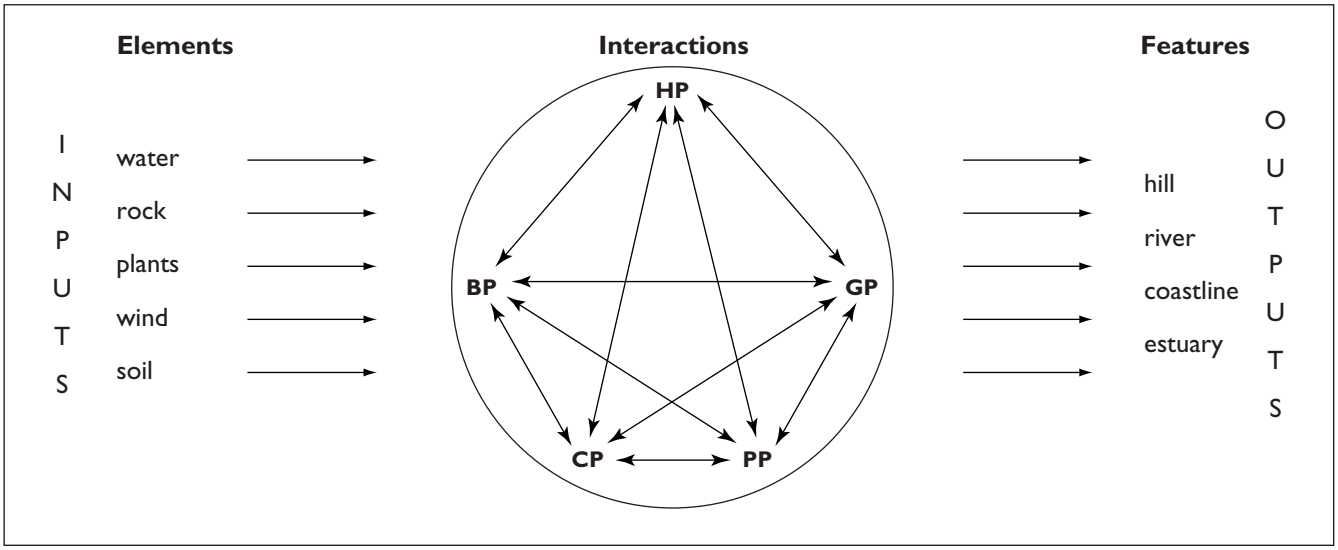


Figure 1.0.9 Process-response model

KEY
HP Hydrological Processes
GP Geomorphological Processes
BP Biogeographical Processes
CP Climatological Processes
PP Pedological Processes

Natural processes, natural interactions

Definition

Explain how the series of related events operating in the geographic environment affect each other.

Inter-process interaction

High order natural processes interact with each other (see Figure 1.0.10).

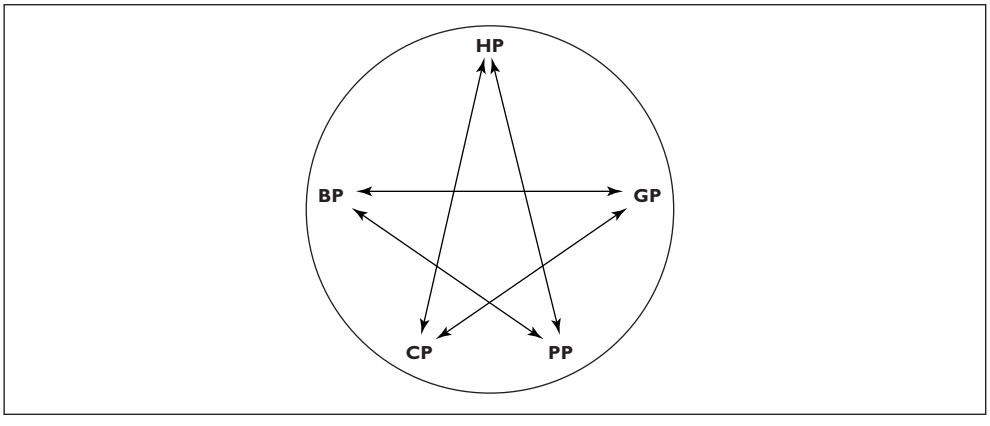


Figure 1.0.10 Process-response model of interaction

For example: mountains, the result of geomorphological processes, can cause orographic rainfall, part of the hydrological process. Within each high order process are low order natural processes which also interact, such as rainfall as a low order process within the hydrological high order process.

Process		**Interaction**	**Process**
Example 1:	**Hydrological** Rainfall	A period of sunshine after rain can cause evaporation and further rainfall.	**Hydrological** Evaporation
Example 2:	**Hydrological** Rainfall	Water running down a slope erodes the rock and soil.	**Geomorphological** Erosion

Figure 1.0.11 Examples of interaction

Intra-process interaction

Within each high order process interactions also occur.

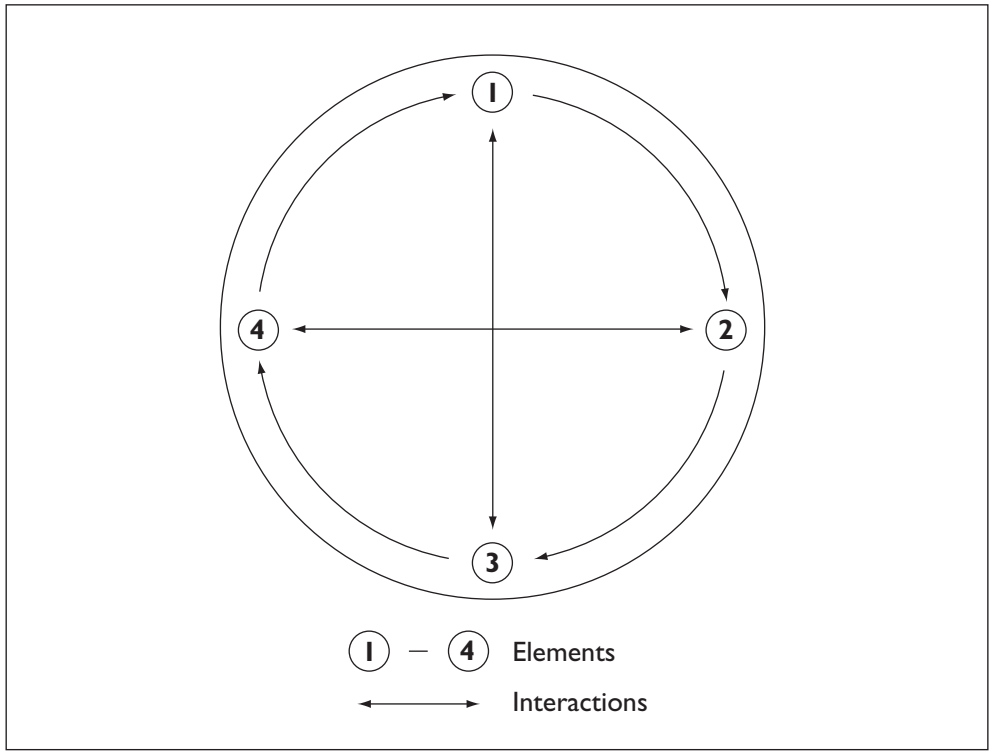


Figure 1.0.12 Hydrological processes

Activity 1

- Place the following processes in the appropriate place on Figure 1.0.12.
  Rainfall
  Condensation
  Solar Radiation
  Evaporation.

Natural processes and spatial variations

Give the reasons for differences in the locations where these sequences of events occur within one geographic environment.

Natural processes operate differently in different places, even within a geographic environment, because the elements and interactions that affect them can vary in terms of time, space, magnitude and frequency (see Figure 1.0.13).

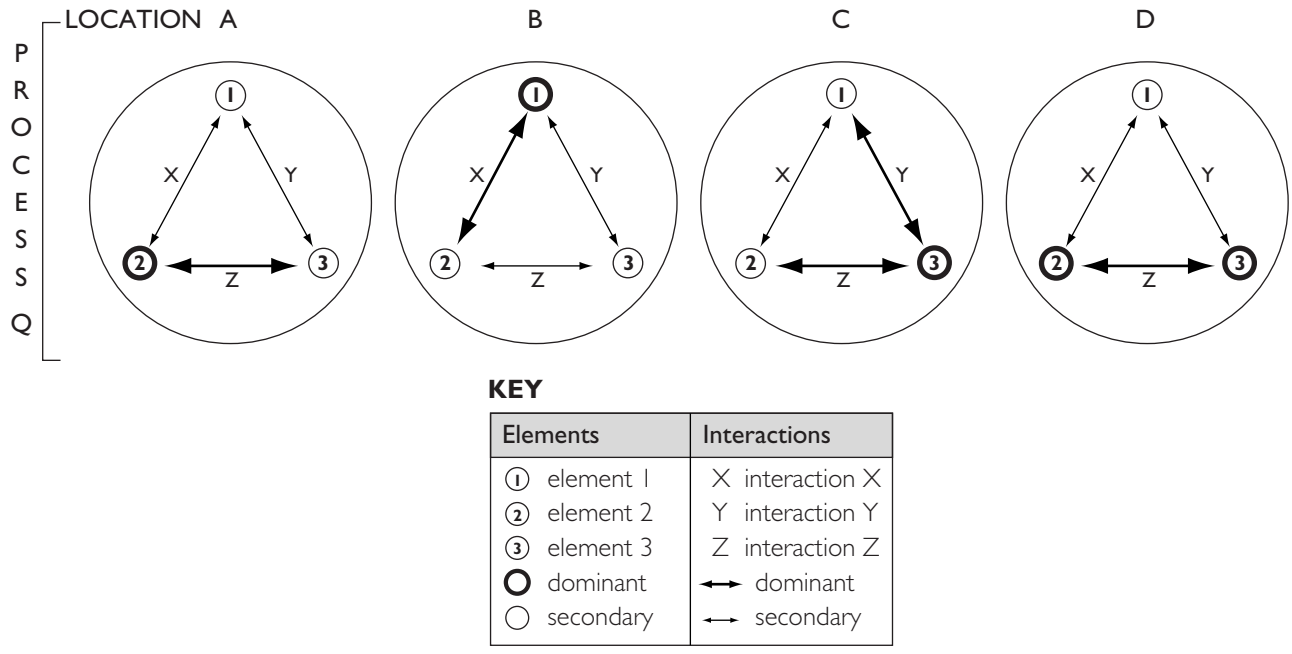


Figure 1.0.13 The same process operating in four locations within one geographic environment

In location A for example, element 2 and interaction Z are dominant, whereas in location D elements 2 and 3 and interaction Z are dominant. Process Q then works differently in each of the four locations within the same geographic environment owing to the variations in time, space, magnitude and frequency, affecting the elements and interactions within it.

Activity 2

- ❑ Process Q in Figure 1.0.13 could be at four different locations along a river or four rivers in one geographic environment. Select one of these scenarios. How could each element be different at each location?

Natural processes and the distribution of natural features

Describe how these sequences of events have influenced where the natural features in the selected geographic environment are located.

The high order processes and their associated low order processes combine over time to create and sculpt the characteristics and location of natural features found within a geographic environment (see Figure 1.0.14).

Figure 1.0.9 provides the context for Figure 1.0.14 where natural features are the outputs resulting from the interaction of natural processes.

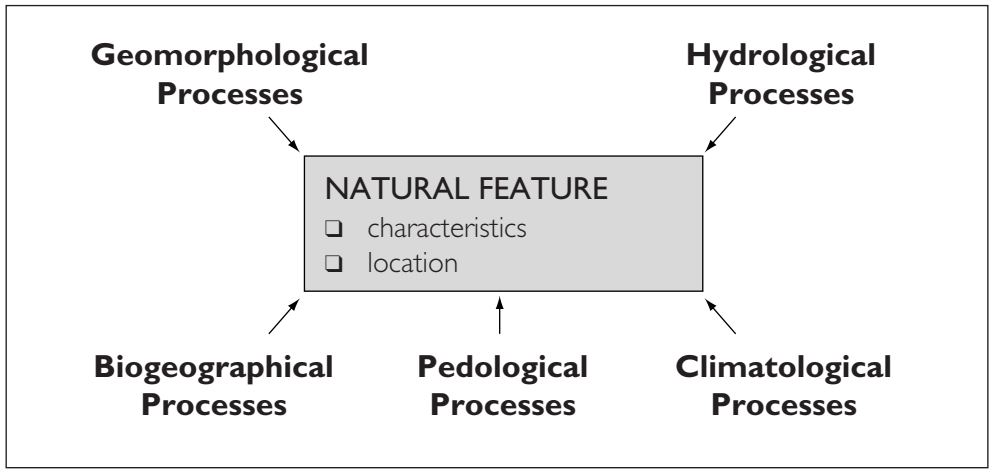


Figure 1.0.14 Process-response outputs

Natural processes and the impact of human activities

To what degree (or how much) have these sequences of events been changed by people?

If you add people to Figure 1.0.8, the elements and interactions involved in a geographic environment can potentially be changed (see Figure 1.0.15).

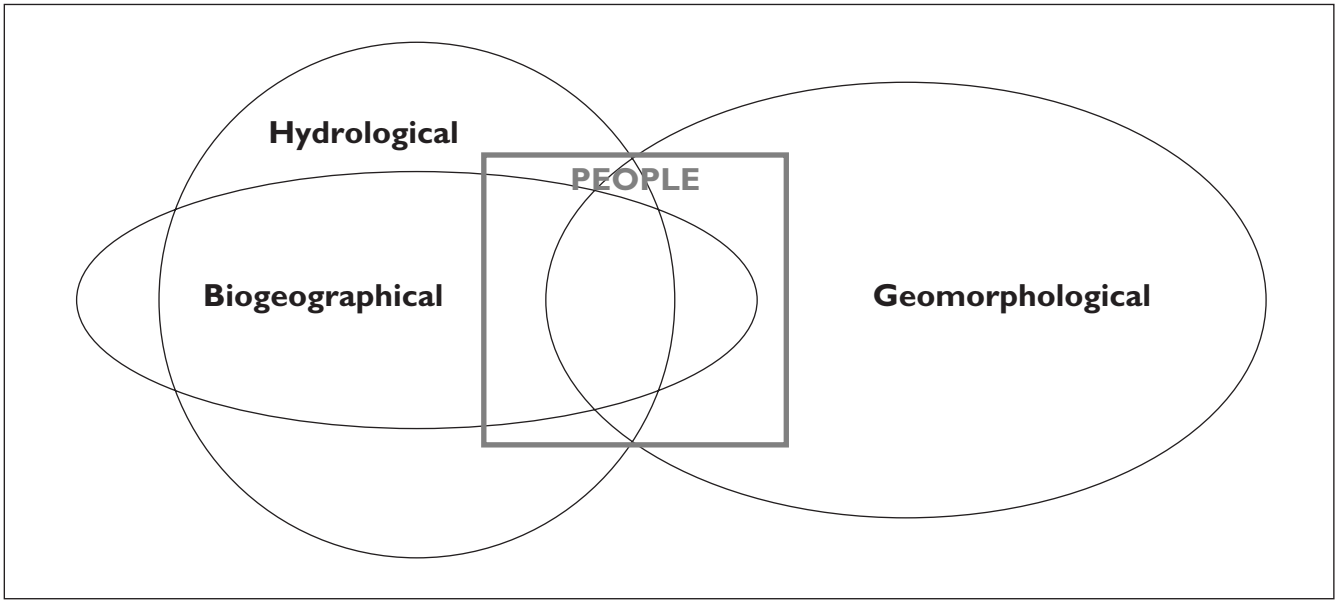


Figure 1.0.15 Simplified interactions model (See Figure 1.0.8)

The effect of the intervention of people into the geographic environment is to change the operation of its natural processes either directly or indirectly. People can alter the rate at which natural processes operate, but not the fact of their operation. The extent of human effects is determined by the effect of people on the time, space, frequency and magnitude of the processes at work (see Figure 1.0.16).

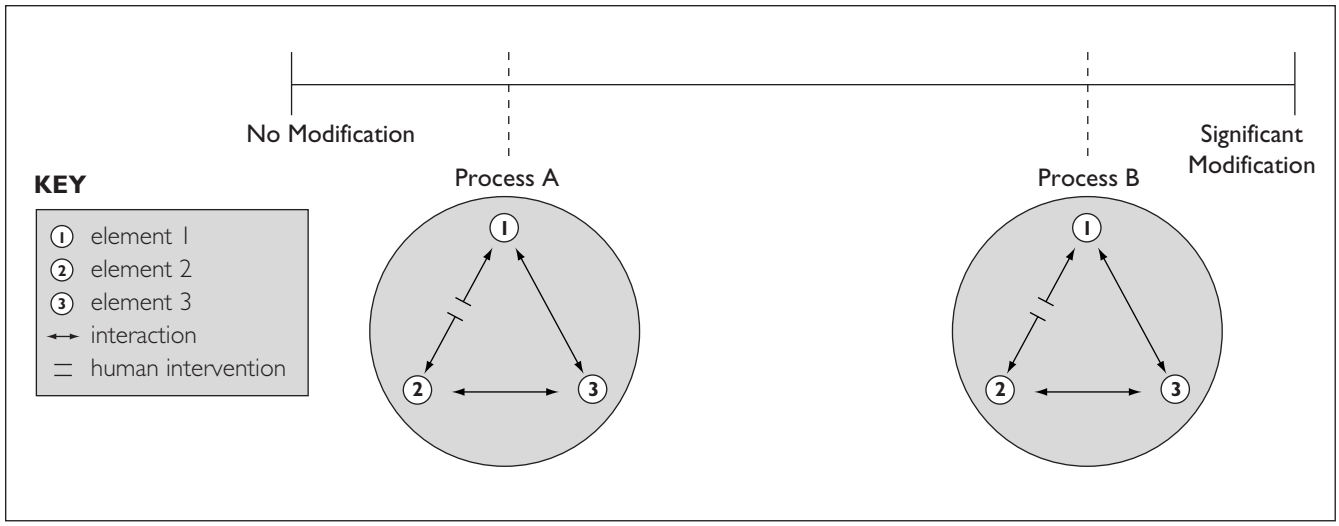


Figure 1.0.16 Continuum of human modification

Process A has been modified to a limited extent by a change to the way elements 1 and 2 interact. Process B has been modified to a significant extent by human action with all three interactions being affected.

Extreme Natural Events And Natural Hazards

Natural events, such as showers of rain or gusts of wind, are caused by nature, not by people.

Natural events occur frequently in many *environments*. **Extreme natural events**, such as tornadoes, occur much less frequently.

A natural event is the result of *a series of related actions* known as **processes**. Rainfall processes, for example, include **evaporation, condensation** and **precipitation.**

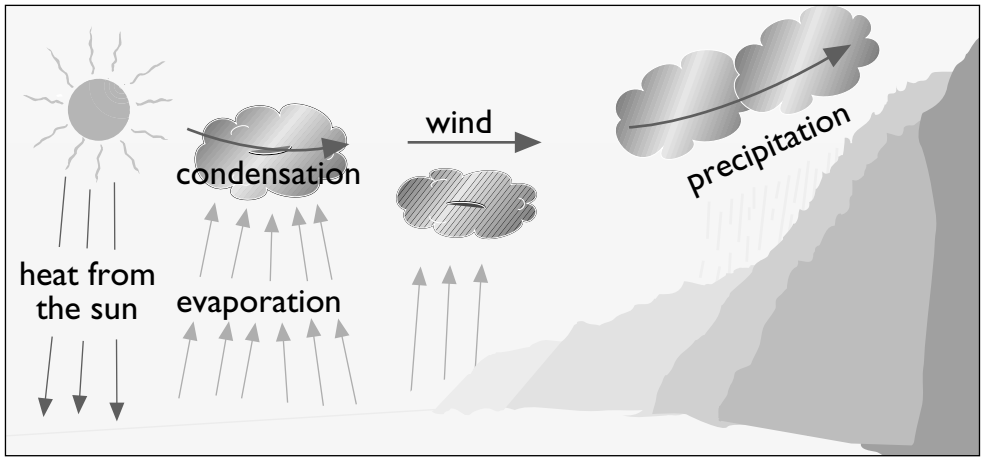


Figure 1.0.17 Rainfall processes

Usually natural processes **maintain** the environment and little change results. The processes of extreme natural events are likely to **modify** or change the environment. For example, a river valley will look quite different after a flood.

Figure 1.0.18 Flood

Extreme natural events are **natural hazards** only if they threaten people's activities (**cultural processes**) or property (**cultural resources**). Natural hazards can be defined as *extreme natural events which put people's actions, property or resources at risk.*

Blizzards in remote regions, well away from people or their property, are *not* a natural hazard. Blizzards which might affect people *are* a natural hazard.

Figure 1.0.19 Blizzard

Wars and other *human* **disasters** are not relevant to this study. Neither is a fire caused by an electrical fault. A fire caused by an earthquake which breaks gas lines is.

Figure 1.0.20 Ballantynes fire

Figure 1.0.21 Napier earthquake 1931

Onset period: Some extreme natural events build up more slowly, and give more warning, than others. A tropical cyclone has a much slower onset period than a hailstorm.

Duration: Some extreme natural events last longer than others. A drought lasts much longer than an earthquake. An earthquake may be over in a few seconds.

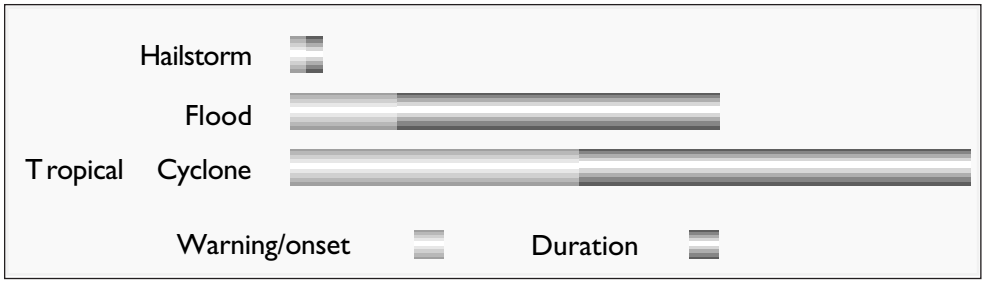


Figure 1.0.22 Warning time and duration of a natural event

Frequency: Some extreme natural events occur less frequently than others but cause more damage when they occur.

New Zealand's natural hazards

New Zealand's environment is largely mountainous and geologically active. It is surrounded by ocean and lies across a belt of westerly winds. Consequently, *extreme natural events* occur frequently in New Zealand.

New Zealand's **population distribution** and *cultural processes* (e.g. **farming, urbanisation**) expose it to a range of *natural hazards*.

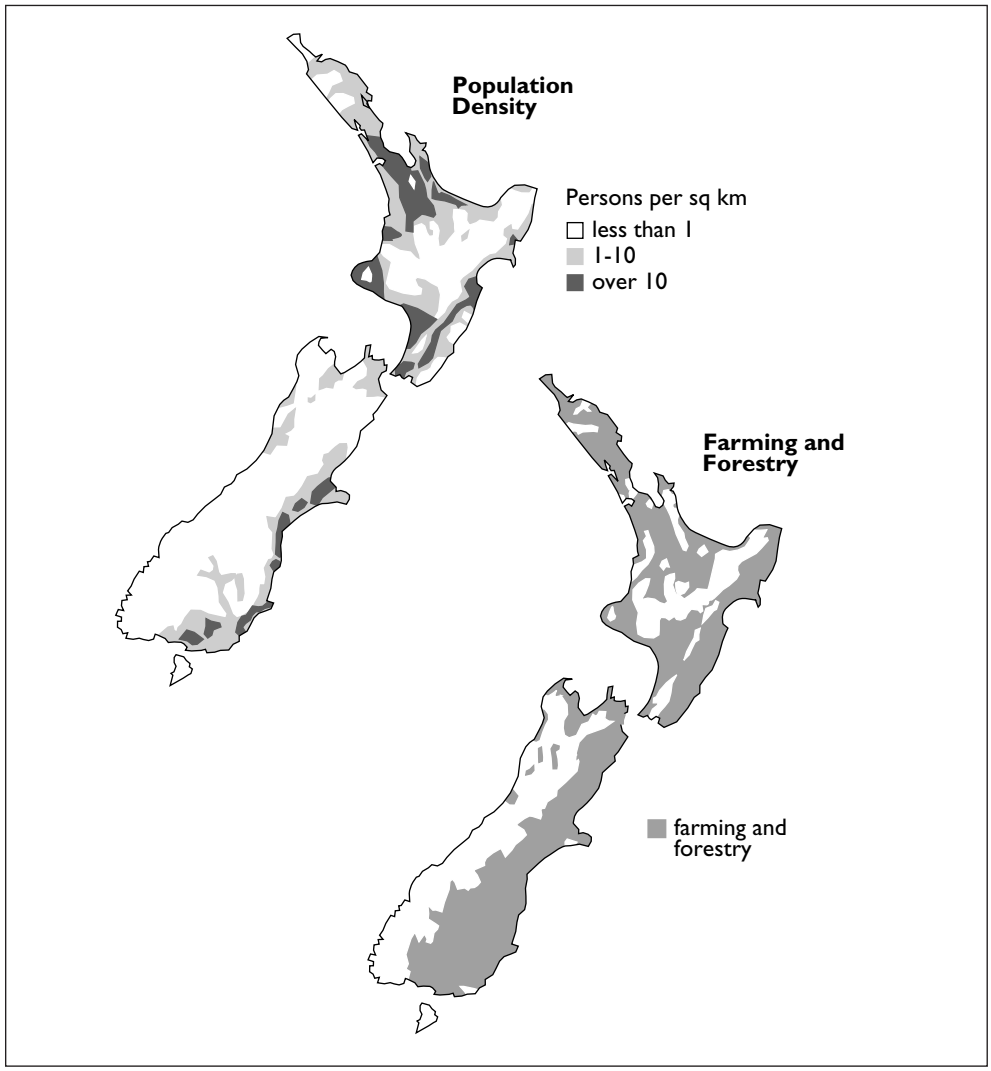


Figure 1.0.23 Population distribution and farming use of land in New Zealand

The most widespread natural hazard in New Zealand is **flooding**. **Earthquakes** and **volcanic eruptions** occur much less frequently, but usually attract more publicity. **Landslips, coastal erosion** and other extreme natural events such as **tornados, cyclones, blizzards, thunderstorms, hailstorms, droughts** and **bush fires** also occur.

Australia's natural hazards

Australia's natural and cultural environments are different from New Zealand's.

Natural hazards in Australia include **droughts, bush fires, tropical cyclones** and **floods**.

Figure 1.0.24 Australian drought

Different parts of Australia are affected by different natural hazards.

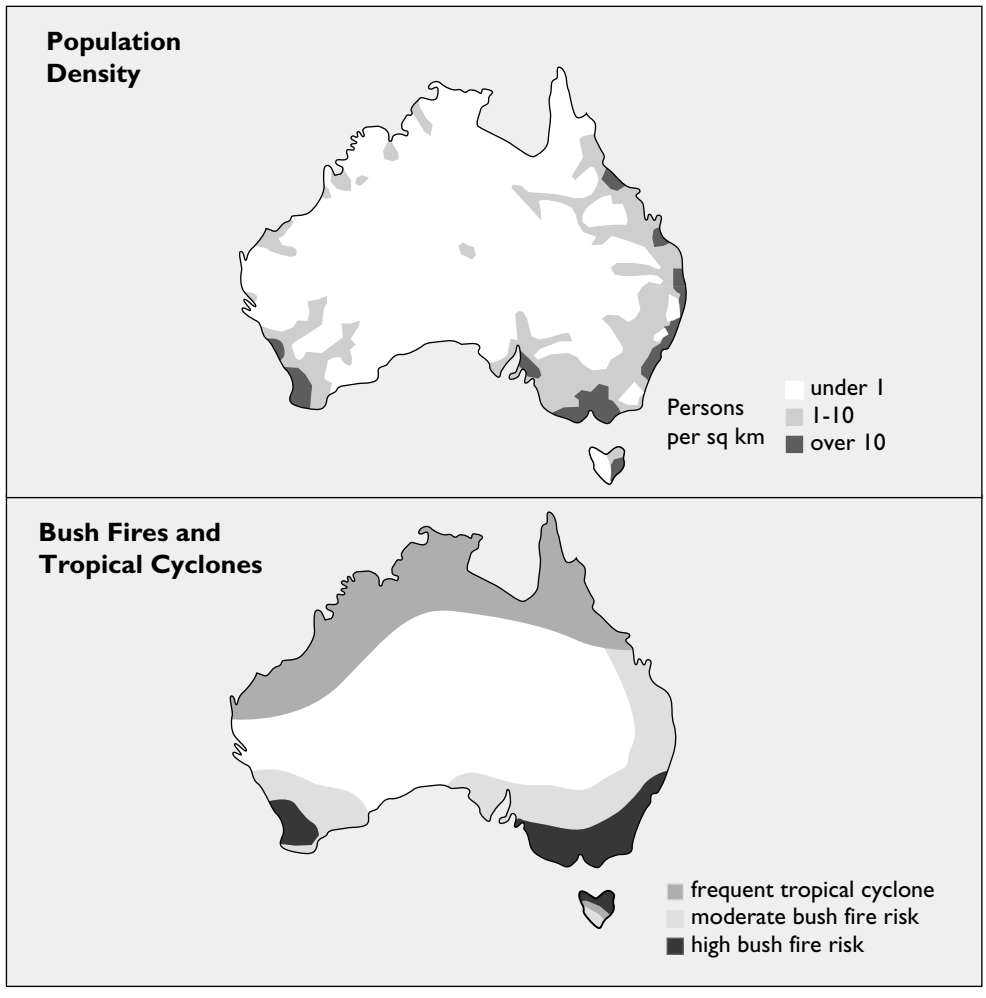
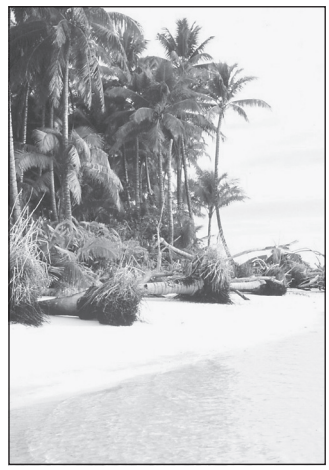


Figure 1.0.25 Population density and natural hazard risk in Australia

Natural hazards of the South West Pacific islands



The islands of the South West Pacific have different natural and cultural environments from both New Zealand and Australia

- They have a **tropical climate,** are surrounded by ocean, and consist mainly of small **volcanic islands** and **coral atolls.**
- Population distribution and cultural processes expose Pacific Islanders to a range of natural hazards.
- Their most common extreme natural events are **tropical cyclones, earthquakes, volcanic eruptions, tsunamis** and **droughts.**

Key Points Summary

- **Natural hazards are extreme natural events which put people or their property at risk.**
- **Extreme natural events vary in their onset times, frequency, duration and impact.**
- **Different environments have different natural and cultural processes operating within them and so experience different natural hazards.**

Activity 3

1 Match up descriptions with terms.

a process	**A** how long an event lasts
b natural hazard	**B** could happen
c onset period	**C** extreme natural event which puts people/ property at risk
d cultural	**D** to do with nature
e duration	**E** build-up to a hazard event
f natural	**F** a series of related actions
g potential	**G** to do with people

2 Decide whether the following statements are true or false. Explain why the false statements are incorrect.

a The Ballantynes fire in Christchurch was a natural disaster.

b All volcanic eruptions are natural hazards.

c Floods have shorter onset periods than droughts.

d New Zealand would be a more hazardous place if it had a larger population.

e Earthquakes are Australia's most serious natural hazard.

f Tropical cyclones are a natural hazard in the South West Pacific.

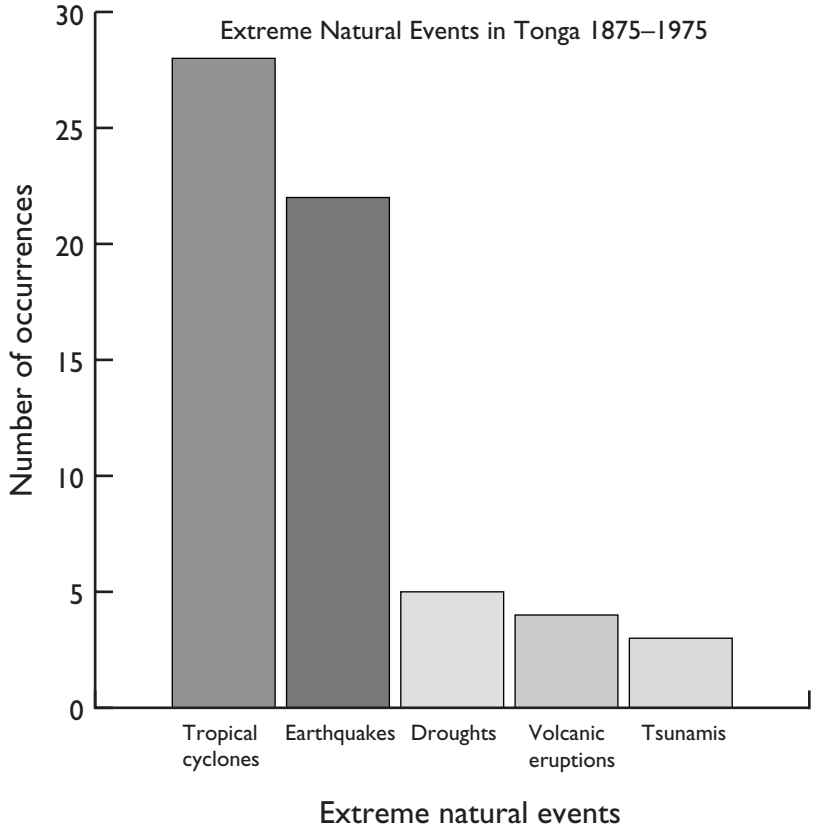
3 Study the graph below and answer these questions:

a How many extreme natural events were experienced by Tonga between 1875 and 1975?

b Which event occurred most frequently?

c What percentage of the events were earthquakes?

d On average, how many extreme natural events were experienced in Tonga each year?



Unit 1

Volcanic Eruptions

Introduction

Volcanology is the scientific study of volcanoes and volcanic eruptions. This branch of science provides scientific and educational information that helps people to reduce the risks and effects when volcanic eruptions occur.

Did You Know?

- The name 'volcano' comes from the ancient Romans. According to Roman myths and legends, the god of fire was Vulcan. He lived on the island of Sicily, inside a fiery mountain. Vulcan was a blacksmith. He made weapons, armour, thunderbolts and lightning for the different gods. He also enjoyed frightening human beings by causing lava flows and explosions.
- There are about 1500 active volcanoes on planet Earth. But Earth is not the only planet in our solar system with volcanoes. There are 1728 active volcanoes on Venus. One of the moons of Jupiter has even more.

These are the focusing questions for this chapter. Keep these in mind as you work through the chapter.

2 Where on a global scale will we find the most volcanic activity? Why will we find it there?

3 How and why do volcanic eruptions occur? What is the sequence of events for volcanic eruptions?

4 How and why are volcanic eruptions a hazard?

5 How do people respond to the hazards of volcanic eruptions? What are some of the strategies that have been developed to reduce the impact of these hazards, and how effective are they?

What Causes Volcanic Eruptions?

Earth's structure

At the centre of the earth is the **core**. The *inner core* is solid and extremely hot. The *outer core* is very hot, but liquid.

Surrounding the core is the **mantle**. Intense heat from the earth's core causes the rocks of the mantle to melt, forming **magma**. Heat from the core causes convection currents in the *semi-liquid* magma.

The earth's cool, brittle, outer shell is called the **crust.**

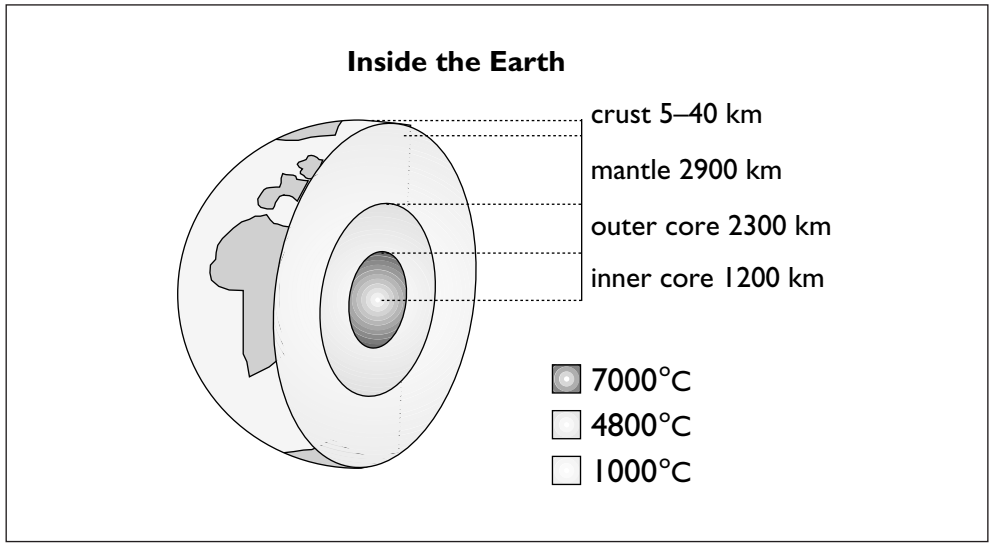


Figure 1.1.1 Inside the Earth

Plate tectonics

According to the theory of **plate tectonics**, the earth's crust is made up of a series of giant plates which 'float' on the mantle.

Convection currents in the mantle cause the plates to move – to *converge* (collide), *diverge* (separate) and *slide* past each other. Plate convergence forces one plate under another, and down into the mantle. This process is known as **subduction**.

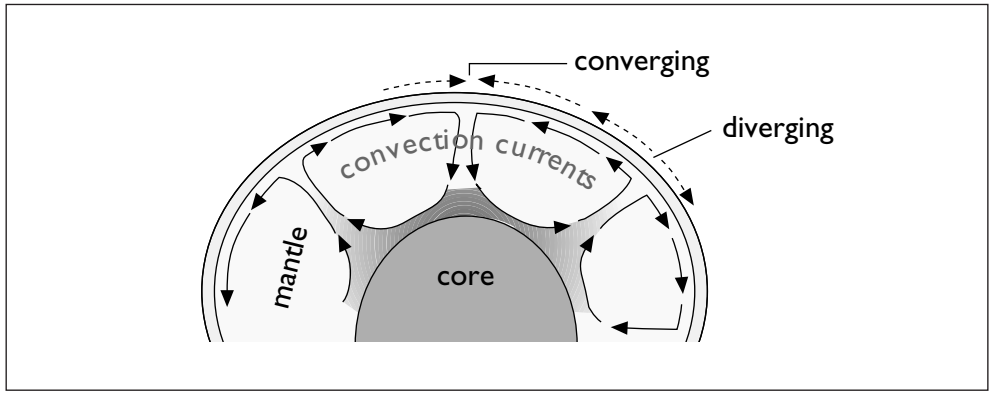


Figure 1.1.2 Subduction

Plate boundaries are like giant cracks in the earth's crust, and on the plate boundaries you find nearly all of the world's volcanoes.

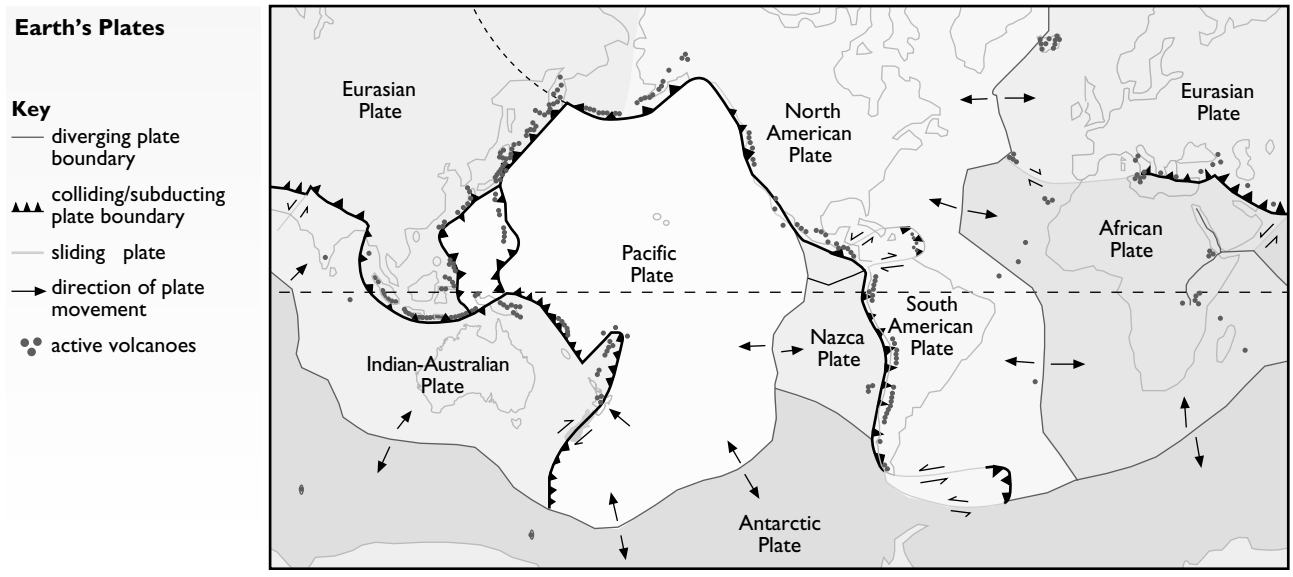


Figure 1.1.3 Earth's plates

Volcanic eruptions

A volcanic eruption is when **magma** (and associated materials and gases) are released into the atmosphere and onto the earth's surface. Magma is sometimes 'stored' in a **magma chamber**, within the earth's crust.

Magma is erupted (forced) through an opening called a **vent** or **fissure**. Erupted magma is called **lava**.

The landform a volcanic eruption creates is called a **volcano**. There are various shapes and sizes of volcano, but many are cone-shaped with a central **crater**.

An **active** volcano is one that has erupted recently.

A **dormant** volcano is one that has not erupted recently, but might erupt again.

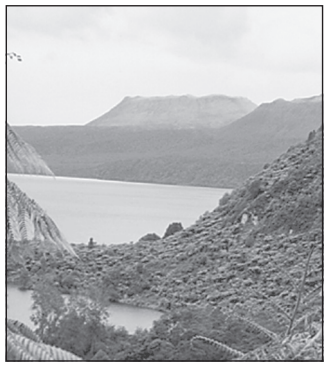
An **extinct** volcano is one that has not erupted recently, and may not erupt again. (Scientists now realise that many volcanoes they once said were extinct may erupt again, so they do not use the term *extinct* much nowadays.)

Types of eruptions

Some eruptions are *explosive*, and others are **effusive** (quieter, gentler). The violence of an eruption depends on the amount of gas it contains, contact with underground water, and the type of lava.

- Gas: As magma rises, dissolved gases are released. If the lava is **viscous** (not very fluid) the gas will be trapped and may eventually blast (explode) its way out.
- Water: If rising magma encounters ground water it instantly produces super-heated steam which explodes like a bomb. This is called a **phreatomagmatic** eruption. Coastal vents and crater lakes can cause phreatic eruptions.

Basaltic



Rhyolitic

Andesitic

Types of lava:

- **Basaltic**: Eruptions at *diverging* plate boundaries bring *pure* magma to the surface. The lava is *basic* and cools slowly to form a volcanic rock called **basalt**. As the lava is fluid (not very *viscous*) and allows gas to escape freely, eruptions are usually *effusive*. Most basaltic eruptions occur along mid-ocean ridges. Example: Iceland, on the Mid-Atlantic Ridge.
- **Rhyolitic**: At *converging* plate boundaries, subducting crust and sea-floor sediments mix with rising magma. If the proportion of crustal rock in the magma is high, the lava is *acidic*, highly viscous and likely to erupt very explosively. It cools quickly to form **rhyolite**. Example: Mount Tarawera, New Zealand.
- **Andesitic**: At *converging* plate boundaries moderate mixing of subducting crust with magma makes *intermediate* lava. Less viscous than rhyolite, it erupts fairly *explosively* and cools quite quickly to form **andesite** (named after the volcanoes of the Andes mountains in South America). Example: Mount St Helens, USA.

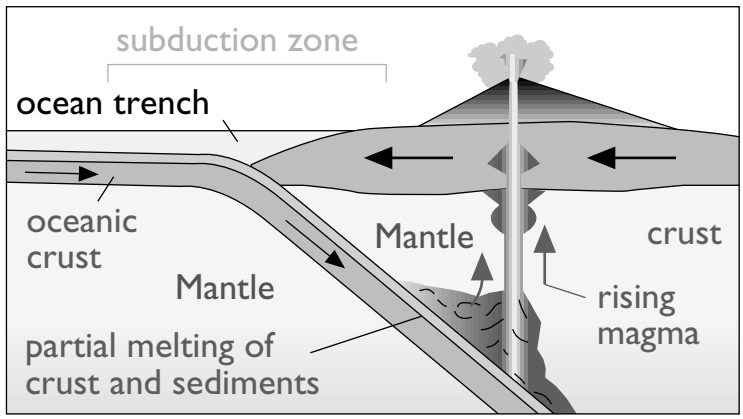


Figure 1.1.4 Converging plates (subduction zone)

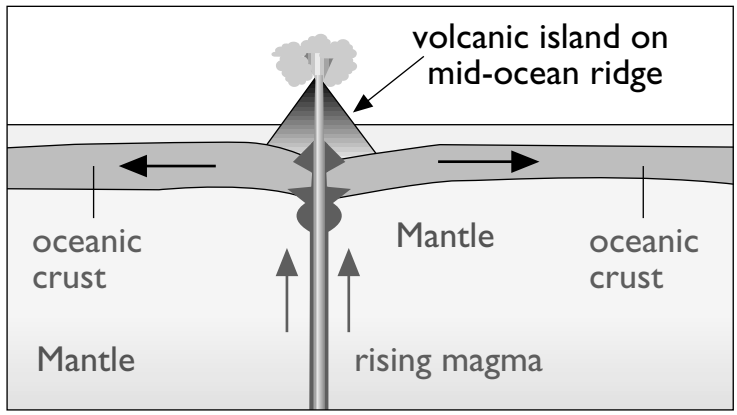


Figure 1.1.5 Diverging plates (mid-ocean ridge)

Products of volcanic eruptions

Eruption products can be divided into two groups: products erupted into the air and products erupted along the surface.

Products erupted into the air:

Tephra	Solid material. **Ash** (smallest), **lapilli**, **scoria**, **lava bombs** (largest)
Gas	Most common gases are steam, sulphur, hydrogen and carbon dioxide.

Products erupted along the surface:

Lava	Molten rock which moves relatively slowly downslope. (**Pumice** is a very frothy lava with a high gas and water content. It cools quickly and is full of bubbles. It can float on water.)
Pyroclastic flow	Extremely hot *glowing cloud* of burning and expanding gas and ash which moves at high speed down the slopes of a volcano. Also known as a **nuée ardente** or **lateral blast.** (The ash may settle and cool to form a rock called **ignimbrite**.)
Lahar	Volcanic mudflow which is a mixture of ash and water (from melted ice/snow, or crater lake). Moves rapidly down valleys.

Volcanic eruptions can also cause:

- earthquakes – as rising magma forces its way up through the crust
- tsunamis – large waves generated by earthquakes
- wind blasts – up to hurricane force if an eruption is explosive.

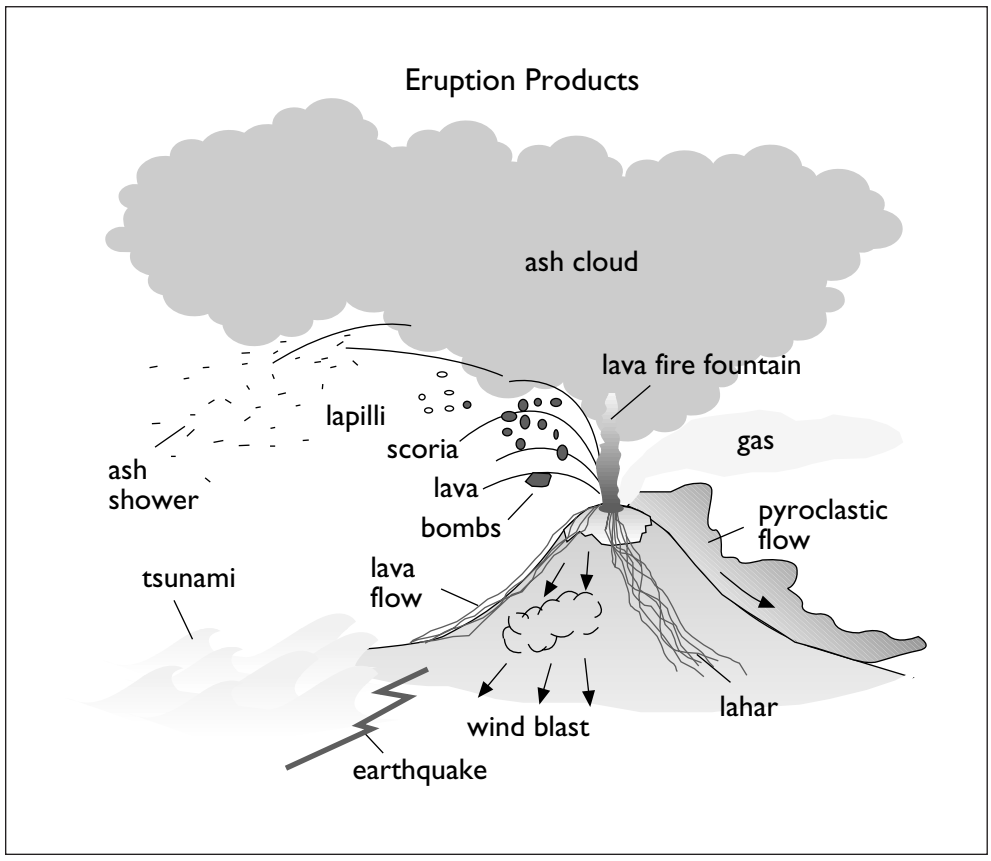


Figure 1.1.6 Eruption products

Global pattern of volcanoes

95% of the world's volcanoes are associated with *subduction zones* along *converging* plate boundaries.

80% of volcanoes are found along the most active subduction zone, which lies around the Pacific Ocean. It is called the **Pacific Ring of Fire.**

5% of volcanoes are found either at diverging plate boundaries (mid-ocean ridges), or at hot spots well away from any plate boundaries. At **hot spots** (e.g. Hawaii), magma from the mantle reaches close to the earth's surface.

Key Points Summary

- ❑ **Heat from the earth's core causes convection currents in the mantle.**
- ❑ **Convection currents in the mantle cause the crustal plates to move.**
- ❑ **Plate boundaries are weaknesses in the crust. Nearly all volcanic eruptions occur along plate boundaries.**
- ❑ **Subduction zone eruptions are usually explosive, and erupt andesitic and rhyolitic lava.**
- ❑ **80% of all volcanoes occur around the Pacific Ring of Fire.**

Activity 1

1 Match up descriptions with terms.

a mantle	**A** not active but could erupt again
b crust	**B** area where the mantle is close to surface of the crust
c plate boundary	**C** layer between earth's crust and core
d vent	**D** quiet, non-explosive
e dormant	**E** solid material erupted into the air
f effusive	**F** erupts fairly explosively
g phreatomagmatic	**G** earth's hard, cool surface layer
h tephra	**H** opening in earth's surface through which lava erupts
i andesitic lava	**I** line of contact between tectonic plates
j hot spot	**J** explosive eruption involving water

2 Decide whether the following statements are true or false. Explain why the false statements are incorrect.

a The earth's core is cool and solid.

b Subduction occurs when tectonic plates diverge.

c Most volcanic eruptions occur near plate boundaries.

d It is hard to decide if a volcano is extinct or dormant.

e Magma releases gas as it rises up through the crust.

f Highly viscous lavas erupt effusively.

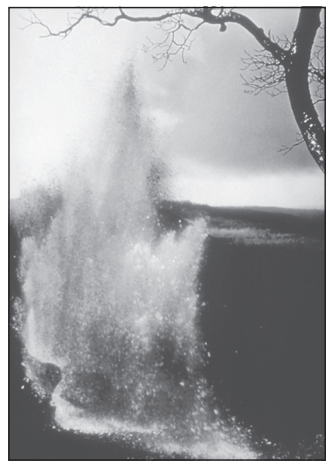
g Pumice is formed from frothy lava.

3 Find evidence in this chapter to support this important geographic idea: Spatial patterns are the result of processes.

4 Find answers to the following questions from the text.
   - **a** What is the difference between magma and lava?
   - **b** What is the difference between a *volcano* and a *volcanic eruption*?
   - **c** Why are *basaltic* eruptions more likely to occur at *diverging* plate boundaries?
   - **d** How did the *Pacific Ring of Fire* get its name?
   - **e** Which flows more quickly: *lava* or a *pyroclastic flow*?

5 Draw a pie graph to present the data under the heading 'Global Pattern of Volcanoes'.

Volcanoes And The Natural Environment



New Zealand's volcanoes

Both the North and South Islands of New Zealand have **igneous** (volcanic) rocks, but volcanic activity is now confined to the North Island. There are seven potentially active volcanic centres. These are: Northland, Auckland, White Island, Okataina/ Rotorua, Taupo, Tongariro, Taranaki (Egmont).

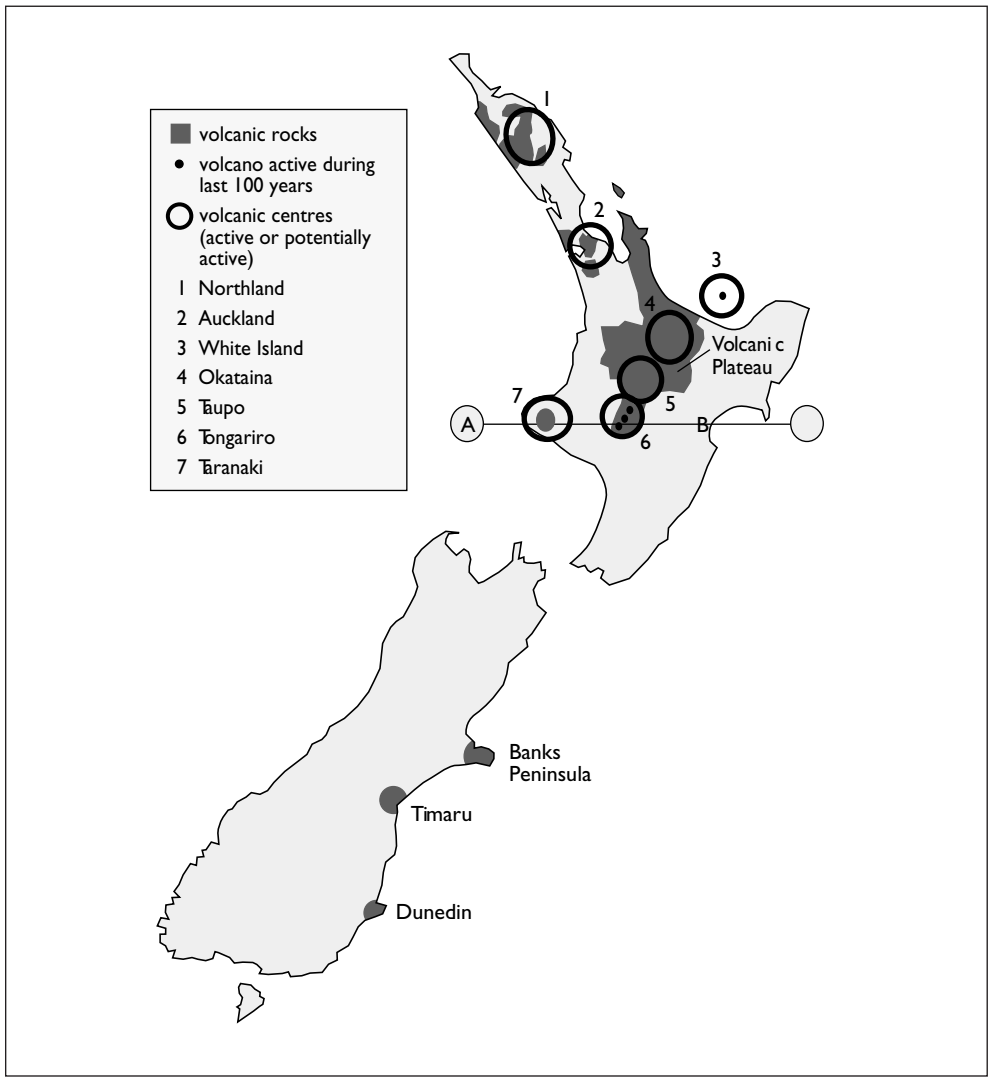


Figure 1.1.7 New Zealand's volcanic areas

Frequency of eruptions

Scientists have been able to establish when some volcanoes have erupted in the past. From this they can calculate *average* eruption frequencies. Five eruptions over a 10 000-year period is on average one eruption every 2000 years.

The frequency of eruptions varies considerably. White Island erupts continuously, but there has been no eruption in the South Island for millions of years.

Three New Zealand volcanoes erupted during the 20th century: White Island, Ruapehu and Ngauruhoe. Tongariro and Tarawera last erupted near the end of the 19th century.

New Zealand's volcanic processes

Scientists believe the very old volcanoes of the Coromandel and the South Island are now extinct.

Most of New Zealand's volcanoes are associated with the subduction of the Pacific Plate under the Indian-Australian Plate. As the plate subducts into the mantle, crustal rocks and ocean sediments mix with magma. This results in the explosive eruption of andesitic lava (e.g. Ruapehu) and rhyolitic lava (e.g. Tarawera). The world's largest eruption in the last 5000 years was the rhyolitic Taupo eruption about 1800 years ago. The large depression formed in this eruption was an area larger than the area of the Fiji Island Viti Levu. The depression filled with water to become the present Lake Taupo.

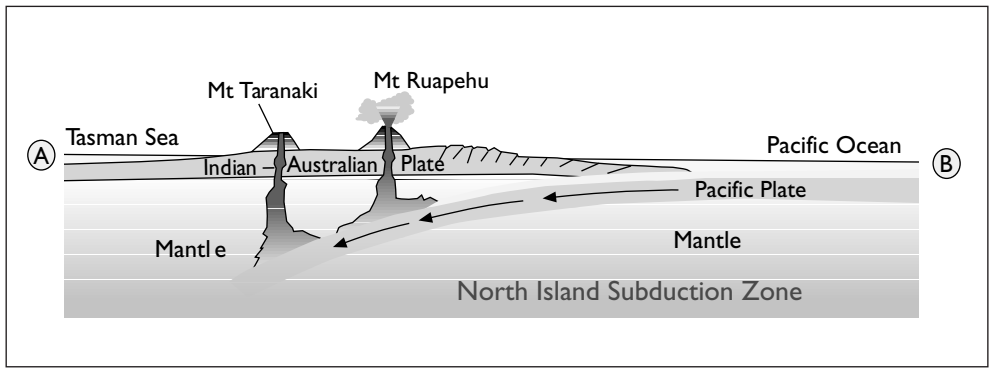


Figure 1.1.8 North Island subduction zone

The volcanoes of Auckland and Northland had a different cause. Associated with **hot spots** under the crust, they erupted basaltic lava. Eruptions were effusive, unless contact with water caused phreatomagmatic eruptions to occur.

Table 1.1.1 Volcanic processes

Volcano type	Examples	How formed
Rhyolite dome	Mount Tarawera	Rhyolitic lava. Cools quickly, does not flow and builds steep-sided dome.
Strato volcano	Mount Ngauruhoe Mount Taranaki	Andesitic lava. Alternating eruptions of ash and lava build up steep-sided cone.
Shield volcano	Rangitoto Island	Basaltic lava. Cools slowly and flows easily to form gently sloping shield-shaped volcano.
Scoria cone	Maungawhau (Mount Eden, Auckland)	Gas-rich basaltic lava erupts as *fire fountain*. Small pieces of 'bubbly' lava cool in the air and fall to the ground as scoria. A cone-shaped mound is built up around the vent.
Parasitic volcano	Fanthams Peak (Mount Taranaki)	Original vent is plugged by solidified lava. New cone grows on side of volcano.
Composite volcano	Mount Ruapehu	A volcano with many vents and cones. Also called a **multiple volcano.**
Caldera	Lake Taupo; Lake Rotorua	Very large eruption of volcanic material causes volcano to collapse in on itself. Leaves large depression which may fill with water.
Explosion crater	Lake Pupuke; Orakei Basin (Auckland)	Explosive phreatomagmatic eruption leaves only a shallow crater surrounded by a ring of **tuff** (volcanic rock fragments). Crater may fill with water.
Plateau	Volcanic Plateau	Extensive flows of lava and other volcanic materials can form a plateau. The North Island's Volcanic Plateau extends from Lake Taupo to the Bay of Plenty.
Lava tunnels	Maungawhau (Mount Eden, Auckland)	Lava flows cool and harden on the surface but keep flowing underneath. When eruption ends a cave system of *lava tunnels* remains beneath the surface.
Mounds	Mount Ruapehu	Unusual mounds of mud and rock on the lower slopes of Mount Ruapehu are thought to be the final deposits of lahars.
Volcanic soils	Taupo and Auckland	Wind can carry tephra away from an eruption – finer material will be carried further. Volcanic soils around Taupo are not naturally fertile; those around Auckland are.

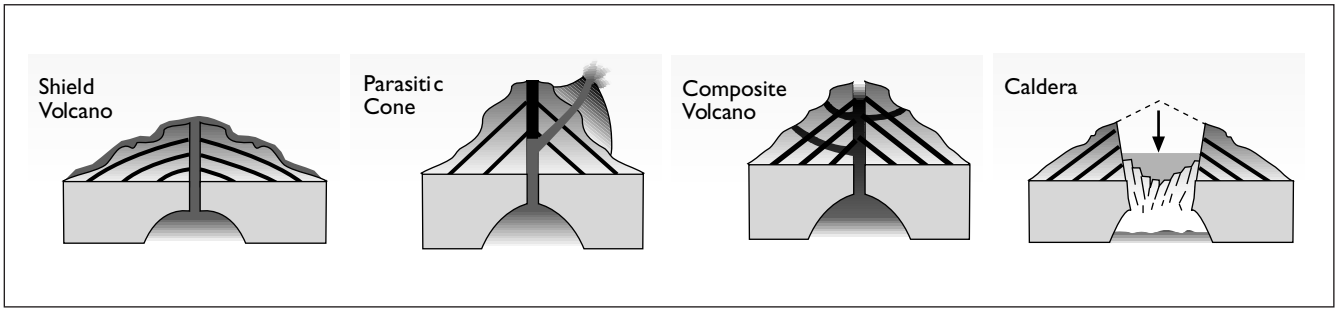


Figure 1.1.9 Volcanic processes

Sequence of natural events

No two volcanic eruptions are exactly the same, but there is a fairly typical sequence of natural events that takes place *before, during* and *after* an eruption. Thus: magma rises up through the crust, magma is released and the volcanic materials spread, erupted materials then settle and redistribute.

The time it takes for rising magma to reach the surface will vary according to the type of magma, how deep it is and the pressure it is under. It is estimated that in Auckland rising basaltic magma would take from two to seven days to reach the surface.

BEFORE: Rising magma

- Earthquakes occur as the magma starts to force its way up through the crust, either directly from the mantle or from a magma chamber in the crust. Small tremors occur at first, later increasing in frequency and intensity.
- Geothermal activity may increase, with mudpools and geysers becoming more active.
- As magma approaches the surface, swarms of earthquakes occur, ground temperatures may rise, surface **deformation** (bulging) may occur and rocks may change their magnetic properties.
- There may be changes in animal behaviour.
- Small quantities of ash, gas or steam may escape.

DURING: Release of magma

- There is a sudden release of pressure in the magma as it breaks through to the surface. Gases in the magma expand rapidly, creating an effect similar to the fizzing when you take the lid off a bottle of lemonade. The nature of the eruption depends on the type and volume of magma/lava being erupted and whether there is contact with ground water.

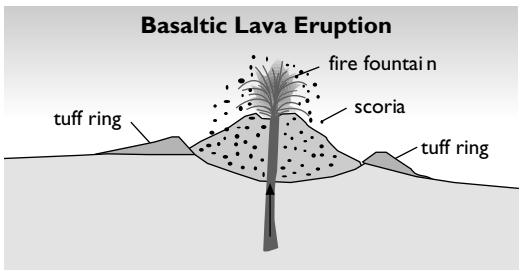
AFTER: Effects on the natural environment

- ❑ The effects of volcanic eruptions on the environment depend on how explosive they are and the type and quantity of material erupted.
- ❑ Volcanic eruptions in New Zealand have created a wide variety of volcanoes and other volcanic features.
- ❑ Volcanic eruptions can also have a temporary (but significant) effect on other aspects of the natural environment, such as choking and diverting streams.

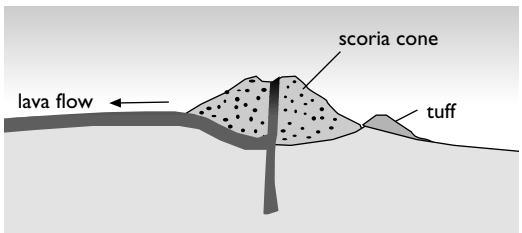
Basaltic Lava Eruption

Either:

- ❑ May start with some **fire fountaining** as gases escape from the fluid lava.

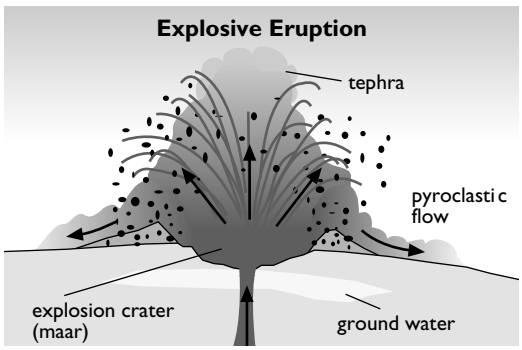


- ❑ A **scoria cone** builds up around the vent.
- ❑ When the gas has been released effusive lava flows begin. the flows end when the magma stops rising.



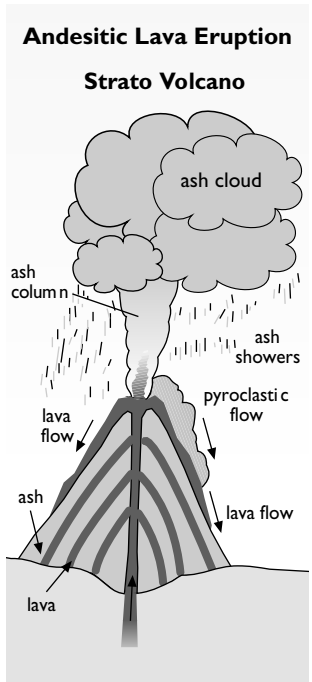
Or:

- ❑ If rising magma meets groundwater before it reaches the surface, an explosive phreatomagnetic eruption occurs.
- ❑ Tephra is blasted into the air, and pyroclastic flows move rapidly over the ground.
- ❑ The volcano will then settle down to effusive lava flows.



Andesitic Lava Eruption

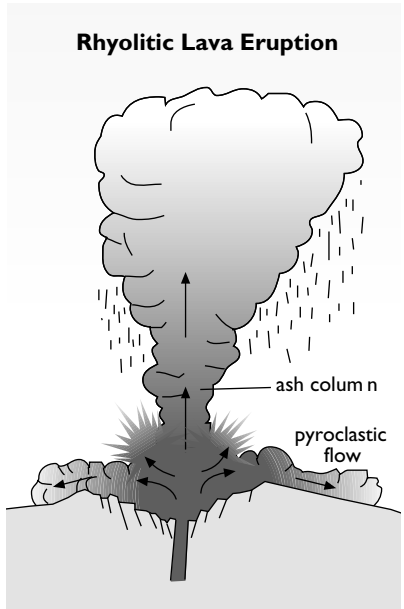
- ❑ Begins with a fairly explosive eruption of tephra and gas owing to the viscous nature of the lava.
- ❑ A tall **ash column** rises above the vent, and pyroclastic flows move rapidly down the slopes of the volcano.



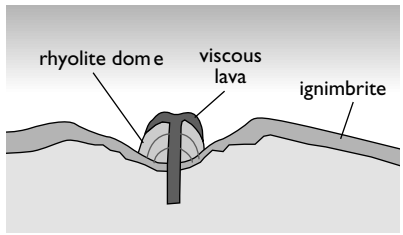
- ❑ Eruptions of tephra and lava continue until the magma stops rising.
- ❑ Lava flows cool quickly and a steep-sided **stratovolcano** develops.

Ryolitic Lava Eruption

- ❑ Begins with a huge eruption as gas explodes out of highly viscous lava. (Like popping a cork from a champagne bottle!).
- ❑ There is a massive eruption of tephra. A towering ash column rises into the sky. Surface pyroclastic flows race away from the shattered vent, and cool to form ignimbrite.



- ❑ The lava is too viscous to flow far and a steep-sided **rhyolitic dome** may develop.



- ❑ If an eruption finally empties its magma chamber source, the volcano may collapse forming a **caldera**.

Figure 1.1.10 Types of lava eruption

Figure 1.1.11 Lava effects

Table 1.1.2 Volcanic eruption effects

Natural environment	Example	Effects
Vegetation	Tarawera	Wind blast from an explosive eruption may completely flatten forest and loose material (ash, mud etc) several metres thick may cover all vegetation. Rain, wind and rivers will remove some of this material within a few months. What remains will eventually become soil and vegetation will grow back.
Rivers/lakes	Lake Waiatarua (Auckland)	Lava flows can block valleys causing lakes to form behind the solidified lava. Lake Waiatarua (now drained) was an example.
Climate	Taupo	A major explosive eruption can affect the climate. In 1991 Mount Pinatubo (Philippines) erupted vast amounts of ash high into the atmosphere and caused cooler summers around the world for several years. The Taupo eruption 1800 years ago gave ancient Romans some spectacular sunsets and poor harvests!

Case Study – Tarawera, 1886

Date	Time	Natural Events
April/May		Earthquakes; changes in lake levels; increase in geothermal activity.
3 June		Supernatural events on Lake Tarawera reported, including sighting of a 'phantom canoe'.
10 June	0.30 a.m.	Earthquake tremors begin, and increase in intensity for next two hours. Minor tephra/steam eruption.
	1.30 a.m.	Major eruption of basalt scoria along a 5 km fissure. Pyroclastic flows for up to 6 km. Ash column rises to height of 10 km, with frequent lightning flashes. Ash eventually carried more than 200 km by strong south-easterly wind.
	4.00 a.m.	Huge phreatomagmatic eruptions occur in Lake Rotomahana. Famous Pink and White Terraces destroyed. Mud/ash spread over wide area.
	5.30 a.m.	Eruption ends, but geothermal activity continues in nearby Waimangu Valley. Ash clouds cause darkness for most of the morning.

Effects on the natural environment:

- 14 kilometre chasm along the entire length of the eruption fissure
- Lake Rotomahana greatly increased in size
- Pink and White Terraces destroyed
- Ash and mud (up to 12 m deep) covered the surrounding landscape, destroying bush and wildlife.

Had the volcano erupted *rhyolitic* lava, then the devastation would have been much greater and more widespread.

Case Study – Ruapehu, 1995

In contrast to Tarawera in 1886, the 1995 Ruapehu eruption sequence lasted for nearly a whole year.

Date	Events
January	Rising magma. Crater lake temperature rises to 51°C (from 15°C). Frequent steam eruptions.
June	Significant earthquake. Chemical change in crater lake water.
September 18	Eruption from vent below crater lake. Lahars flow down the mountain. Frequent steam/ash/lava eruptions continue for several weeks and ash column rises 12 km into the sky.
October	Crater lake dries up and steam eruptions end.
November	Volcanic activity dies down. Crater lake starts to fill again.

Effects on the natural environment:

- The eruption looked spectacular and had serious economic effects but there were no significant long-term effects on the natural environment.
- Although wind-blown ash fell over large areas of the North Island they were no more than a few millimetres thick near the volcano. Rain and summer snow-melt washed away most of the ash deposits.
- There were some eruptions of lava (bombs etc) but no lava flows.

Key Points Summary

- All volcanic activity in New Zealand is now confined to the North Island.
- Each volcano has a different eruption frequency.
- Most of New Zealand's volcanic activity is associated with plate subduction.
- There is a general sequence of natural events in all eruptions, but each eruption is unique in some way.
- New Zealand has a wide variety of volcanic landforms.

Activity 2

1 Match up descriptions with terms.

a White Island	**A** site of huge eruption 1800 years ago
b extinct volcanoes	**B** bulging of ground surface prior to an eruption
c Taupo	**C** volcanic feature formed by fire fountaining
d hot spot volcanoes	**D** a collapsed volcano, usually containing a lake
e deformation	**E** New Zealand's most continuously active volcano
f strato volcano	**F** gently sloping volcano, e.g. Rangitoto Island
g scoria cone	**G** large area of volcanic deposits north of Ruapehu
h shield volcano	**H** Coromandel and South Island volcanoes
i caldera	**I** steep-sided volcano with alternating layers of ash and lava
j Volcanic Plateau	**J** Auckland and Northland volcanic fields

2 Decide whether the following statements are true or false. Explain why the false statements are incorrect.

a New Zealand's igneous rocks are found only in the North Island.

b Four New Zealand volcanoes erupted during the 20th Century.

c Ruapehu, Taranaki and Tarawera are typical subduction zone volcanoes.

d Earthquakes are an early indication of rising magma.

e All eruptions experience a similar sequence of events.

f Scoria cones are associated with eruptions of basalt lava.

g Lake Pupuke (Auckland) is an example of a caldera.

3 Find evidence in this chapter to support this important geographic idea: Some changes in the environment are predictable or recurrent (will occur again and again) while others are unpredictable or erratic.

4 Find answers to the following questions in the text.

a What are New Zealand's seven active or potentially active volcanic centres?

b Which New Zealand volcanoes erupted during the 20th century?

c Why was the Taupo eruption in approximately AD 186 not a natural hazard?

d What are the signs of magma approaching the earth's surface?

e Why can gas have such a major effect on how a volcano erupts?

f Why does rhyolitic lava produce steep-sided volcanic domes?

g What evidence is there to suggest that the 1886 Tarawera eruption was phreatomagmatic?

h What was the source of the lahars that flowed down the slopes of Ruapehu?

5 Write a geographic paragraph to outline the sequence of natural events associated with a volcanic eruption.

Figure 1.1.12 Eruption of Ngaruahoe, 1974

Living With Volcanoes In New Zealand

Human response

When signs of a forthcoming volcanic eruption are detected a cultural (human) response follows. The response to each eruption is unique, but there is a fairly typical sequence of cultural events.

The sequence of cultural events can be studied in three stages – *before, during* and *after* the eruption. As with all natural hazards, the cultural events overlap with the sequence of natural events. The amount of overlap depends on how quickly the warning signs are detected and acted upon.

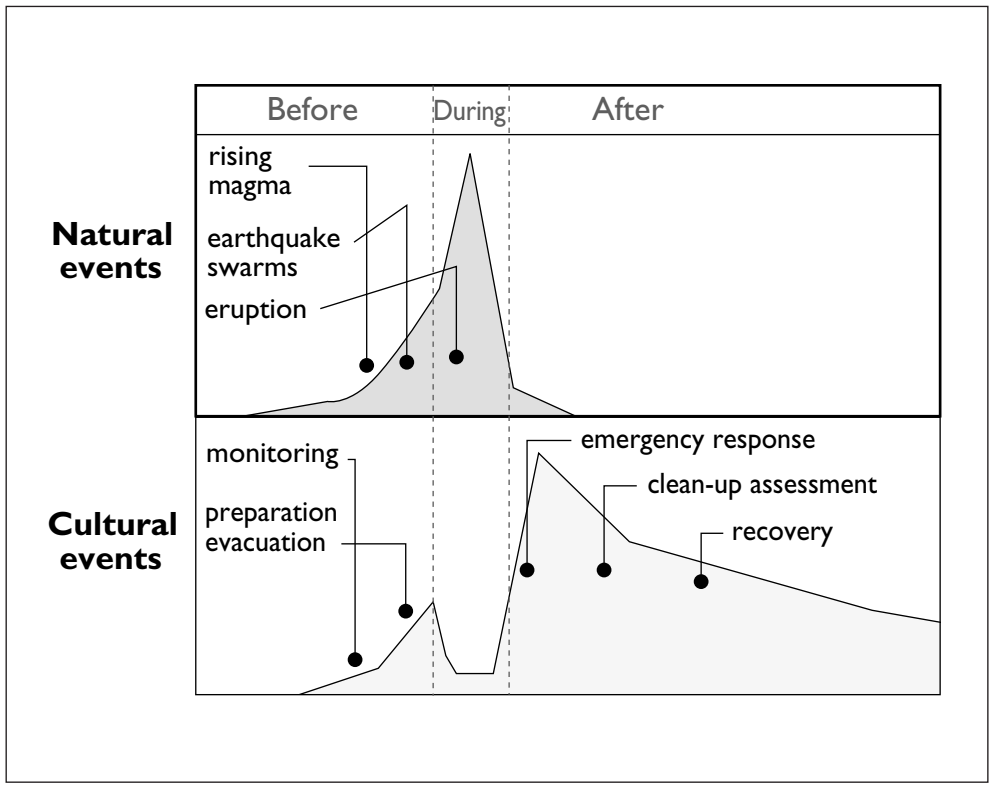


Figure 1.1.13 Human response

Sequence of cultural events

BEFORE:

Preparation (days)

- If seismometers (instruments which measure earthquake shock) detect tremors which are thought to be caused by rising magma, then more seismometers are brought in to help **volcanologists** (people who study volcanoes) to pinpoint the likely eruption site.
- People become concerned. Some may leave the area voluntarily.
- Business activities may be cancelled or delayed. Panic buying and stockpiling of vital supplies (e.g. candles, batteries) may occur and cause shortages.
- If a life-threatening eruption is considered likely, a **Civil Defence emergency** is declared. Information and advice is broadcast on radio and TV.

- **Evacuation** of the threatened area begins when the government declares a Civil Defence emergency. The size of the evacuation area depends on the type of eruption expected.

DURING:

Survival (hours–days–months)

- The duration (the length of time) of eruptions varies. Tarawera erupted for several hours in 1886, while Ruapehu erupted intermittently over nearly a year in 1995.
- Deaths and injuries are likely if people are not evacuated. Those in the danger area who follow emergency procedures are more likely to survive.
- Volcanologists from around the world come to monitor, record and learn from the eruption.

AFTER:

Emergency response (days)

- When the eruption ends or quietens, emergency services search for survivors and may be required to do such things as put out fires.
- Survivors are taken to evacuation centres, or hospitals if they are injured, well away from the danger area.

Clean-up and assessment (weeks)

- The government assesses the damage to determine how much emergency assistance is required.
- Badly damaged buildings are demolished ash deposits swept away. Essential services such as electricity, water and sewerage (**lifelines**) are restored as quickly as possible to prevent health hazards.

Repair and reconstruction (months or years)

- Some evacuees return home. Others decide to sell their homes and move to a safer area.
- Insurance claims assessed. Damaged property is repaired or rebuilt.
- More services are restored and infrastructure repaired. Reconstruction of major infrastructure items (railway lines, motorways) may take years to complete.

Plan for future eruptions

- Disaster plans and procedures are re-evaluated.

Social and economic effects

Volcanic eruptions have social and economic effects. The term social relates to people's health, education, recreation, lifestyles, relationships with others, and so on. The term economic relates to all aspects of business, including jobs, income, profits, trade, resources, transport, banking and so on.

The scale of the effects will depend on the type, size, timing, duration and location of the eruption.

Death and injury

- An explosive eruption at night, in an urban area, with little or no warning, would cause the greatest number of deaths.
- Fast-moving pyroclastic flows are the most deadly features of volcanic eruptions. They leave no time to escape. On the other hand, lava flows are generally slow enough to escape from, even on foot.

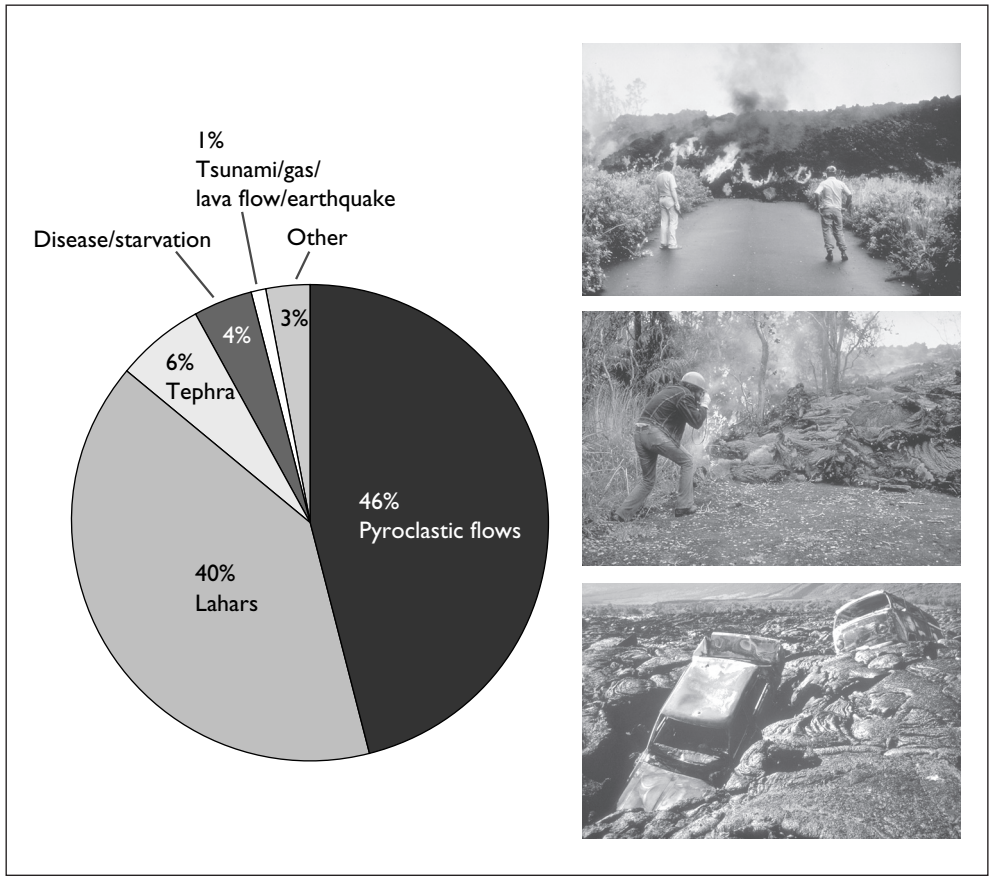


Figure 1.1.14 Causes of death from worldwide volcanic eruptions 1900–85

Trauma and disruption

- People may suffer emotionally because of a volcanic eruption, particularly if family, friends or neighbours have been killed. Children may be separated from their families if an eruption occurs during school time.
- Many people will have their lives disrupted for a period of time, especially those who are evacuated, or who lose their homes, possessions, jobs or schools.
- People may need counselling (special advice) to help them recover emotionally from an eruption experience.

Economic impact

- An eruption in a large urban area (e.g. Auckland) would have a greater economic effect than in a rural area (e.g. Northland). An eruption in Auckland could affect the whole New Zealand economy for many years because a quarter of New Zealand's population lives in Auckland.
- Some businesses might be closed for months. Some would close permanently. Businesses and employees would lose income and less would be spent in shops.
- Many suppliers of goods and services could lose their contracts with clients in other regions or countries.
- Reconstruction increases economic activity and creates some new jobs for a while, particularly in the construction industry.

Minimising the effects of eruptions

What can be done to minimise the effects of volcanic eruptions?

Can scientists in New Zealand identify all potentially active volcanic areas? Yes. Scientists have identified seven potentially active volcanic centres, all in the North Island.

Can people and their property be moved from these volcanic areas? No. This is not practical and it would be hard to make people move in a democratic country. People are attracted to volcanic areas by their fertile soils (e.g. market gardening in Mangere, Auckland), their beauty and tourist potential (e.g. skifields on Mt Ruapehu) and their geothermal power resources (e.g. Wairakei, near Taupo).

Figure 1.1.15 Volcanic areas can make beautiful tourist spots

Can eruptions be predicted? No. Nobody knows enough about each volcanic centre to make accurate predictions. Inaccurate predictions would do more harm than good.

Can early warning signs of volcanic eruptions be detected? Yes. Scientists from the **Institute of Geological and Nuclear Sciences (IGNS)** monitor all volcanic centres. Several techniques are used to detect early warning signs:

- **seismometers** to detect earth tremors associated with rising magma
- **tiltmeters** and levelling surveys to detect ground deformation (bulging)
- temperature measurements to detect heat from rising magma.

Can we learn from eruptions? Yes. We can learn from eruptions of overseas volcanoes (e.g. Mount St Helens, USA, 1980; Nevado del Ruiz, Colombia, 1985).

Lesson for NZ in Colombian tragedy

New Zealand's civil defence system could cope with a major volcanic eruption as long as it had adequate warning, says its director, Edward Latter.

Civil Defence staff here were eager to establish the warning signs the Colombian volcano, Nevado del Ruiz, gave before it erupted killing more than 20,000 people, he said.

The North Island mountains, especially Mt Egmont, could cause a similar disaster, he said.

These mountains are about the same height as Nevado del Ruiz. The snow and ice on their peaks would melt in an eruption, forming a major flood of mud and debris, as had happened in Colombia.

Mt Egmont, being an almost perfect cone, could have mud and lava flows in all directions.

And the large population at its foot would mean a huge evacuation task.

Mt Ruapehu was regularly monitored, Mr Latter said.

He said he was not skilled enough in geology to comment on Mt Egmont's volcanic activity.

"I believe the system could cope reasonably well if there was enough warning. The public doesn't need to have any apprehension.

"There's a temptation to say let's send somebody over there, but that would be ghoulish and they would be in the way."

New Zealand, because of its civil defence system, was better prepared for such a disaster than the Colombians had been, he said.

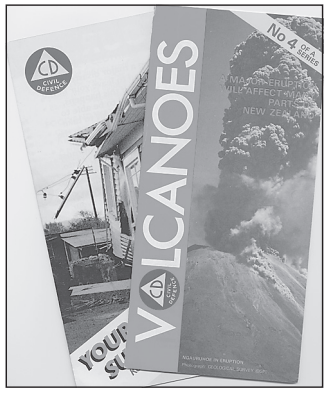
Can we prepare for volcanic eruptions? Yes. We can prepare for future eruptions. Preparing for natural hazards is known as emergency management.

Emergency management and civil defence

The Civil Defence organisation of New Zealand was set up by the government in the 1950s to protect New Zealanders from natural and other disasters. It is now part of the Ministry of Civil Defence and Emergency Management.

Civil Defence has the authority to declare an emergency and to take full control during the emergency. Civil Defence personnel may:

- evacuate buildings and otherplaces
- restrict entry into buildings
- remove vehicles which block their work
- requisition (make use of) private property that may assist them during the emergency, e.g. a person's family home or car.



The Ministry of Civil Defence and Emergency Management ensures that people are prepared for volcanic eruptions and other natural hazards. They use the slogan, 'Know what to do before you have to do it!'

New Zealand's *Yellow Pages* phone books include Civil Defence emergency information and procedures; brochures are published and widely distributed.

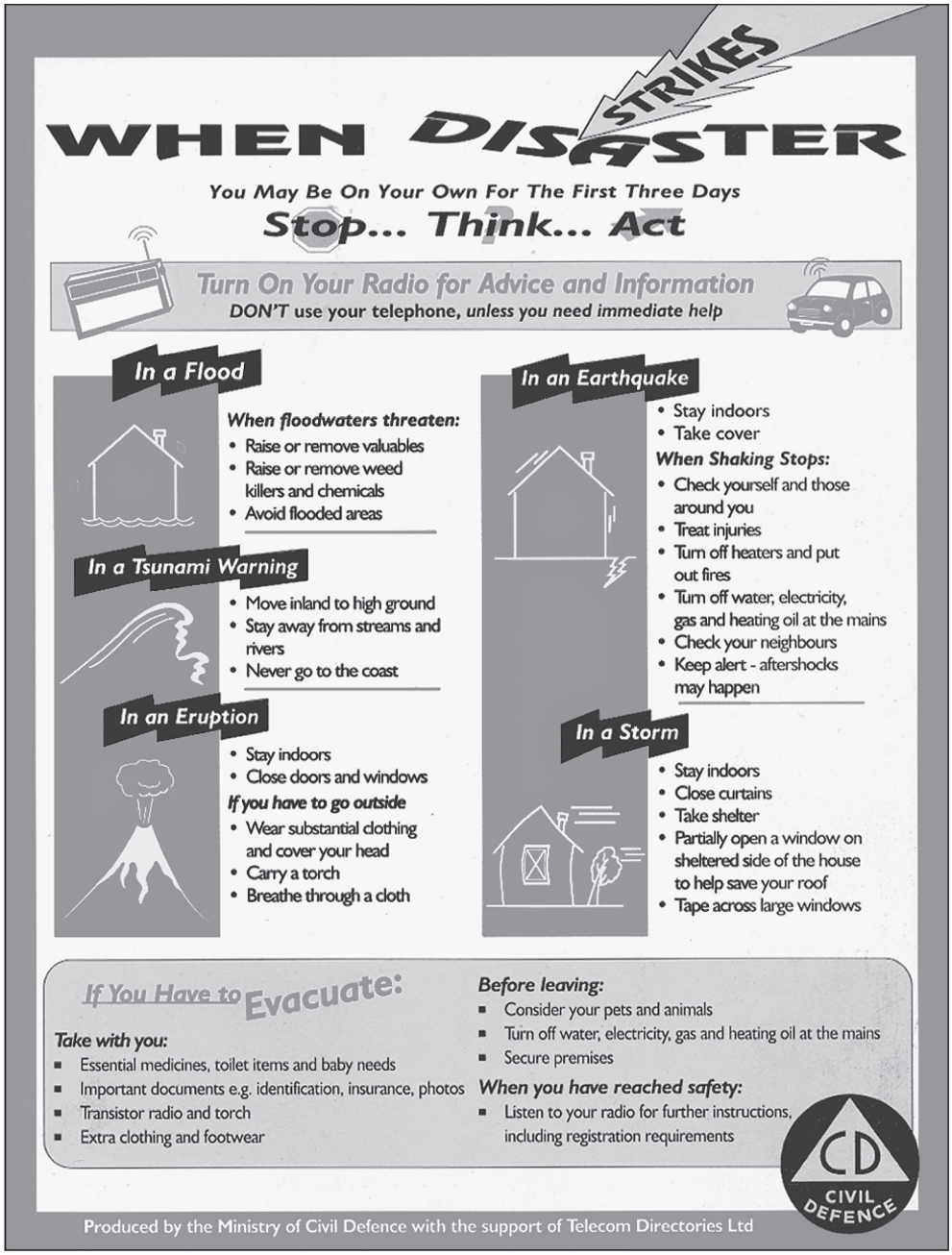


Figure 1.1.16 Civil Defence

The **Earthquake Commission (EQC)** was set up by the government in 1945 to provide insurance cover for homes damaged by volcanic eruptions and other natural disasters.

Increasing the effects of eruptions

Thanks to organisations like IGNS, the Ministry of Civil Defence and Emergency Management and EQC, New Zealanders are now better prepared for volcanic eruptions than ever before. Despite this, the volcanic hazard in New Zealand continues to increase.

The hazard is increasing for several reasons:

- the population is growing larger
- population growth is most rapid in the North Island where the volcanic threat is greatest
- the greatest population growth over the past fifty years has been in Auckland, which is situated on a volcanic field containing 49 volcanoes!
- economic development means there is more to lose as new houses, industries and other facilities are created each year.

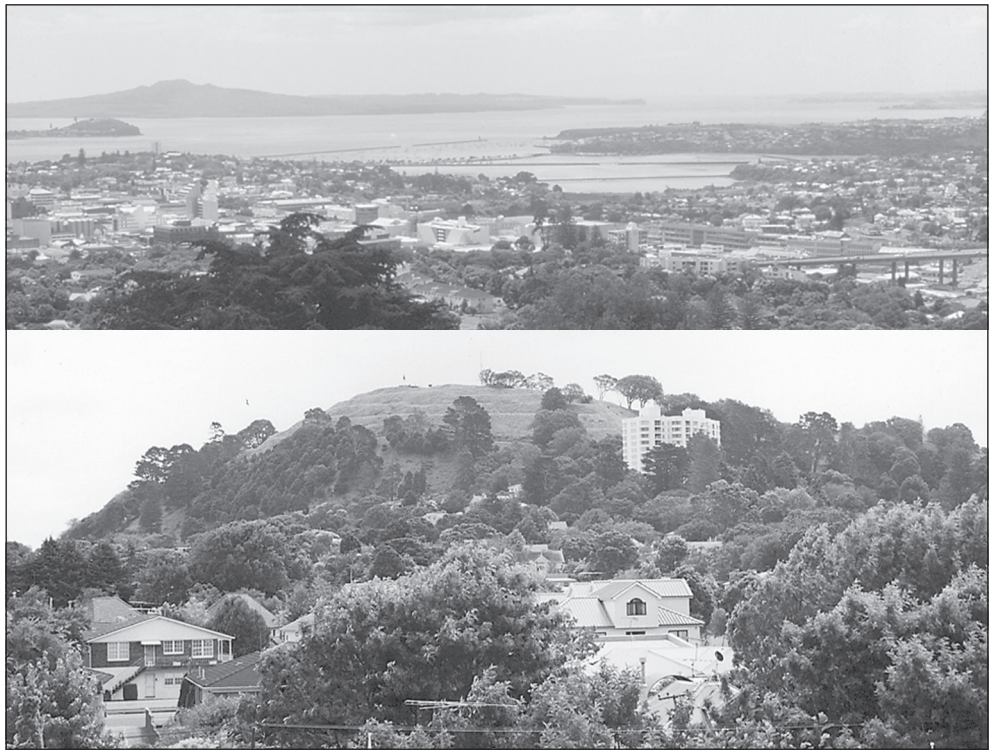


Figure 1.1.17 Auckland is built on a volcanic field

Case Study – Tarawera, 1886

In 1886 there was little scientific understanding of volcanic processes and the early warning signs of an eruption at Tarawera, near Rotorua, were not recognised. Some local Maori sensed that all was not well, but no specific eruption warnings were issued. Most people did not respond until the mountain blew its top! By then it was too late and many lives were lost.

BEFORE:

- Warning signs generally went unrecognised.

DURING:

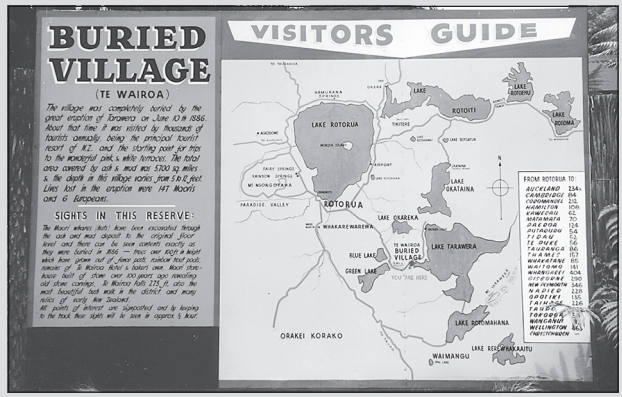
- At least 150 people were killed, most of them at the Maori villages of Te Ariki, Moura and Te Wairoa.
- Most deaths were caused by falling scoria, ash and mud. At Te Ariki all inhabitants were killed by a violent pyroclastic flow. Tephra deposits were 12 m thick at Moura.
- At Te Wairoa burning ash and scoria set fire to several buildings. The weight of ash and mud on roofs caused the hotel, mill and school to collapse, killing the schoolmaster, members of his family and a tourist.

(cont.)

- Ash fall in Rotorua persuaded many people to flee for the safety of Tauranga. Ash later reached Tauranga, Whakatane, and even a ship 220 km away in the Bay of Plenty.

AFTER:

- Rescue volunteers headed for Te Wairoa in horse-drawn buggies until stopped by deep ash and mud. Darkness made travel difficult.
- The Mayor of Tauranga requested steamships be sent from Auckland to evacuate fleeing survivors.
- The loss of the world-famous Pink and White Terraces destroyed the tourist industry associated with them.



- Today tourism has recovered and the 1886 eruption is itself now one of the area's attractions!

Case Study – Ruapehu, 1945 and 1995

The 1945 and 1995 eruptions of Mt Ruapehu were a similar size, but the volcanic hazard was much greater in 1995. In the fifty years between the two eruptions:

- the Tongariro power scheme had been built
- a major tourist industry had developed around Tongariro National Park
- two new skifields had opened.

As a result of these developments the economic impact of the 1995 eruption was much greater. It closed Ruapehu's skifields. Many jobs were lost and ski operators and tourism businesses lost millions of dollars as skiers and holidaymakers spent their money elsewhere.


1945 eruption


1995 eruption

Case Study – 1953, Tangiwai Disaster

DURING:

- Lava from the 1945 eruption of Mount Ruapehu blocked the crater lake's overflow tunnel and ice and volcanic debris raised the rim of the crater.

AFTER:

- The lake level rose for eight years until an ice wall gave way and a flood of water, like a delayed-action lahar, rushed down the Whangaehu valley.
- About two hours later, and 35 km downstream, the flood washed away the Tangiwai rail bridge.
- A few minutes later the Auckland to Wellington train plunged into the raging flood and 151 lives were lost.
- After the Tangiwai disaster a flood/lahar warning system was established on the Whangaehu River. Today, a flood in the upper river would trigger an alarm and the road and rail bridges would be closed.

Key Points Summary

- Natural events (eruptions) trigger a sequence of cultural events (the human response).
- If an eruption in a populated area is likely, a Civil Defence emergency will be declared and people evacuated.
- Research, monitoring and preparation decrease volcanic hazards.
- Population growth and economic development increase volcanic hazards. The volcanic hazard in New Zealand is increasing.
- New Zealand's worst volcanic disasters were the Tarawera eruption (1886) and Tangiwai disaster (1953).

Activity 3

1 Match up descriptions with terms.

a EQC	**A** site of New Zealand's worst volcanic disaster in 1886
b economic activity	**B** moving people away from danger
c lifelines	**C** gives special powers to cope with a disaster
d evacuation	**D** human activity which generates income or wealth
e Tarawera	**E** essential services, e.g. electricity supply
f Civil Defence emergency	**F** provides insurance cover for volcanic damage

2 Decide whether the following statements are true or false. Explain why the false statements are incorrect.

a Earthquakes are a reliable warning of a volcanic eruption to follow.

b About 150 people were killed by the Tarawera eruption in 1886.

c Seismometers are used to detect ground deformation before an eruption.

d The rapid growth of Auckland is increasing the volcanic hazard.

e New Zealand is now better prepared for volcanic eruptions so the hazard must be decreasing.

3 Explain the differences in the sequence of natural and cultural events in the model on pages 30 and 36.

4 Prepare arguments to support and oppose this statement: The volcanic eruption hazard in New Zealand is increasing.

5 Find the answers to the following questions in the text.

a How much warning might Aucklanders receive before an eruption?

b How can the Yellow Pages phone book help reduce the effects of volcanic eruptions?

c Why does Civil Defence use the slogan 'Know what you have to do before you have to do it!'?

d What special powers do Civil Defence officers have during a Civil Defence emergency?

e What can New Zealand learn from overseas eruptions?

f How might the sequence of cultural events have been different if Tarawera had erupted in 1986 rather than 1886

g What was unusual about the sequence of events associated with the Tangiwai disaster of 1953?

Other Pacific Case Studies From The Past And Present

The **Pacific Ring of Fire** has produced 66% of the world's **Holocene** volcanoes and 65% of its dated eruptions, largely as a result of subduction of the huge Pacific plate and several smaller plates. The region between New Zealand and Fiji that is described here is geographically small but volcanologically important.

The Kingdom of Tonga is an archipelago of two parallel island belts: the island belt to the east is low, fertile, coralline (limestone), and well populated, while the belt to the west is young, volcanic, and ranges from steep cones to ephemeral (short-lived) islands. The unbroken line of subduction, from New Zealand through the Kermadecs and Tonga, ends abruptly and the trench swings west toward the remarkable, doughnut-shaped island of Niuafo'ou, a basaltic shield volcano with a large, lake-filled caldera. European contact with Tonga began in the seventeenth century and Captain Cook named them the Friendly Isles in 1773; the first recorded eruption was in the next year.

The Sāmoan islands are formed by a hotspot to the north-east of the Tonga-Kermadec-New Zealand subduction zone, and are volcanically distinct from their neighbours. They were invaded by Fijians in the early thirteenth century, but may well have been settled thousands of years earlier. European contact was first made by the Dutch in 1722, but detailed record keeping began with the arrival of missionaries from London in 1830. The 1725 eruption of Savai'i, covering 190 km^2 with 2 km^3 of lava, was the first historical volcanism in this part of the region. In 1900 the islands were divided, with the smaller eastern islands going to the US and the larger, more populated, and more volcanic western islands going to Germany. New Zealand annexed Western Sāmoa and administered it from 1914 to 1962, when it became independent.

Source: based on Simkin and Siebert, *1994*

Following are two photographic essays about volcanic eruptions in Sāmoa and in one of our close island neighbours in the Kingdom of Tonga.

Sāmoa's Last Volcanic Eruption

Matavanu volcano, in the districts of Gagaifoma'uga and Gaga'emauga on the island of Savai'i, erupted in 1905. At the time of this major eruption, Sāmoa as a nation was under the colonial rule of Germany. The lava flow covered the villages of Salae'ula and Lealatele. To help solve the problem of the loss of homes and lands, Catholic priests, Methodist pastors and the German administrators arranged to relocate these villages to the island of Upolu.

In 1908, those from Lealatele were settled near Tuana'i and Sale'imoa villages. Today they make up the village of Le'auva'a.

On 10 August 1909, a steamer carrying the people of Salea'ula arrived at Utu'utu Lefaga on the Safata border. This location became the village of Salamumu. Today, while the residents of these two villages (Le'auva'a and Salamumu) live in Upolu, they are part of the constituencies of Gaga'emauga on the island of Savai'i. Their modern political identity remains based on the island of Savai'i, which is still the source of their parliamentary representation.

Volcanic Profile: Savai'i

Country	Sāmoa
Sub-region	Sāmoan Islands
Volcano Number	044–04 =
Volcano type	Shield Volcano
Volcano Status	Historical
Last known eruption	1911
Summit elevation	1858 m
Latititude	13.612 degrees S
Longitude	172.525 degress W
General Description	Savai'i, the largest and highest of the Sāmoan islands, is made up of a massive basaltic shield volcano built up along a west-north-west/east-south-east-trending rift zone that splits into two rifts on the east side of the 75-km-long, oval-shaped island.
Geological History	❑ Pliocene and Pleistocene shield formation ❑ stream and marine erosion ❑ partial submergence (in the sea) ❑ growth of coral reefs ❑ Late-stage Pleistocene and Holocene eruptions produced voluminous lava flows that partially buried fringing reefs ❑ Numerous cinder cones and lava cones dot the centre of Savai'i, which has a low-angle, dome-like profile and reaches an elevation of 1858 m. ❑ Additional cones occur in the north-central area, and a large number are found in the south-central part of the island. ❑ Three eruptions, including two in the 20th Century, produced voluminous lava flows that reached the northern coast along broad fronts up to about 15 km wide, destroying several villages and overtopping fringing reefs.

Source: Smithsonian Institution, Global Volcanism Program.

(cont.)

1 Sāmoa. House destroyed by lava

2 Sāmoa. Lava flowing into the sea, Savaiʻi

3 Sāmoa. Lava flowing into the sea, Savaiʻi

4 London Missionary Society church in Sāmoa, damaged by lava

Activity 4

Use the photographs and written information about the Matavanu eruption and what you have learned about volcanic eruptions to write full answers to the following questions. Make sure you give specific reasons for your answers.

1 Which tectonic processes led to the volcanic activities that built up the islands of Sāmoa?

2 What type of volcano is the one on Savaiʻi?

3 What type of eruption happened at Matavanu in 1905? Could it have been *explosive* or *effusive*?

4 What type of lava flowed during the eruption? Could it have been *basaltic*, *rhyolitic* or *andesitic*?

5 What were some of the *volcanic products* of the Matavanu volcanic eruption? (Reminder: give reasons for your answers. Try and use evidence from what you have read and from what you have seen in the photographs.)

6 What are examples of the physical features that resulted over time in the environment after the volcanic eruption?

7 What were some of the effects of the Matavanu eruption on people? How did people respond?

8 Choose either Photo 1 or Photo 4. Study the photograph carefully. What do you think happened to the people and the buildings in the photograph? Draw a flow diagram to describe the series of events that resulted in what you can see in the photo. Begin with: 'Movement of lava to the church/house'

Niuafoʻou in the Kingdom of Tonga

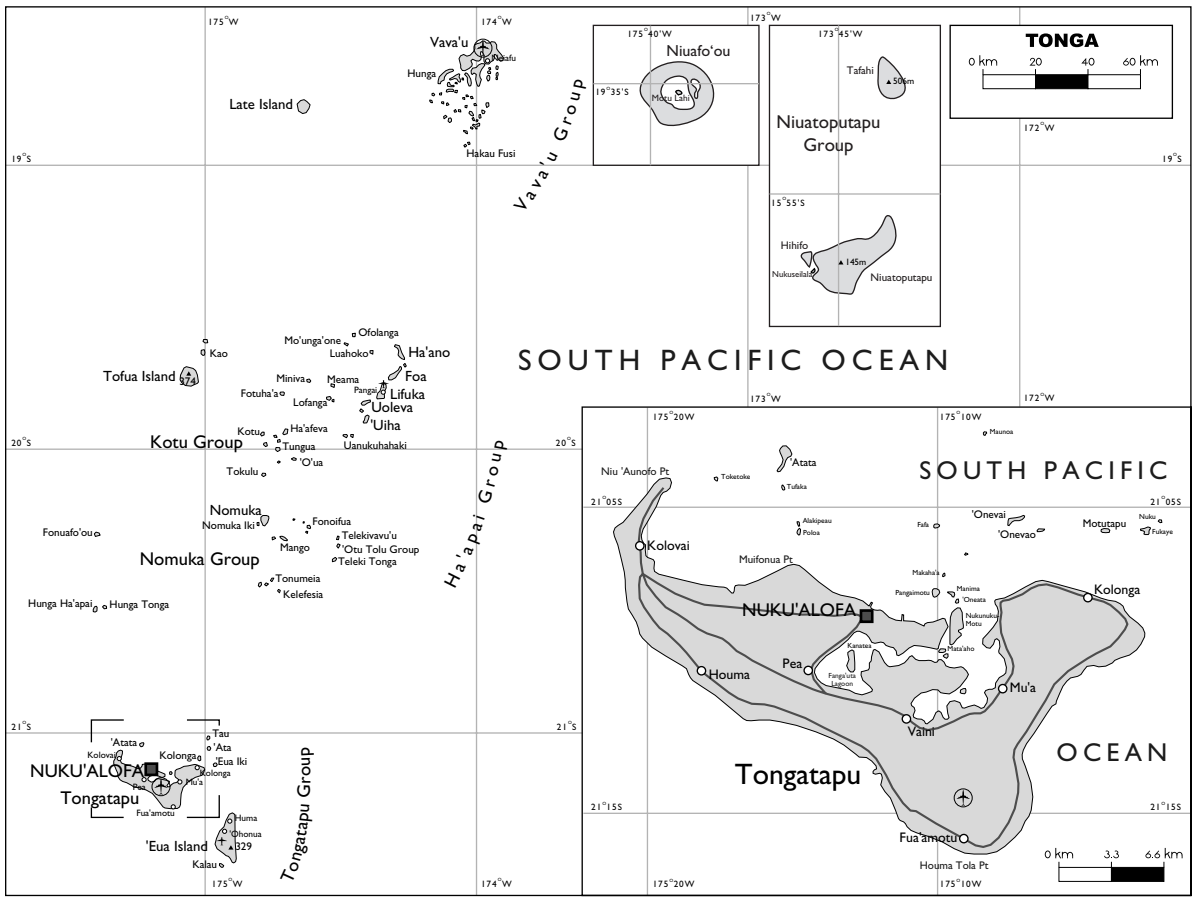


Figure 1.1.18 Islands of Tonga

The Kingdom of Tonga consists of four main island groups. From South to North: the groups are Tongatapu, Haʻapai, Vavaʻu and the Niuas. Fewer than 40 of Tonga's 170 or so islands are inhabited now and the population numbers less than 100 000. The most populated island is Tongatapu with 53 800 residents, followed by the Vavaʻu group (25 000), the Haʻapai group (14 000), 'Eua (5 000) and the two Niuas (3 000).

Niua Islands are of great interest because of volcanic activity. They are made up of the tiny islands of Niuafoʻou, Niuatoputapu and Tafahi. These islands are about 270 km north of Vavaʻu. They are the most isolated of Tonga's islands.

Niuafoʻou is the most northerly island of the kingdom, 337 km north-west of Vavaʻu, It is a volcano on an underwater ridge 190 km west of the line of all the other volcanoes of Tonga. Niuafoʻou has many volcanic eruptions, and there have been at least ten major events recorded since 1853.

The island is a steep-sided caldera; the rim is over 120 m high, rising to Mokotu (250 m). The coastline is rocky and steep with no reef, and the few beaches are stony with black sand. The only landing place is the end of a lava flow at Futu, in the west. All the villages are in the east.

The island ring encloses two lakes. The largest, Vai Lahi, is 23 m above sea level, 4 km wide, and 84 m deep. It has three islands plus a low one which appears when the water level drops. Vai Lahi is separated from the smaller Vai Mataʻaho by a wasteland of sand hills and pines. The inner walls of the main crater lake and the eastern slopes north of Tongamamaʻo have dense forest. Forest is also growing slowly over the lava-covered western slopes. Coastal vegetation is found on the entire southern coast. All the rest of the island has coconut palms, trees and mixed agriculture.

Activity 5

Study carefully the series of photographs of Niuafoʻou on the following two pages. There are ten altogether. Here are ten statements to describe the volcanic features in each of the photographs. Match each statement with the correct photograph.

a The lava must have flowed slowly as a thick and very hot liquid (like thick tomato sauce oozing from a bottle) down a slope.

b The people of the island use the volcanic rock for building boundary walls and roads.

c Parts of the island which were not affected by the last eruption have fertile soil – good for growing food crops.

d The largest lake in the middle of the island is really a caldera.

e Hot springs and pools.

f You can find evidence of lava flows from the past in the coastal cliffs of the island.

g Pumice rocks – another product of a volcanic eruption.

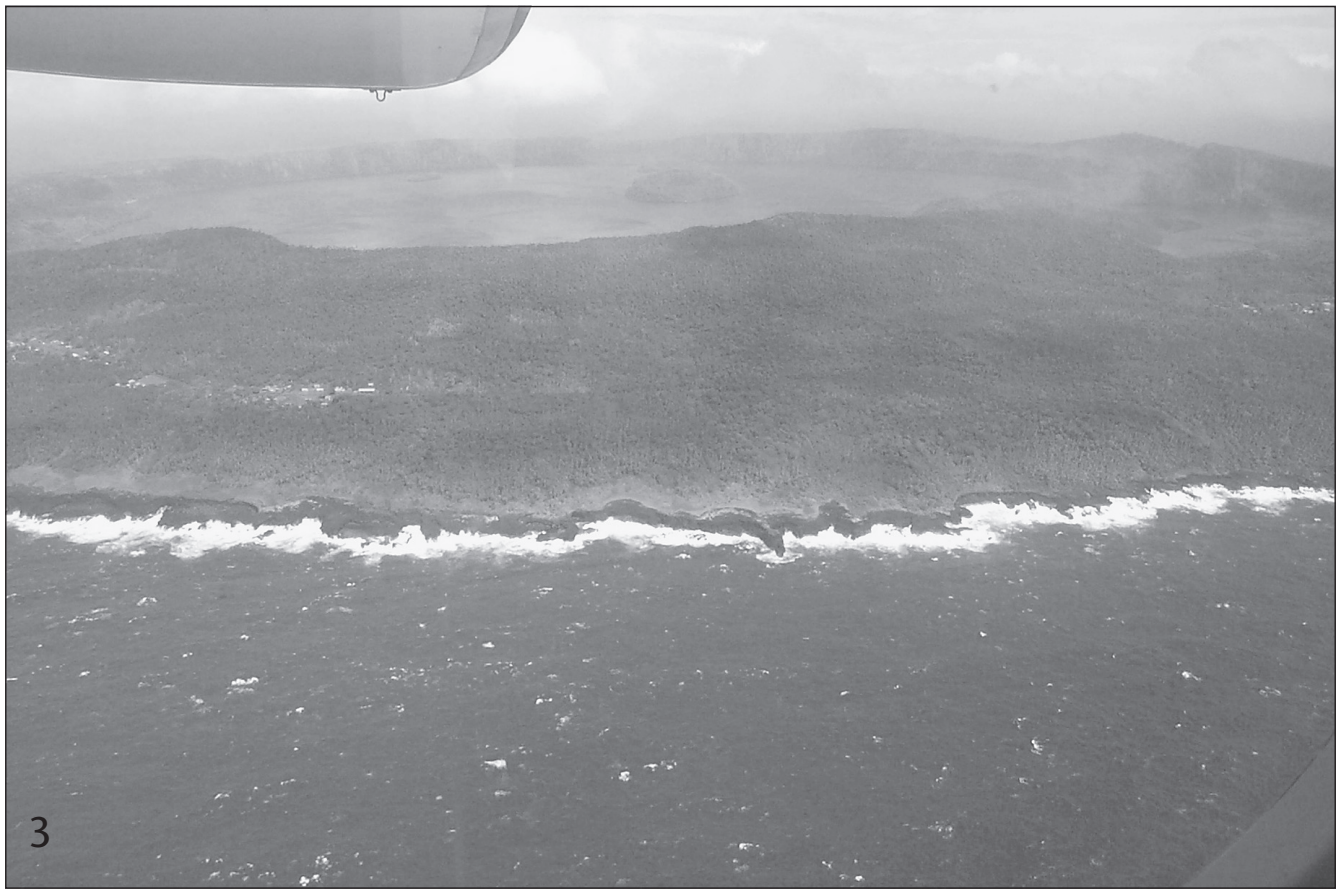
h Evidence in the present of the direction and flow of the lava in the past.

i It will take hundreds of years for the edge of this lava flow to develop a soil layer that is suitable for plants (like the ones next to it) to grow in.

k Small islands in the caldera.


1


2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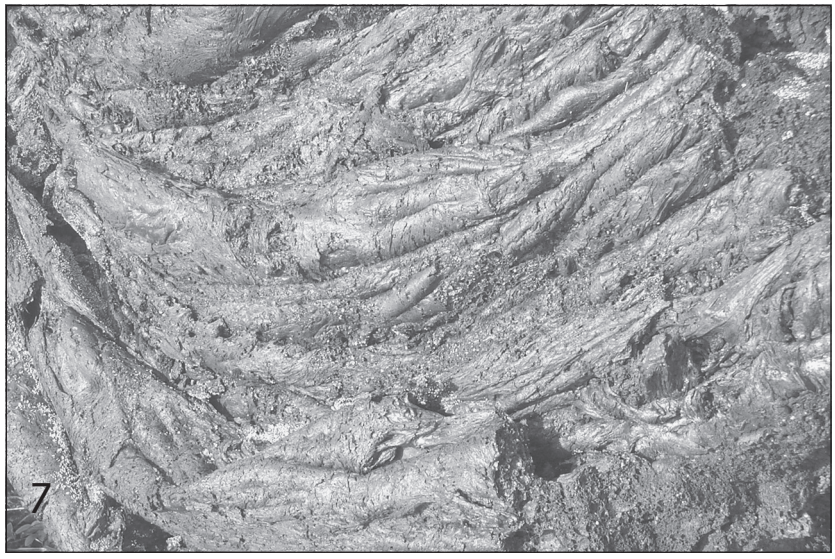
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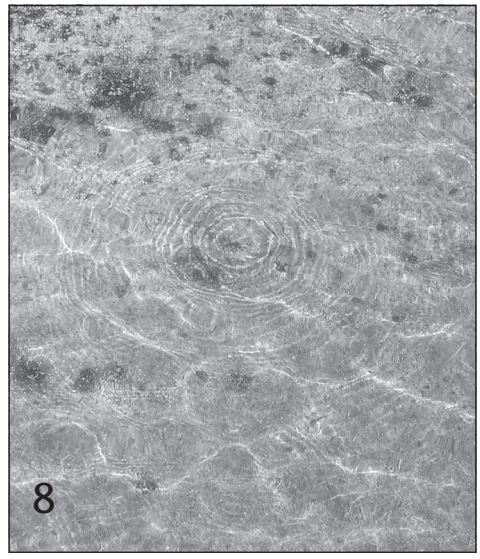
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Volcanic Profile: Niuafo'ou

Country	Tonga
Sub-region	Tonga Islands
Volcano Number	0403–11 =
Volcano type	Shield Volcano
Volcano Status	Historical
Last known eruption	1985
Summit elevation	260 m
Latitude	15.60 degrees S
Longitude	175.63 degress W
General Description	Niuafo'ou ('Tin Can Island') is a low, 8-km-wide island that forms the summit of a largely submerged basaltic shield volcano. Niuafo'ou is an isolated volcanic island in the north central Lau Basin about 170 km west of the northern end of the Tofua volcanic arc. The circular island encloses a 5-km-wide caldera that is mostly filled by a lake whose bottom extends to below sea level. The inner walls of the caldera drop sharply to the caldera lake, named Big Lake (or Vai Lahi), which contains several small islands and pyroclastic cones on its NE shore.
Geological History	Historical eruptions, mostly from circumferential fissures on the west-to-south side of the island, have been recorded since 1814 and have often damaged villages on this small ring-shaped island. A major eruption at Niuafo'ou in 1946 forced evacuation of most of its 1200 inhabitants.

Source: Smithsonian Institution, Global Volcanism Program.

Niuafo'ou has been an active volcano for thousands of years. It is a most unusual volcano because there have been two types of eruptions.

1. Explosions from the craters in the caldera produce magma. This is surface material carried down by subduction and re-melted.
2. Lava flows from long cracks in the outer slopes are deep mantle material pushing up.

In 1853 the village of 'Ahau was destroyed, killing 25 people. Lava flows from eruptions in 1912 and 1929 destroyed all bush and gardens on the western slopes and the village of Futu, and cut off the harbour. There were eruptions in 1935, 1936, and 1943. But the most violent eruption was in 1946.

Sister Mary Julia, of the Catholic Mission at Angaha, wrote this description in 1946:

> The tragic event occurred on Monday, September 9th at 7:30 p.m. after an hour of earth tremors and quakes and shakes. We had counted 27 really good ones.
>
> Father was making kava on his verandah with a few natives who, looking towards Piu and 'Ahau where the 1943 eruption had occurred, unanimously declared that there was no danger. Had they glanced northward and noticed how the sky looked over the rocky coast, they would have let the kava bowl drop down at once.
>
> A crash and a boom-boom was heard behind the house towards the sea. All the while the 'atomic bombs' were popping out at a distance. The noise of the sea, the detonations from the rocky coast – all were deafening.
>
> We went to our rooms and got busy pulling a mat from the bed . . . A blanket . . . all was tumbling down in the rush. While we were packing, the heat was getting to be unbearable. The fire had jumped and was running our way. There was no time to lose or we would be buried alive.
>
> When we passed the corner of the church, I happened to turn my head towards the landing. What I saw was enough to turn anyone into an icy ball . . . A pillar of fire and clouds of smoke with pieces of fire bouncing up and falling on every side. All seemed to be running full speed towards us.
>
> Lightning flashed and muttering thunder sounded through the air and continually grew louder. The atmosphere was heavy with the odour of sulphur – a mouthful swallowed while jumping over the fence was choking me. We followed Taipaleti up and up the steep, sheer perpendicular slope, as difficult to climb as a coconut tree.
>
> Next morning from Piu heights we had a view of the village of Angaha. Horrible to see – the town had turned into a lava field. The radio station – no trace of it! The post office was a belching crater; the postmaster's house a piece of molten lava. Copra sheds were burning slowly. Where was the Government school? – gone too under the piled-up lava. Scattered along the coast from Pulei to Kekei were craters shaped like Christmas puddings, fire and steam still puffing out of them. But miracle of miracles, the Catholic Church was still standing untouched, surrounded by craters and smoking lava fields.
>
> We ventured into the town to try to rescue our belongings, walking stealthily and in great trepidation, fearing at every step to disappear into one of those wide-open fiery mouths belching on every side. At every detonation the earth opened somewhere. I paused in front of the church.
>
> Suddenly, a deafening noise and a stream of red, overwhelming fumes spewed in the air. Behind the church another crash was heard and the ground opened at my feet. We were in real danger.
>
> That memorable night of 10th of September was to be still worse than the night before. Up on the heights of Piu we all slept on mats on the ground.

(cont.)

All of a sudden there was a noise like half a dozen cannon roaring at the same time and then monster volcanoes buried under the sea began to pour out tons and tons of red-hot stones, sulphur, and lava. What a sight it was to see fire coming out of the water! A dozen big mouths spitting out fire from midnight until 7 a.m., Wednesday morning. From my ringside seat at the sinister performance, I watched all night.

Source: The Fire Has Jumped *compiled by Garth Rogers in 1987.*

After the eruption of 1946, the government decided that it was too dangerous for people to continue to live on Niuafo'ou, and by December 1946 all 1300 inhabitants were evacuated and resettled on the island of 'Eua. In 1958, the first group of 200 people were allowed to return. In 1985 the island was shaken again, and steam came from the ground over the southwest quarter. But the people have remained.

The volcano seems dead today – but the sand at the lake bottom is 60 degrees Celsius, and the springs in the little inner crater are hot. These show that magma is close to the surface. The *roman* bird uses the heat by laying its eggs in deep holes near the lake edge to hatch in the warm sand (32 degrees Celsius). Volcanic activity is definitely a natural hazard for the people of this island.

Activity 6

Use the photographs and written information about the Niua Islands, and what you have learned about volcanic eruptions to write full answers to the following questions. Make sure you give specific reasons for your answers.

1 Which tectonic processes led to the volcanic activities that built up the islands of Tonga, particularly the northern island of Niuafo'ou?

2 What type of volcano was the one in Niuafo'ou?

3 What type of eruption happened in Niuafo'ou in 1946? Could it have been *explosive* or *effusive*?

4 What type of lava flowed during the eruption? Could it have been *basaltic*, *rhyolitic* or *andesitic*?

5 What were some of the *volcanic products* of the volcanic eruption? (Reminder: give reasons for your answers. Try and use evidence from what you have read and from what you have seen in the photographs).

6 What are examples of the physical features that resulted over time in the environment after the volcanic eruption in 1946.

7 What were some of the effects of this eruption on people? How did people respond?

8 Read Sister Maria's eyewitness account of the eruption carefully. Draw a flow diagram to describe the series of events that she describes.

Revision

Think back to the focusing questions at the beginning of this chapter. Work through each set of activities below to help you to revise and organise what you have learned in this chapter.

Focusing Question 2. Where on a global scale will we find volcanic activity? Why will we find it there?

- ❑ Write sentences to describe the general location of active volcanoes throughout the world. Include at least one named example of an active volcano in each of these areas – South America; North America; Europe; Asia; the Pacific.
- ❑ Draw a sketch map of the world, with the main continents. Locate the volcanoes you have named on this map.
- ❑ What is the core? The mantle? The crust?
- ❑ What is a plate? What is a plate boundary?
- ❑ What are convection currents?
- ❑ What happens in a subduction zone? What is convergence? What is divergence?
- ❑ What is the *Pacific Rim of Fire*?
- ❑ What is a hot spot?

Focusing Question 3. How and why do volcanic eruptions occur? What is the sequence of events for volcanic eruptions?

One way to order the sequence of events when a volcanic eruption occurs is to identify the periods of time when certain events take place . The following list shows one way of doing this:

- ❑ before the eruption
- ❑ immediately before the eruption
- ❑ during the eruption
- ❑ immediately after the eruption
- ❑ two to 10 days after the eruption
- ❑ up to 50 years after the eruption.

Two types of lists or sequences can be developed – using the list of stages or periods of time above. One can be for the sequence of events in the natural environment – and the other can be the sequence of events in the cultural environment.

- ❑ Write two lists (as described above – one for the physical environment and one for the cultural environment) to show the sequence of events for a specific volcanic eruption that you have studied.
- ❑ Write paragraphs to complete this task: 'Describe the sequence of events that occurs during a volcanic eruption'.

Focusing Question 4. How and why are volcanic eruptions a hazard?

- ❑ Write paragraphs to answer this focusing question. You must include specific examples to illustrate or support your answers.

Focusing Question 5. How do people respond to the hazards of volcanic eruptions? What are some of the strategies that scientists and governments have developed to reduce the impact of these hazards, and how effective are they?

- ❑ Think about what it must be like to live in an area in New Zealand, or in Tonga, where a volcanic eruption is a risk, even though there has not been one for many years. Write sentences to describe how people live with such a risk.
- ❑ Copy and complete this chart.

Country or Area	Strategy to Reduce Risk of the Hazard	Its Relative Effectiveness (1 = excellent, 5 = very poor)

Unit 2

Tropical Cyclones

Introduction

Tropical cyclones are extreme natural events that become hazards when the lives and settlements of human beings are affected. Tropical cyclones are like volcanic eruptions – we cannot prevent them. However, the greater knowledge and understanding that we have of tropical cyclones, the more we are able to reduce the effects that tropical cyclones as hazards have on our lives.

Did You Know?

- There are other names for tropical cyclones in different parts of the world.For example, they are called *typhoons* in the Western Pacific; *hurricanes* in the United States and in the Caribbean; *baguios* in South-East Asia close to Indonesia and the Philippines; and *willie willies* in Australia.
- A tropical cyclone is a powerful circular storm with very strong winds. The centre has extremely low air pressure. Winds move in a circular pattern out and away from this centre. In the southern hemisphere, the winds revolve in a clockwise direction. In the northern hemisphere, the winds revolve in an anti-clockwise direction.

These are the focusing questions for this chapter. Keep these in mind as you work through the chapter.

2 Where on a global scale will we find tropical cyclones? Why will we find them there?

3 How and why do tropical cyclones occur? What is the sequence of events for tropical cyclones?

4 How and why are tropical cyclones a hazard?

5 How do people respond to the hazards of tropical cyclones? What are some of the strategies that have been developed to reduce the impact of these hazards, and how effective are they?

Processes Causing Tropical Cyclones

What processes cause tropical cyclones? How often are they hazardous in the South West Pacific?

The processes causing tropical cyclones to be hazardous in the South West Pacific are summarised in Figure 1.2.1.

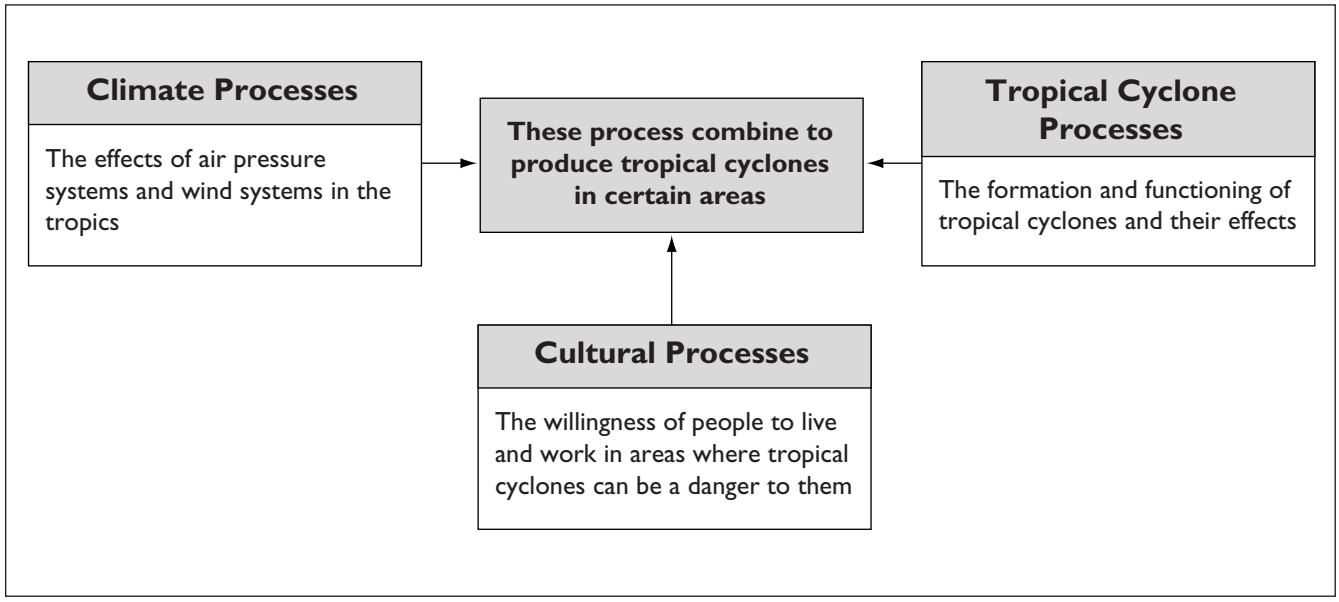


Figure 1.2.1 Processes producing tropical cyclones

Climate processes

Tropical cyclones are *very* low **depressions**. The air pressure is so low that air rushes in towards the centre, creating very strong winds. There is a large low pressure zone at the equator because the sun is overhead (**A**) causing the air to rise (**B**). The air rises into the upper atmosphere (**C**) where it cools and, becoming heavier, descends at latitudes 25°–35° north and south of the equator (**D**). As the air at the equator is rising, air from **sub-tropical** regions is sucked toward the equator to replace it. This movement of air is called the trade winds (**E**). See Figure 1.2.2.

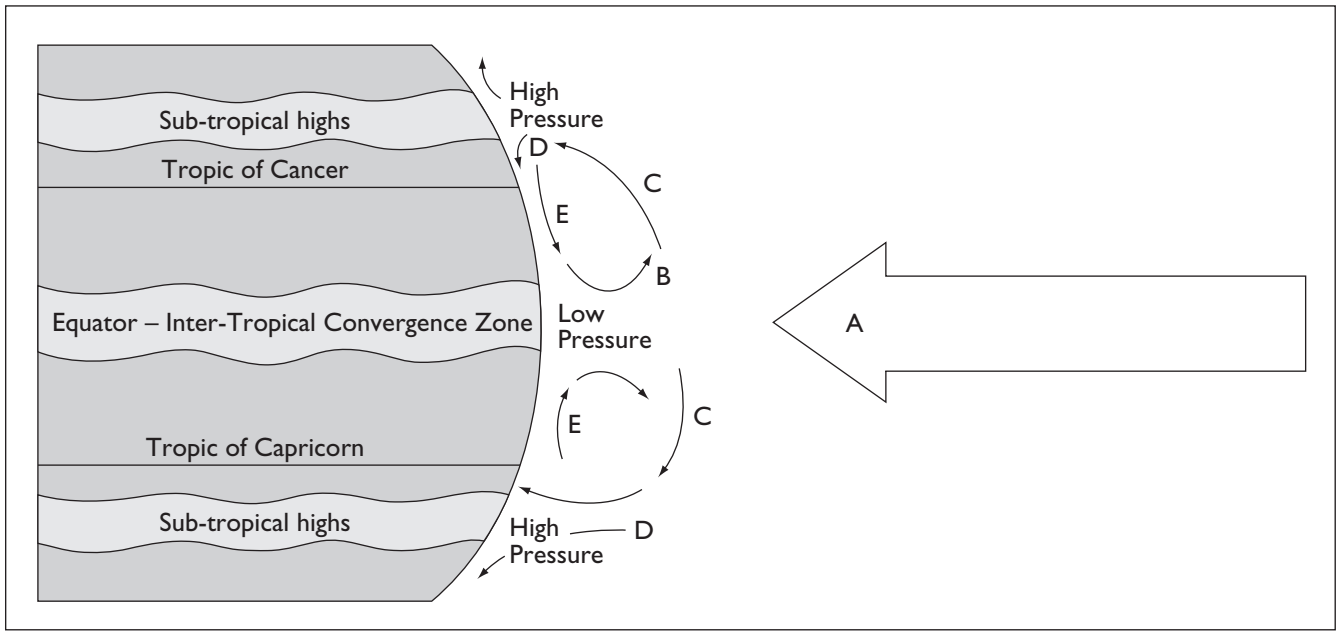


Figure 1.2.2 Air pressure in the tropics

As these winds moving towards the equator meet, rainstorms can occur, similar to frontal rainfall. The places where these form are called Inter-Tropical Convergence Zones (ITCZ) – see Figure 1.2.3.

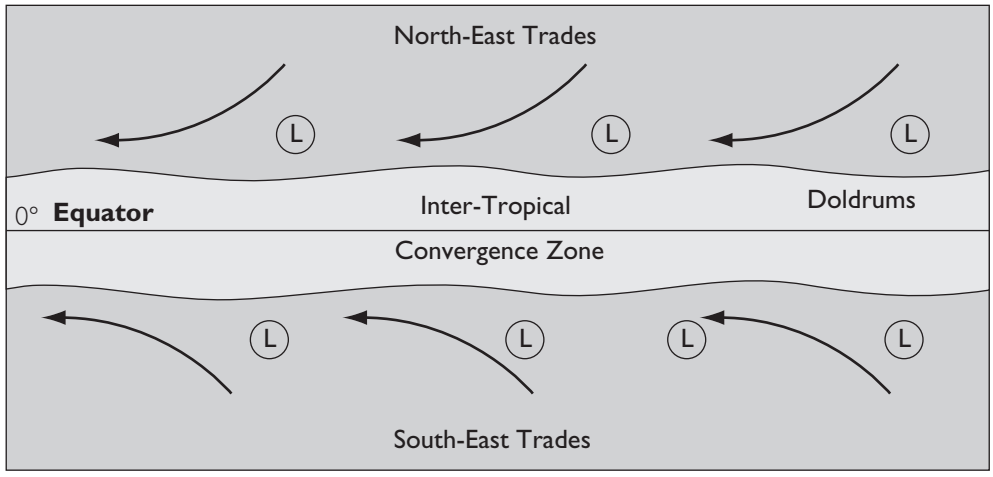


Figure 1.2.3 Inter-tropical convergence zone

The trade winds blowing towards the ITCZ do not blow in a straight line but on an angle from the south-east in the Southern Hemisphere. This is caused by the force of the Earth's rotation which deflects or bends the winds. This is called the **coriolis force**.

The coriolis force is weak at the equator but strong enough at the edge of the ITCZ to spin the winds into low pressure systems. Under special conditions, these can develop into tropical cyclones.

Activity 1

Fill in the gaps in the following sentences using the words listed in the box.

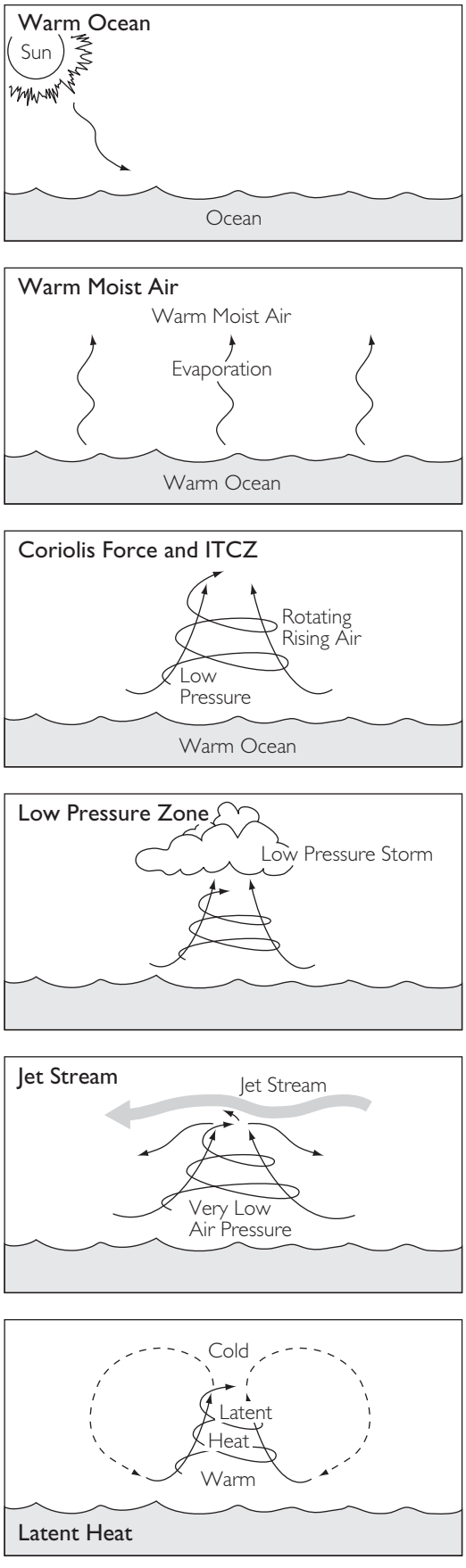
Tropical cyclones, sometimes called _____, are huge storms bringing _____, _____ and _____. They start as _____ pressure systems near the edge of the _____. They form here because the _____ winds converge and are bent by the _____ force to form _____.

rain	typhoons
trade	waves
wind	depressions
coriolis	
ITCZ	
low	

Figure 1.2.3a An aerial view of tropical cyclone damage in Tonga.

Tropical cyclone processes

The combination of features needed to turn a low pressure zone into a tropical cyclone is shown in Figure 1.2.4.



The sun heats the ocean (a minimum water temperature of 26.5°C is needed for tropical cyclones to form).

The warm ocean heats the air above and causes rapid evaporation of water.

The warm, moist air rises and the Coriolis force and ITCZ spin the rising air in a clockwise direction (in the southern hemisphere).

The moist air is sucked in, it rises and cools, condensing and forming clouds and rain.

Jet streams are high speed air currents circling the Earth between 10° and 30° latitude. When a jet stream passes a deep depression (low) it sucks the air out of it causing more air to rush in.

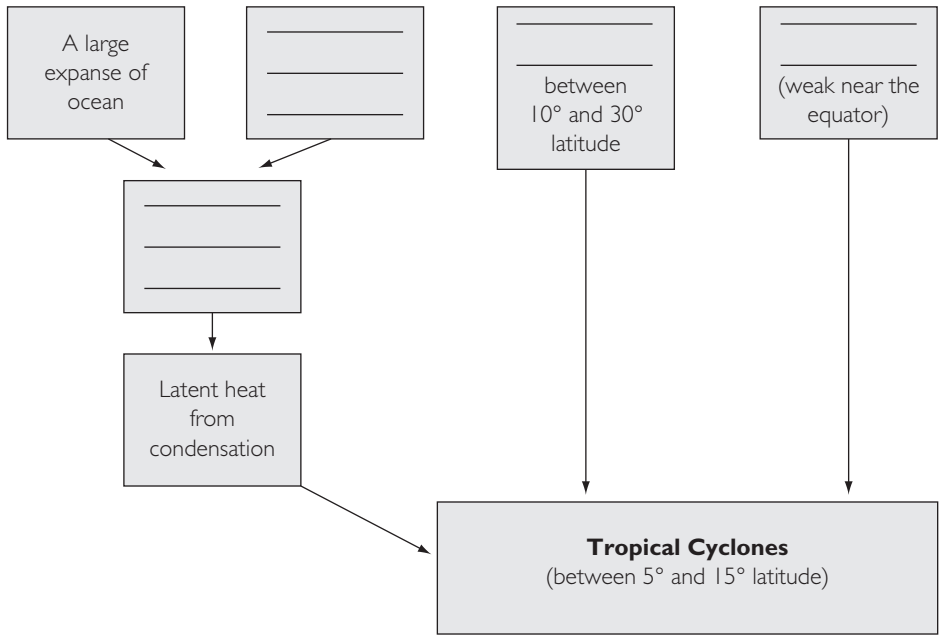
Tropical cyclones depend on a continuous supply of warm, moist air to give them energy. As the warm, moist air condenses, huge amounts of heat (latent heat) are released, keeping the tropical cyclone warm and the wind spiralling.

Figure 1.2.4 Tropical cyclone processes

Figure 1.2.4a Tropical cyclone

Activity 2

1 Referring to Figure 1.2.4 complete the following diagram using the words below.



- ❑ Coriolis force
- ❑ Intense heat of the sun at tropical latitudes
- ❑ Ocean heated at least 26.5°C
- ❑ Jet stream.

2 Write a paragraph stating why tropical cyclones form between latitudes 5°–15°.

3 Warm air rises and cool air descends. With this in mind, look at Figure 1.2.4 (Latent Heat box) and explain how the supply of latent heat can be a continuous cycle.

When and where do tropical cyclones occur in the South West Pacific?

Annual frequency – see Table 1.2.1.

Table 1.2.1 Tropical cyclones 1958–1977

Year	South West Pacific	World Total
1958	7	81
1959	2	69
1960	8	70
1961	4	81
1962	3	78
1963	7	72
1964	4	84
1965	4	79
1966	6	80
1967	8	91
1968	8	84
1969	6	72
1970	3	82
1971	6	97
1972	10	88
1973	8	74
1974	3	74
1975	5	76
1976	9	85
1977	7	67
Total	118	1584
Average	5.9	79.2

Total for one tropical season is attributed to the year in which the season began.

Monthly frequency – see Table 1.2.2.

Table 1.2.2 Monthly frequency (average) in South West Pacific

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2.0	2.0	1.9	0.7	0.1	0.1	-	-	-	-	0.1	0.7

Activity 3

1 Using Table 1.2.1:

- **a** Construct a line graph to show the South West Pacific's statistics
- **b** In what way is the average:
  - ❑ misleading?
  - ❑ helpful?

2 Using Table 1.2.2:

- **a** Construct a bar graph
- **b** In what *season* do most tropical cyclones occur in the South Pacific? Why?

Location – see Figures 1.2.5–1.2.7

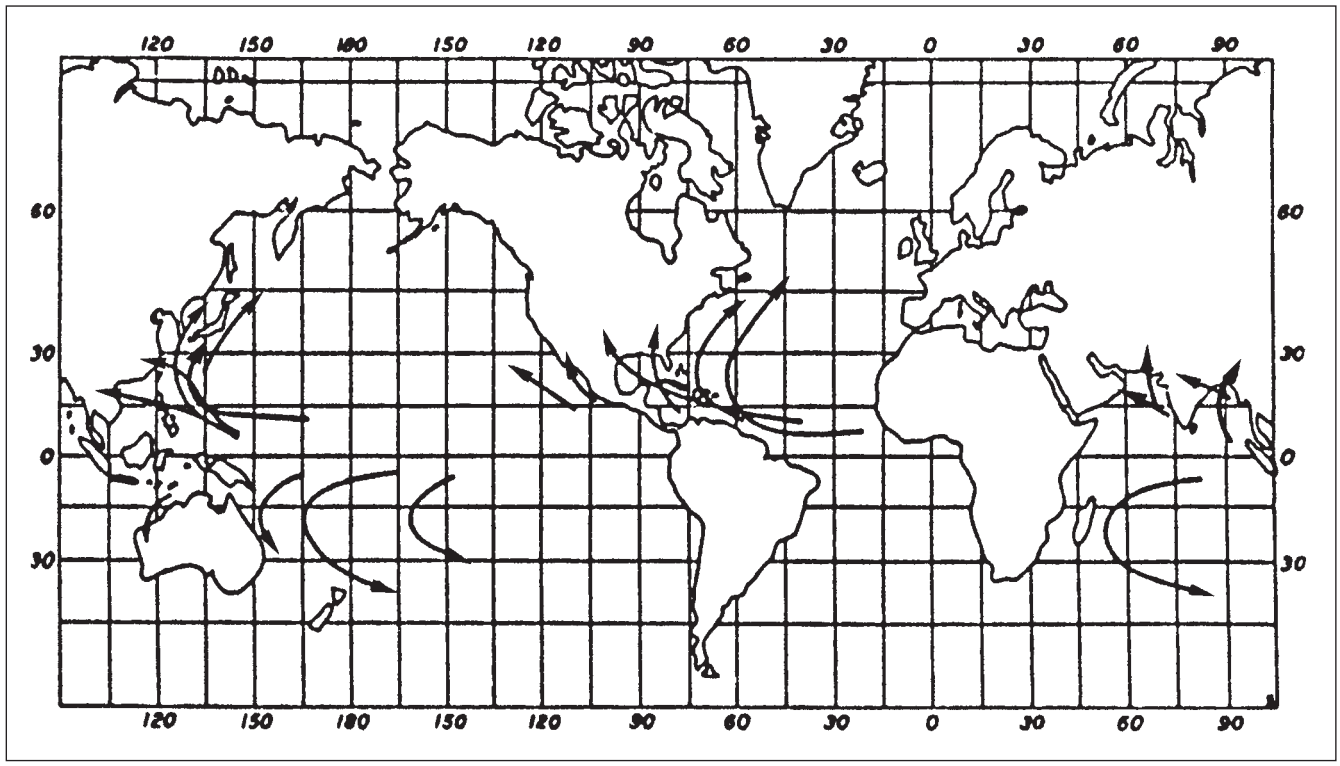


Figure 1.2.5 World pattern of tropical cyclones

Activity 4

Refer to Figure 1.2.5.

- **a** Where do most of the world's tropical cyclones occur?
- **b** Why is this?

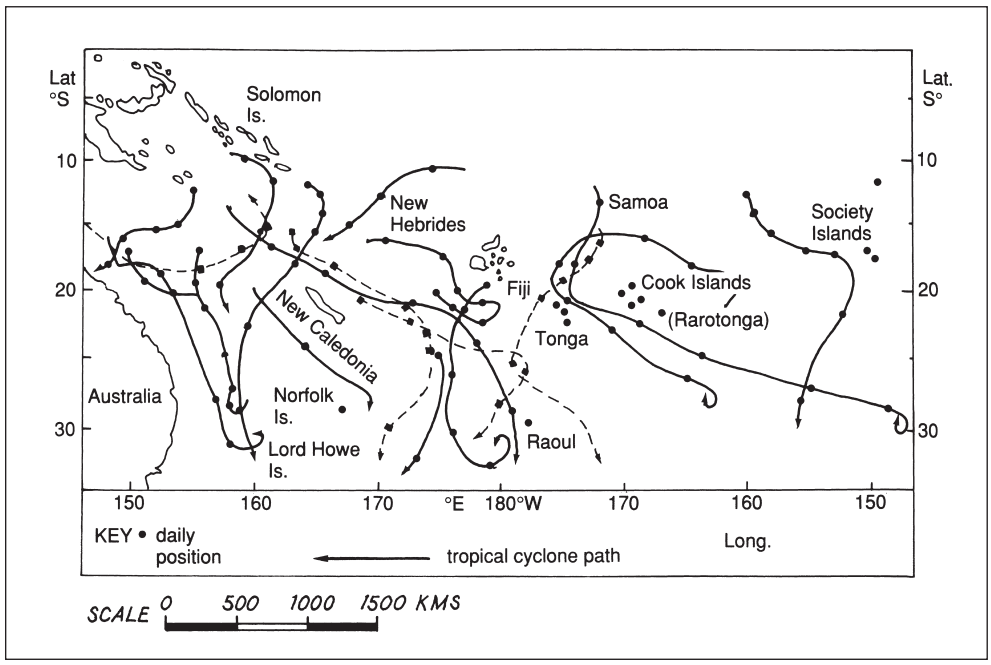


Figure 1.2.6 Tropical cyclones in the South West Pacific (10 year period)

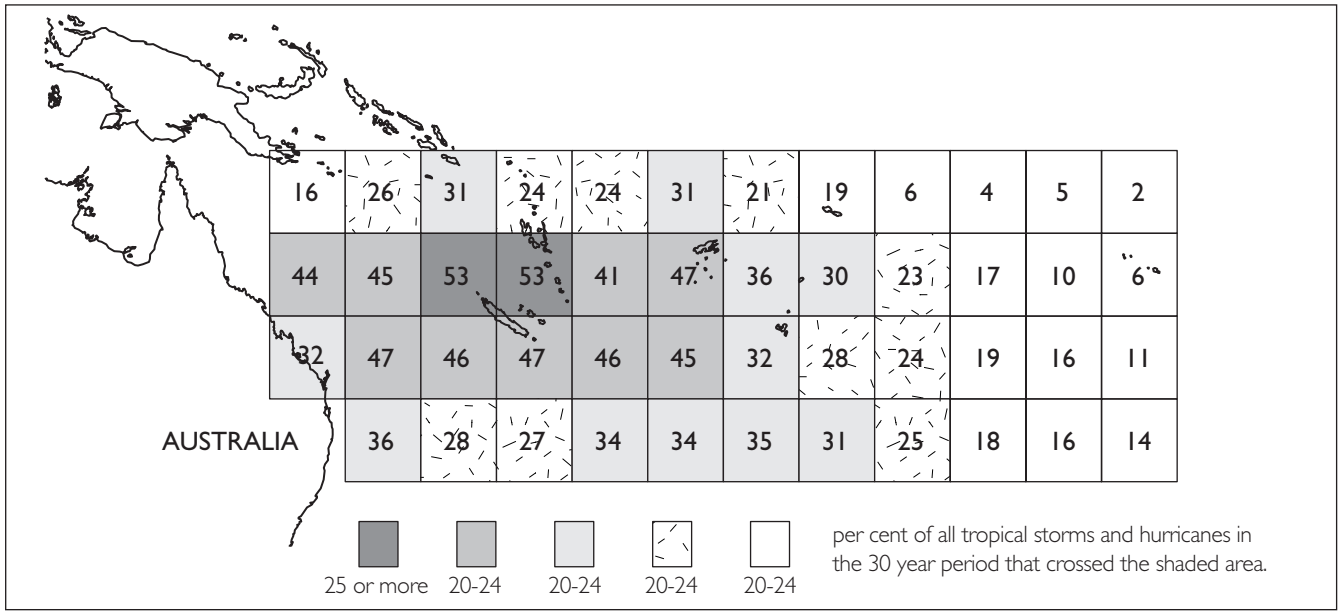


Figure 1.2.7 Number of tropical cyclones that passed through each square (30 year period)

Activity 5

1 Refer to Figure 1.2.6.

- **a** Between which latitudes do most tropical cyclones form?
- **b** What is the average number of days tropical cyclones last for?
- **c** Between which latitudes do most tropical cyclones die out? Why?
- **d** What is the furthest distance travelled by a tropical cyclone in one day? What problems does this pose?
- **e** In what general direction do tropical cyclones travel in the South West Pacific?

2 Using Figure 1.2.7.

- **a** Name the island groups that experience the most tropical cyclones.
- **b** Describe and explain the pattern on the map.

Sequence Of Events

What is the sequence of events when a tropical cyclone is hazardous?

Every tropical cyclone is different in terms of its duration (how long it lasts) and the strength of its force. However, whenever tropical cyclones are hazardous to people, there is a general sequence of events.

Stage 1: Processes on and above the Earth

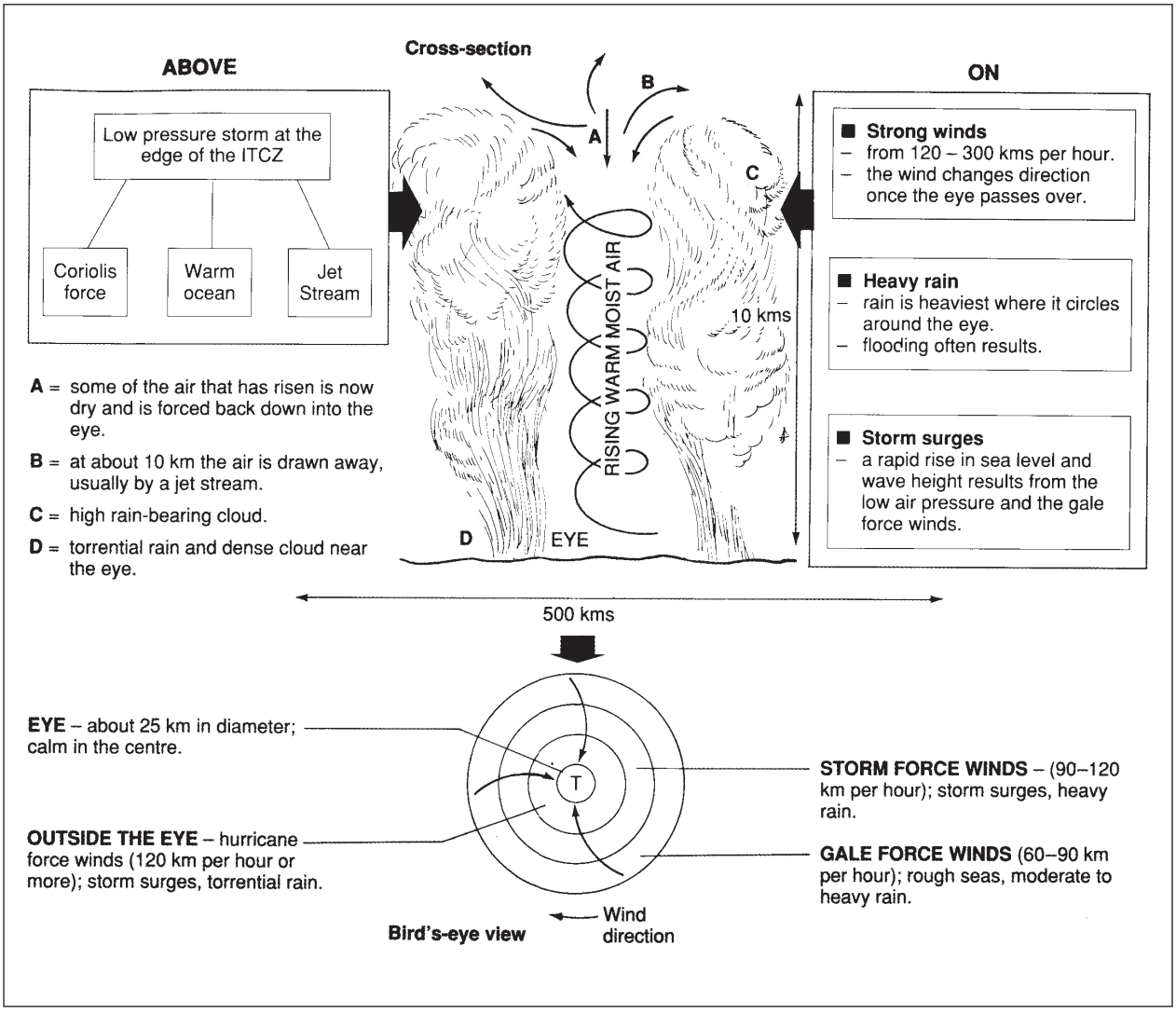


Figure 1.2.8 Sequence of events

Activity 6

Imagine the tropical cyclone above is moving towards an island.

1. In which direction is it likely to be heading? (See also figure 1.2.6.)
2. Why does the wind change to the opposite direction after the eye passes?
3. Draw a flow diagram to show the sequence of events likely to occur:
   - ❑ before the eye arrives
   - ❑ while the eye is overhead
   - ❑ after the eye passes.

Stage 2: Emergency response

- ❑ Meteorologists observe the formation of tropical cyclones by using satellite photographs.
- ❑ Warnings are issued to locations likely to be in the path of the tropical cyclone.
- ❑ Emergency procedures are carried out, for example, staying indoors, listening to the radio, evacuation.
- ❑ The wind, rain and storm surges arrive and then stop as the eye passes over.

Stage 3: After the eye

Winds now come from the opposite direction again bringing heavy rainfall and storm surges. Wind damage and flooding again result. As the tropical cyclone continues its path towards the south-east and into the higher latitudes, the ocean becomes cooler and the cyclone loses its source of energy and becomes a depression once again. The same happens if a cyclone moves over a large land mass such as Australia.

Stage 4: Recovery

As the winds die down and the flood waters recede, the damage can be assessed and the clean-up can begin. Emergency aid (water, food, clothing, temporary housing) is made available and evacuation will occur if necessary.

Stage 5: Rehabilitation

Long-term recovery may take 2–3 years and includes:

- ❑ rebuilding houses, schools, shops and factories
- ❑ repairing damaged transport links (e.g. roads, airports)
- ❑ re-establishing agriculture, industry and the tourist industry.

The process is likely to be slow because Pacific Island nations tend to be small and have only limited resources. What resources they have are concentrated on small islands so that, if an island is hit, a large proportion of its resources will be threatened.

Activity 7

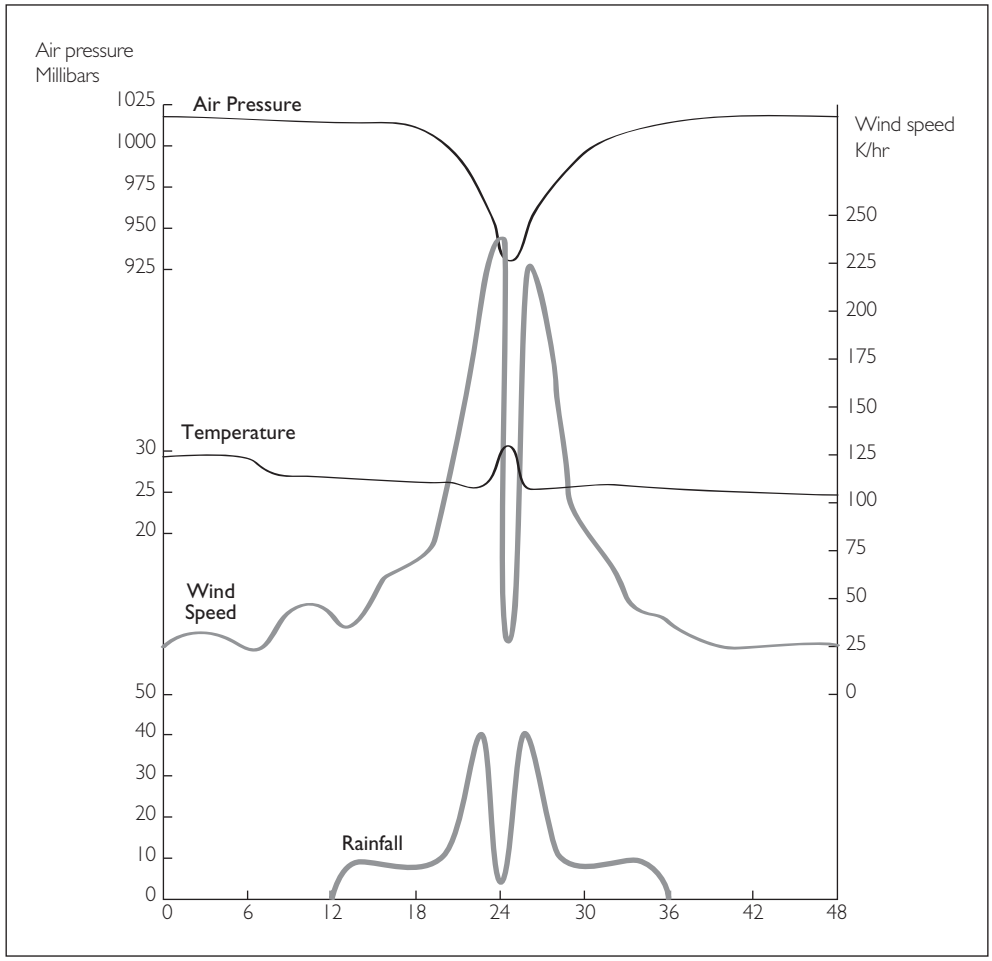


Figure 1.2.9 Weather changes

1 Using Figure 1.2.9 describe the changing weather conditions for each of the time periods below:

- ❑ 0–20 hours
- ❑ 21–28 hours
- ❑ 29–48 hours.

Give each time period a title.

2 Copy Figure 1.2.9 and using numbers indicate on your copy where the five stages in Figure 1.2.8 would fit.

3 How could Figure 1.2.9 help people prepare for a tropical cyclone?

Activity 8

Case Study – Tonga (1982)

Important events during the passage of Cyclone Isaac, which struck Tonga, are summarised below in random order. Read them through and then write them down in the correct order, based on the stages in Figure 1.2.8.

The Tongan government set up the National Office of Disaster Relief and Reconstruction to co-ordinate a two-year reconstruction programme. The main goal was to build 2400 houses. Many of these were to be prefabricated houses with iron roofs, timber frames and concrete foundations. The economy, put back two years, was to be re-established, based on ground crops such as vegetables rather than vulnerable tree crops (bananas and coconuts).

Six people died and houses and crops were devastated (e.g. 95% of houses in the Haʻapai Island group were damaged and 90% of the coconut, banana and breadfruit crops lost). Communications were cut and there was no way of telling the immediate extent of the damage throughout Tonga.

Cyclone Isaac developed about 160 km north-east of Sāmoa and travelled southwest at an average speed of 12 knots. The depression deepened as it moved towards Tonga, producing winds of 160 km per hour and greater.

As the cyclone approached, wind from the north-east hit Tonga's buildings and vegetation. After the eye had passed, the wind changed direction, coming from the south-west and destroying the already weakened buildings, trees and plants.

Five RAAF Hercules from Australia and two RNZAF Hercules from New Zealand flew in with food, tents and medical supplies. Food and shelter were the greatest needs. Some islands remained dependent on aid for two to three months. Villages throughout Tonga used the 'extended family' links to work together for recovery.

Physical Changes

What are the effects of tropical cyclones on the land?

The word 'land' can have a narrow meaning (soil and earth) or a wider meaning (**natural environment**). Here we use the wider meaning and study the **physical** changes resulting from tropical cyclones.

Physical changes

The extent of changes caused by tropical cyclones depends on the type of island affected, the length and energy (force) of each aspect of the tropical cyclone (wind, storm surges, high seas, rainfall). There are two types of island in the Pacific Ocean:

- high islands (volcanic mountainous islands)
- low islands (**coral atolls**).

The different relief features of the two island types create different effects as they are lashed by wind, waves and rain (see Figure 1.2.10).

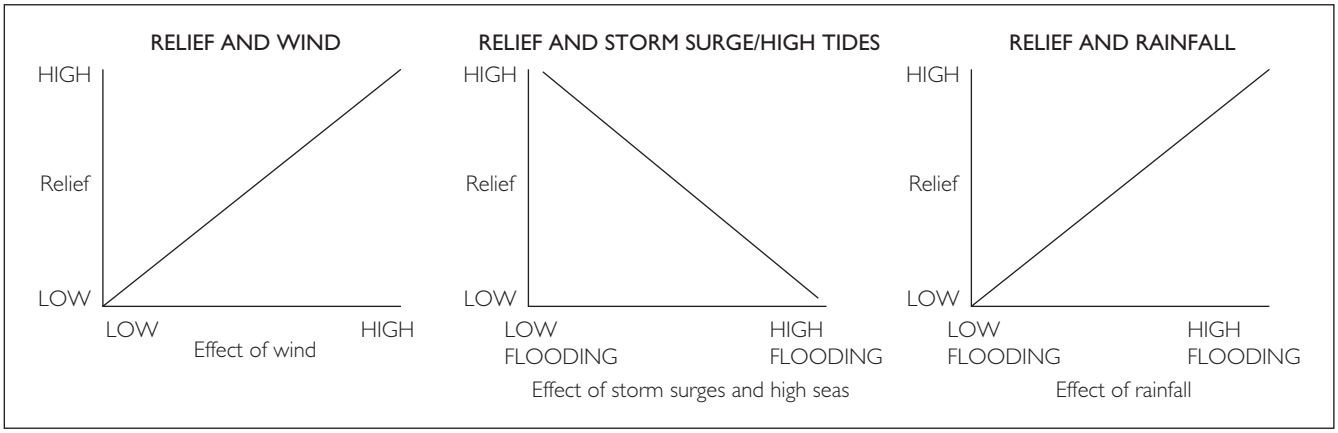


Figure 1.2.10 Physical changes

The effects shown in Figure 1.2.10 on high and low islands are summarised in Figures 1.2.11 and 1.2.12.

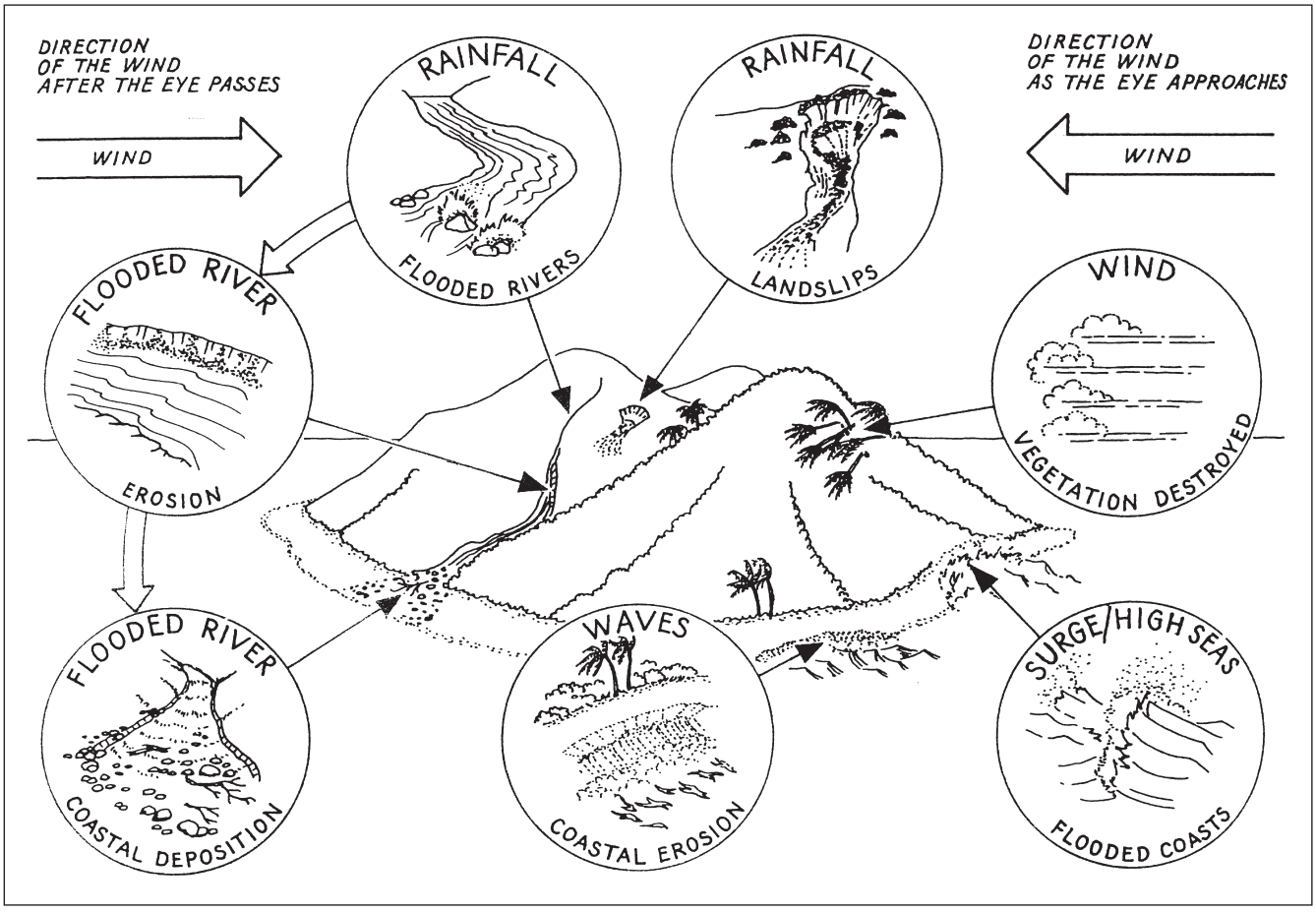


Figure 1.2.11 Effects of tropical cyclones on high islands

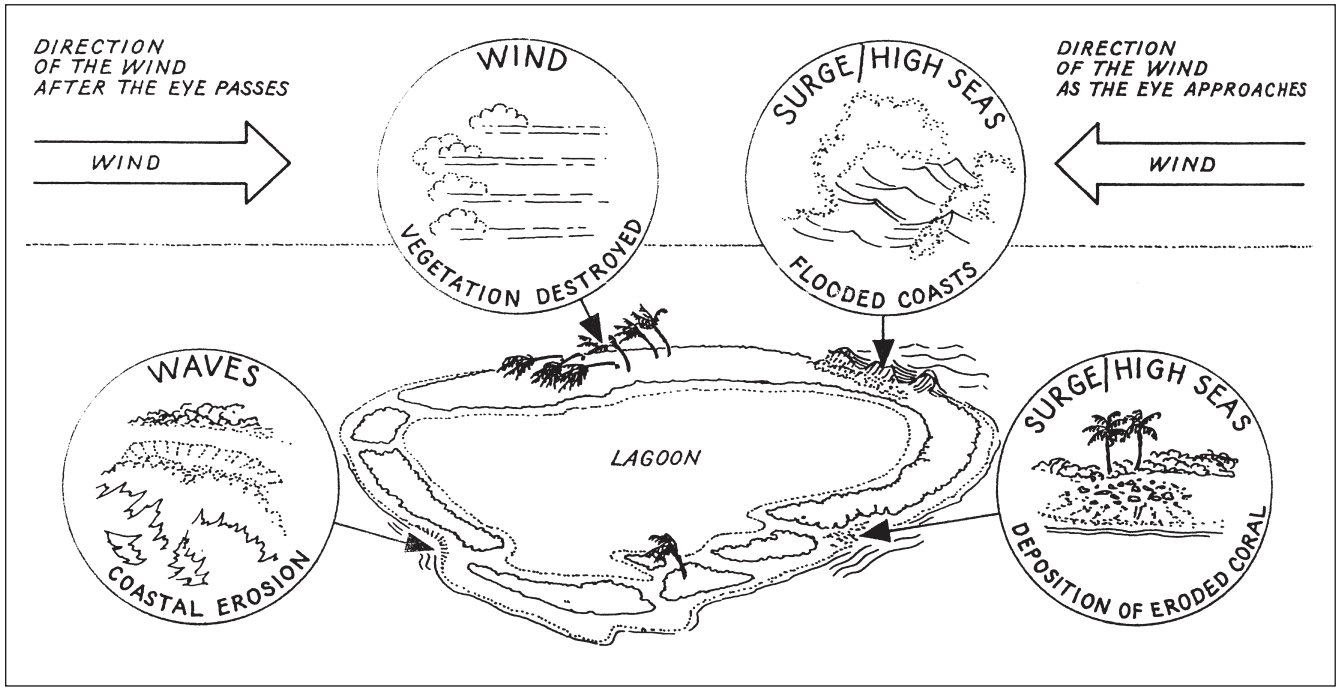


Figure 1.2.12 Effects of tropical cyclones on low islands

Examples

Some of the effects summarised in Figures 1.2.11–1.2.12 are shown in the photographs below.

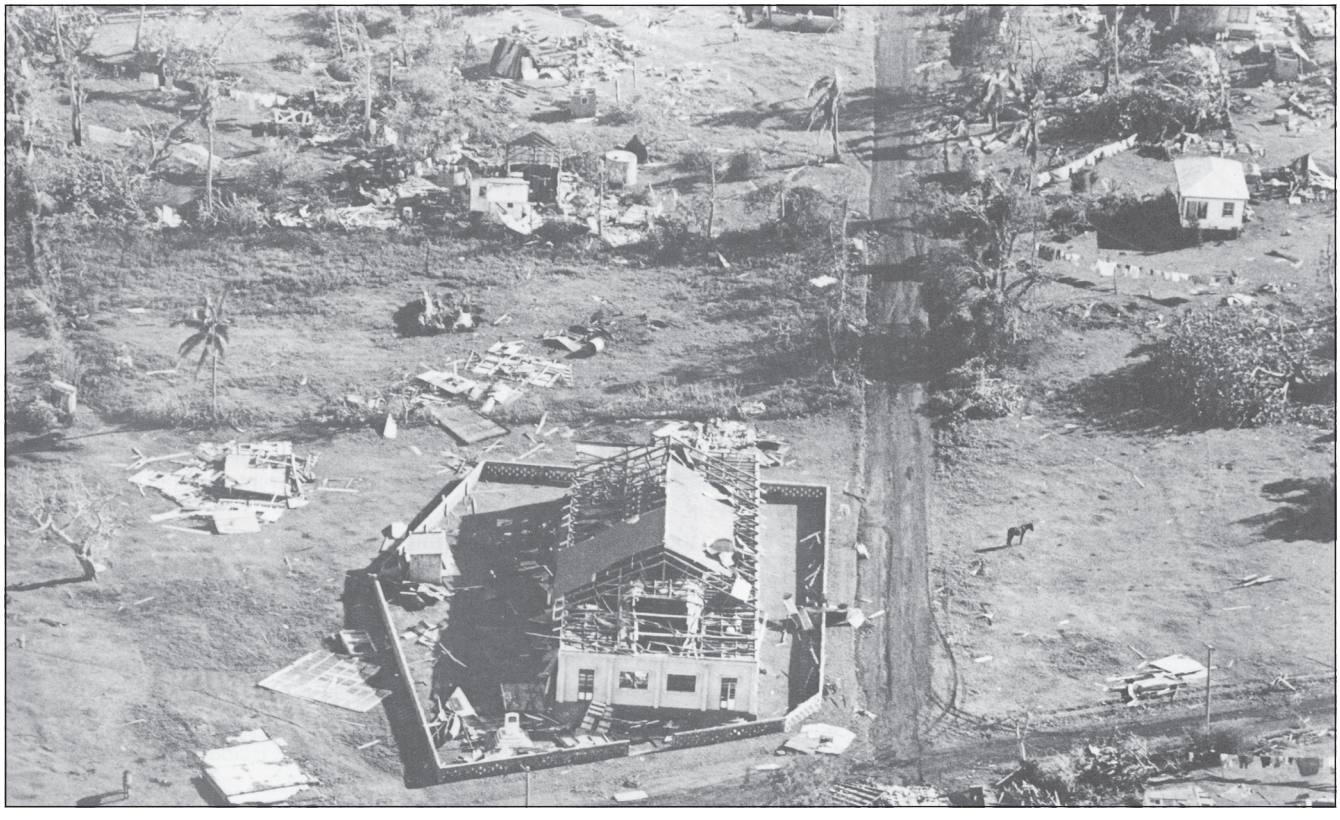


Figure 1.2.13 Tropical cyclone damage in Tonga

Figure 1.2.14 Tropical cyclone damage in Fiji.

Activity 9

1 Add another layer of information to Figure 1.2.8 (Stage 1) that shows the effects of tropical cyclones on the land.

2 Explain the differences in effects resulting from tropical cyclones for high islands compared to low islands using Figures 1.2.10–1.2.12.

Effects On People

How do tropical cyclones affect economic and social activities?

Cyclone damage

Tropical cyclones can threaten human life and property in a number of ways:

wind damage

storm surge →

high seas →

heavy rainfall →

FLOODING

Effects on economic activities

Tropical cyclones have not caused great loss of life in the Pacific Islands, but they have caused extensive damage to property and agriculture and disrupted island economies for years after the event.

Pacific Island nations are mostly **developing** nations. They are very small countries with few **economic** resources. They rely heavily on agricultural exports and tourism for their overseas earnings. A high proportion of the local population relies on **subsistence** agriculture.

A tropical cyclone can destroy an island nation's economy very quickly by wiping out its export crops and tourist facilities. It can also create a high level of dependence on foreign aid if subsistence crops are destroyed.

Figure 1.2.15 summarises how tropical cyclones can affect island economies.

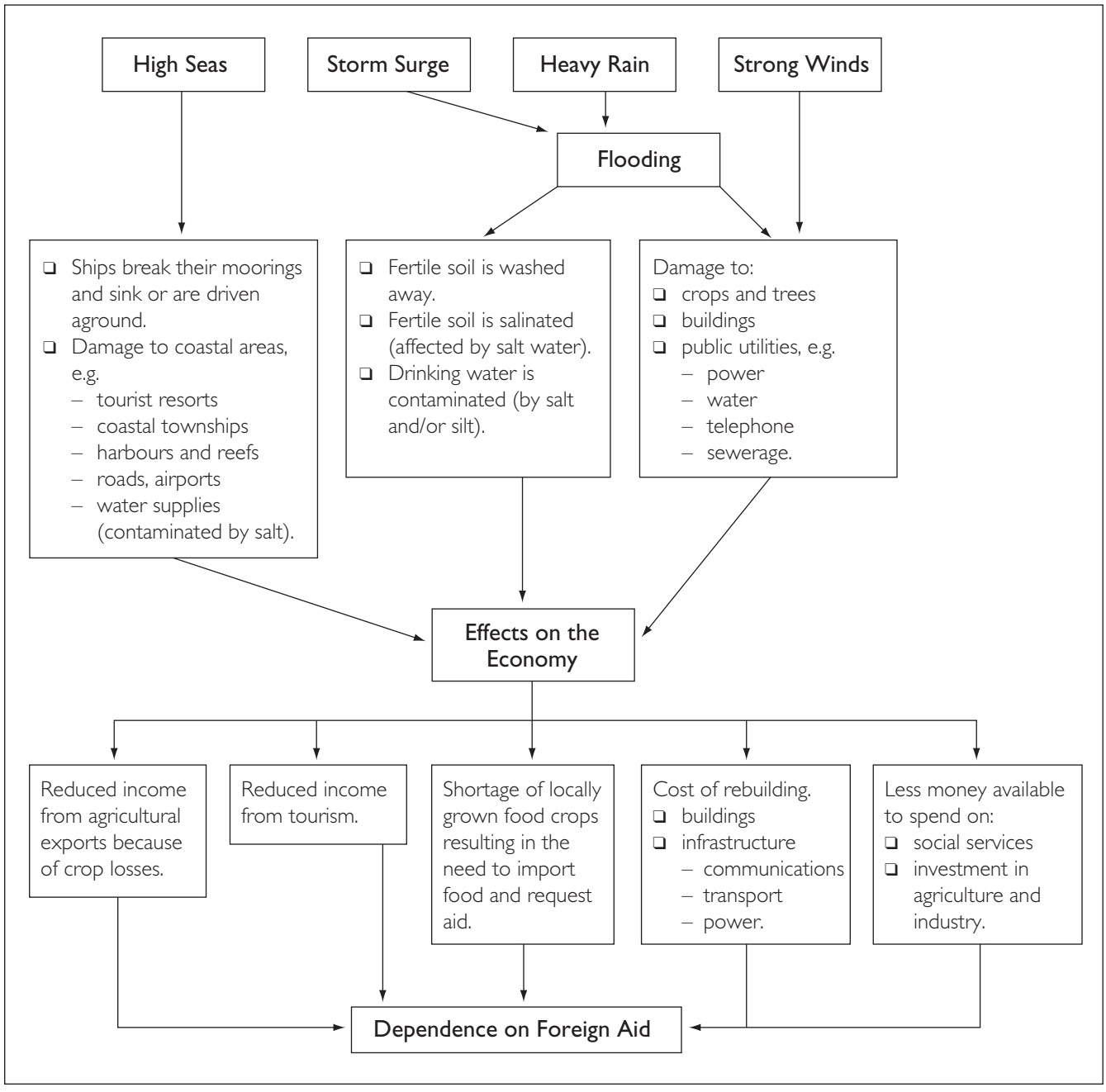


Figure 1.2.15 Economic effects

Activity 10

1 Copy Figures 1.2.11 and 1.2.12 (without the circled information).

2 Add to the drawings examples of the following features:

- **a** farmland
- **b** residential land use, e.g. hotels
- **c** urban areas
- **d** a factory
- **e** transport routes.

3 Add new circles that show possible effects on people as summarised in Figure 1.2.15.

4 Construct a diagram similar to Figure 1.2.15 using the information in Figure 1.2.16.

Production of copra – mainstay of Vanuatu's export trade – is expected to decline as a result of the damage inflicted on coconut plantations by Cyclone Nigel (Jan. 1985).

The storm carved through the main copra-producing region, stripping nuts and fronds off palms and up-rooting up to 25 per cent of the trees in some plantations.

A Government agricultural survey predicts that 1985 production will be down by 30 percent (14 600 tonnes) on the figure for last year, which represented, by value, 84 per cent of total exports.

By mid-year, however, export tonnages were running at a similar level to last year's shipments. Government officials assumed the industry was being sustained temporarily by the windthrow of mature nuts

The same survey revealed a grave situation for subsistence food supplies in some areas, especially South Maewo and North Pentecost, where crop losses as high as 100 per cent were reported. The survey said it would take six months for normal supplies to be restored.

Source: *Development*, Sept 1985.

Figure 1.2.16 Economic effects on Vanuatu

Effects on social activities

Tropical cyclones can cause death, social disruption and mental stress (see Figure 1.2.17).

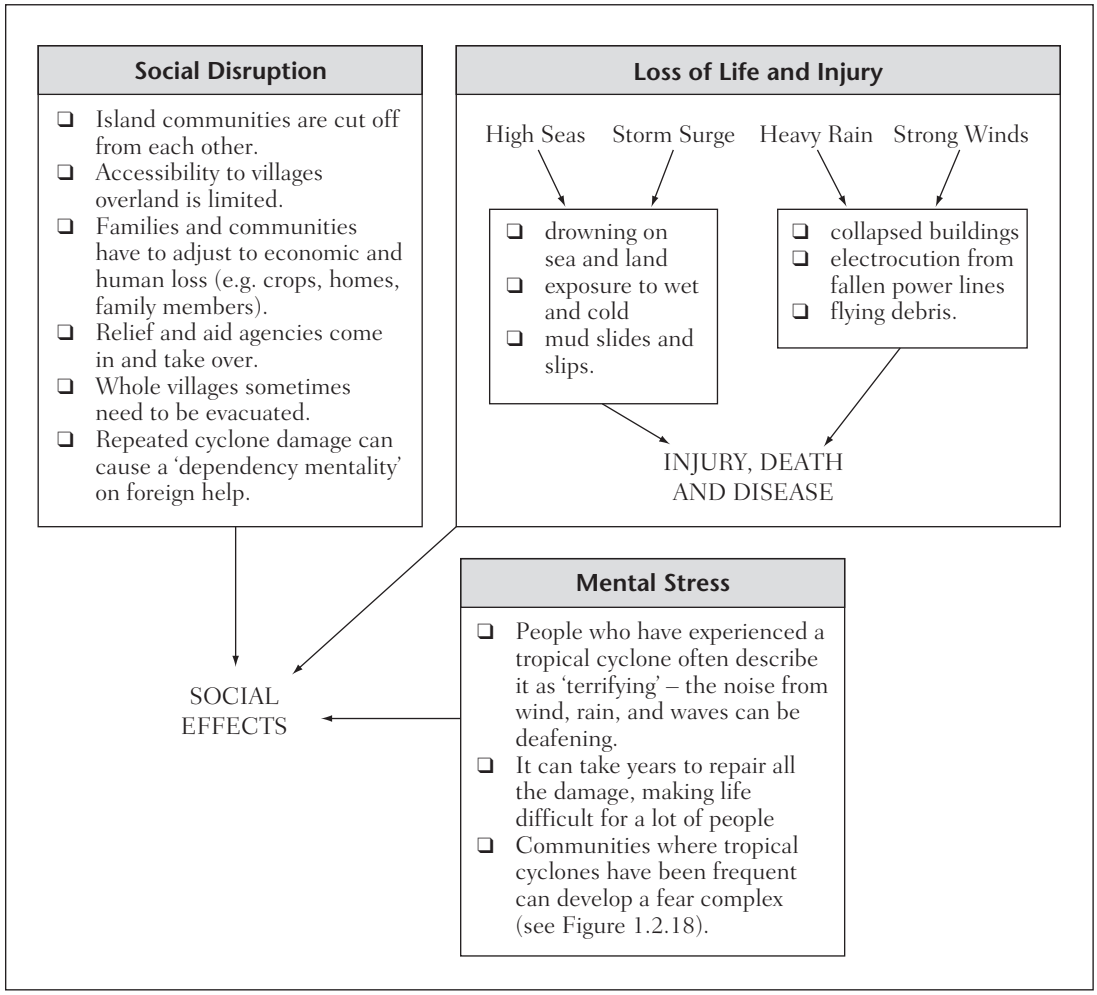


Figure 1.2.17 Effects on people

New Levels of intensity – and terror

Cyclones Eric and Nigel created history in Fiji when they slammed into the western shores of the main island of Viti Levu in January in the space of 48 hours (on 17th and 19th January, 1985).

Such a phenomenon had never been heard of.

Bearing wind speeds greater than those of the notorious Hurricane Bebe in 1972, Eric and Nigel reached peak intensity over Fiji water, having a few days earlier caused havoc in Vanuatu.

Western Division people had experienced cyclones before – at least one a year for the past six years. Indeed, they were still getting over a mauling from Cyclone Oscar in 1983.

But Eric and Nigel struck a new note of terror, especially as many of the evacuation centres – concrete school buildings and churches – had collapsed in the storms.

Where was safe?

A fortnight later, Cyclone Gavin, its centre passing to the south of the main islands, brought torrential rain and flooding. One man was drowned, another electrocuted by fallen power lines.

Then in mid-March Cyclone Hina boomed out of the western ocean. This was a super-cyclone. Forecasters estimated wind speeds of up to 160 knots.

The storm came to within 24 hours' striking distance of the coast when it veered away, and its most violent zone passed to the south.

Hina was the fourth – and last – cyclone of the season.

Its psychological impact was unusually pronounced, given that the population was not unused to nightmare storms.

'In the past', says Emergency Services Committee executive Tom Tuliloma, 'people would tend to stay by their home till the cyclones passed. This year we had people evacuating in large numbers as warnings were issued of an advancing hurricane. They were really frightened.'

Development, September 1985–9

Figure 1.2.18 Effects in Fiji

Activity 11

Using Figure 1.2.18 answer the following questions.

1 How many tropical cyclones affected Fiji in the 1984/85 cyclone season?

2 How does the timing of these cyclones support the data in Table 1.2.2?

3 What was the impact of the 1984/85 cyclone season on the people of Fiji?

Positive and negative effects

Usually tropical cyclones affect people in negative ways. There can be some benefits to people however (see Table 1.2.3). Read the information on page 69 of this book about Cyclone Isaac, (on page 69) and fill in the gaps for Table 1.2.3

Table 1.2.3 Economic and social effects: Tonga 1982

	Positive	**Negative**
Economic	_ building materials _____	_ buildings _____
	_ crops _____	_ economy _____
	_ transport links _____	_ communications _____
Social	_ aid _____	_ deaths _____
	_ community spirit _____	_ isolation _____
	_ Government _____	_ dependence _____

Influence Of People

How can people increase or decrease the likelihood or effects of tropical cyclones being hazardous?

The Likelihood

Figures 1.2.1–1.2.4 show clearly why people have a limited influence on whether or not tropical cyclones will occur. The processes that produce the wind, rain, and high seas are generated *above* the Earth's surface and are therefore completely beyond human control or influence. Whether or not these natural **elements** become hazardous is partly the result of processes *on* the Earth's surface which *can* be influenced by people.

The definition of a natural hazard on page 16 makes it clear that a natural hazard is more than a natural event. People must in some way be endangered for it to be a hazard. The likelihood of tropical cyclones being hazardous to people can be increased by cultural processes (see Figure 1.2.19).

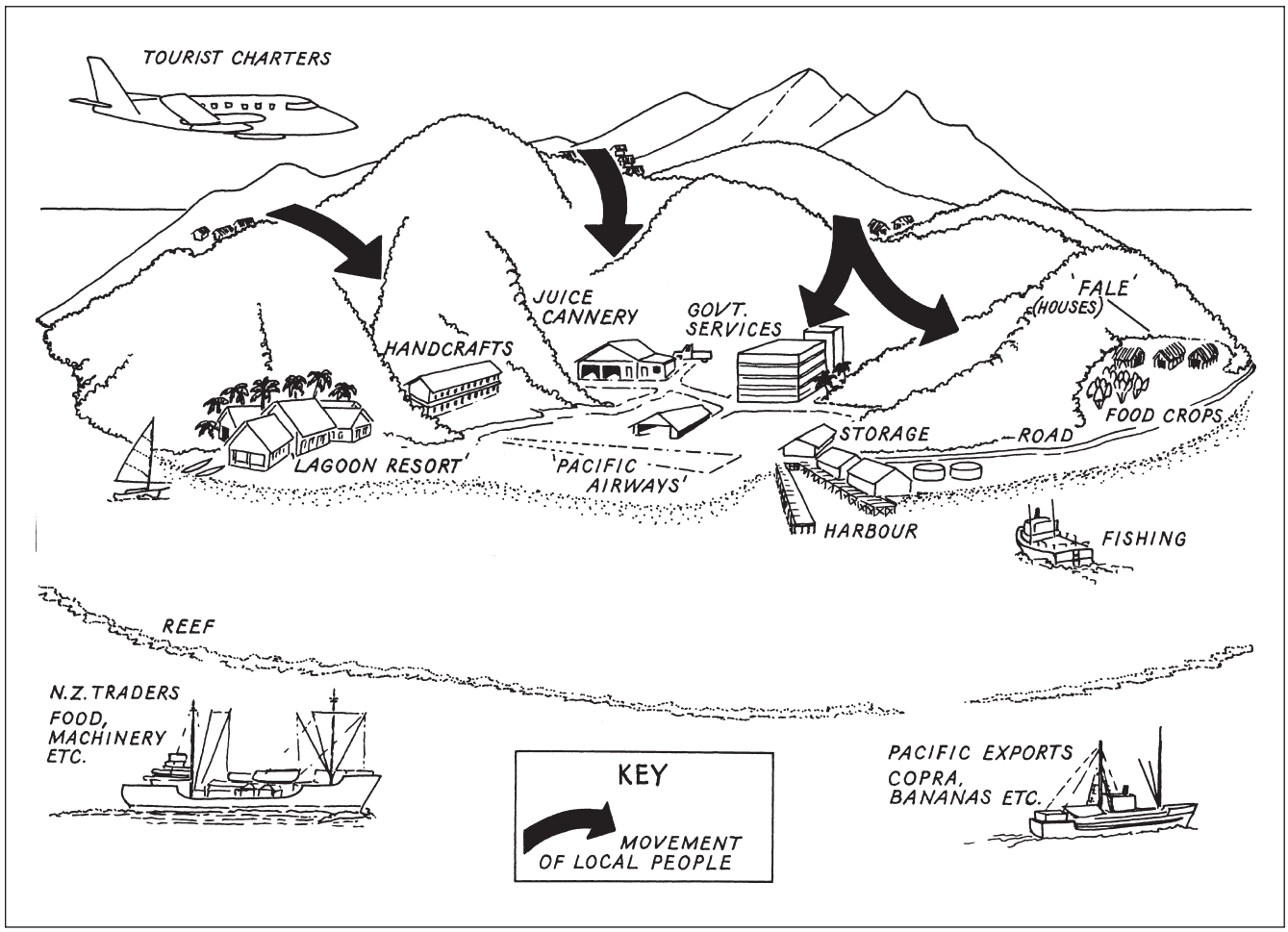


Figure 1.2.19 The coastal concentration on Pacific islands

Since the arrival of Europeans in the Pacific Islands the focus of economic activity and population **distribution** has moved from the scattered villages to coastal urban settlements (see Figure 1.2.19). As a result, flooding in particular is likely to be more hazardous to more people. People can do little about the amount of rain that falls, or the water deposited on beaches by storm surges and high seas, but they can increase the likelihood of these being hazardous by living and working in flood-prone areas.

Activity 12

Based on Figure 1.2.19, construct a flow diagram which starts with

EUROPEAN ARRIVAL

and ends with

INCREASED HAZARD LIKELIHOOD

Increasing the effects

People, by their presence in certain locations, and the decisions they make about the use of these locations, can increase the effects of tropical cyclones (see Figure 1.2.20).

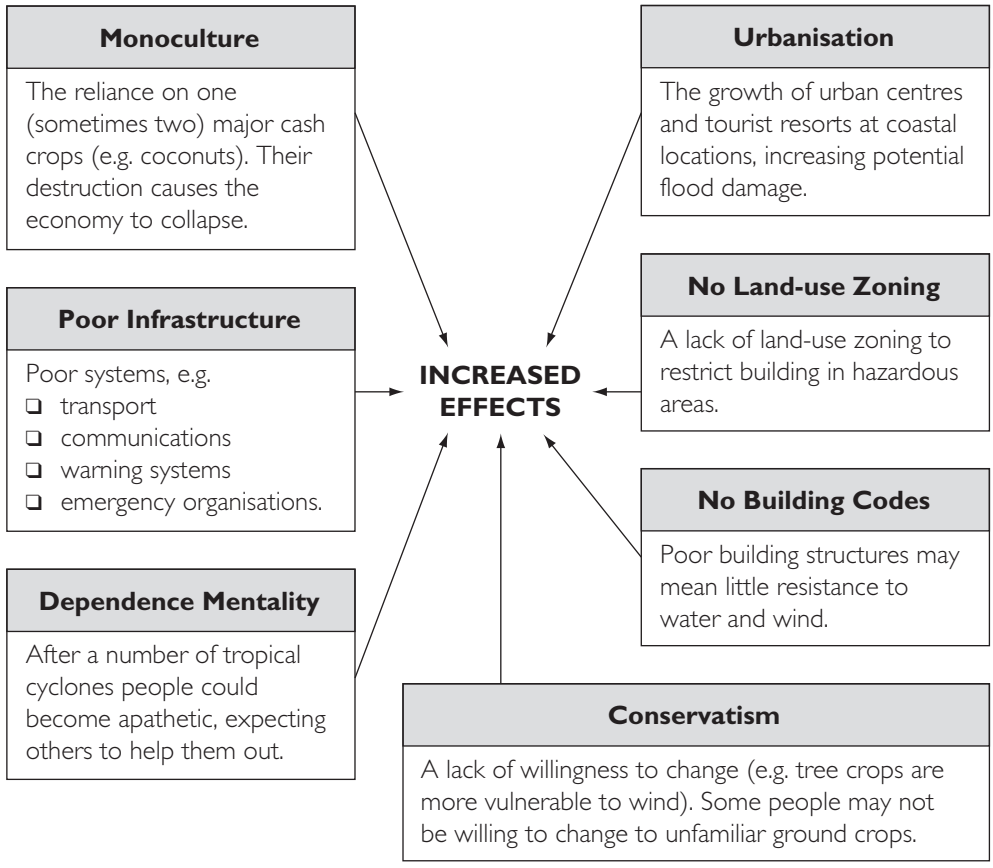


Figure 1.2.20 Increasing the effects

Decreasing the effects

By making certain decisions, people can decrease the effects of tropical cyclones at three stages as the cyclones happen:

- ❑ before the tropical cyclone comes, preparedness (see Figure 1.2.21)
- ❑ as the cyclone threatens and while it rages (see Table 1.2.4)
- ❑ after the cyclone has passed (see Figure 1.2.22).

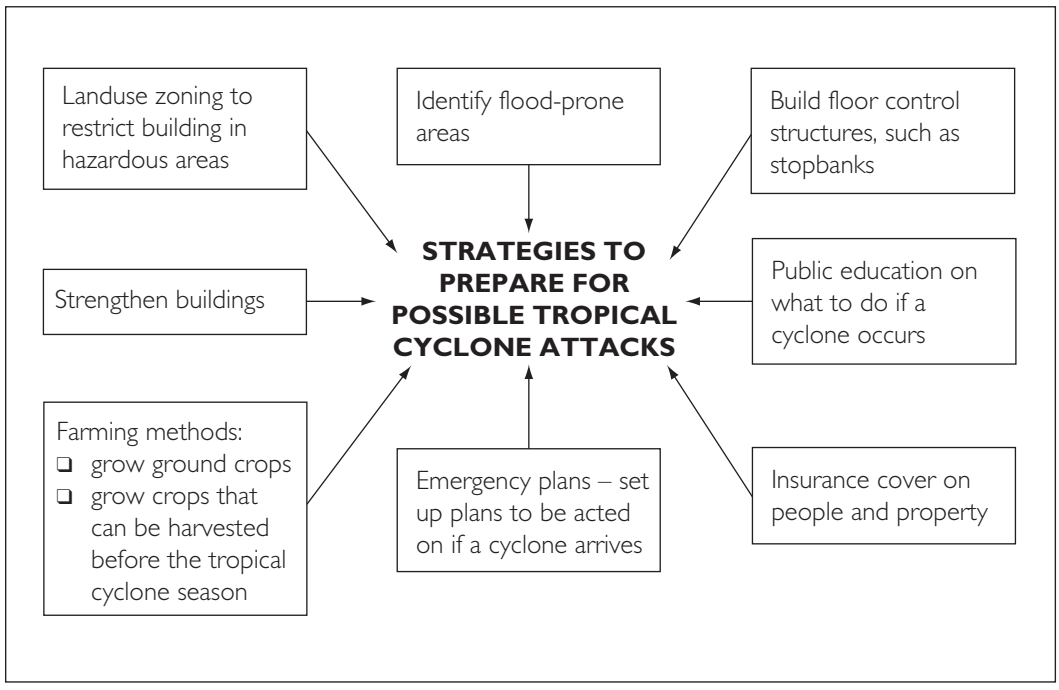


Figure 1.2.21 Being prepared

Activity 13

Reconstruct the information in Figures 1.2.21–1.2.22 and Table 1.2.4 using the structure outlined in stages on pages 66 and 67.

Table 1.2.4 What to do

National Organisation	Individuals
1 Use all available warning systems. **2** Keep the public informed over the radio. **3** Co-ordinate evacuations where needed.	**1** Listen to the radio and follow instructions. **2** Put up hurricane shelters on windows. **3** Secure objects outside. **4** Move boats to safety. **5** Move away from low-lying areas. **6** Stay indoors during the storm.

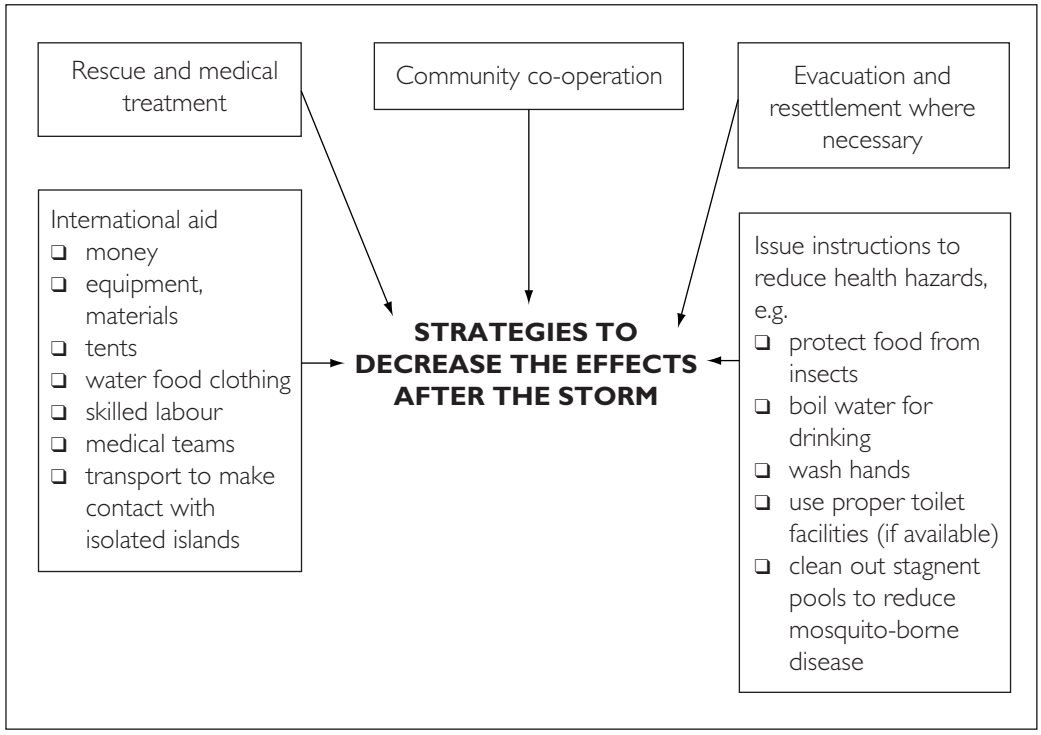


Figure 1.2.22 Reconstruction

Examples – see Figure 1.2.23.

Fiji Learns Hard Way

From bitter experience Fiji knows a lot about hurricane relief and rehabilitation.

Radio plays a critical communications role in any disaster in Fiji.

Radio Fiji's two programmes are linked and the station will stay on the air around the clock (normally it closes down at 11pm on week days and midnight at weekends) to broadcast warnings, advice and 'cheerful music' till the danger has passed.

Resort hotels braced for cyclones

Last year the beach in front of the hotel was built up with extra sand to provide a buffer against storm surge.

Wide response from NZ

Starting with an aerial reconnaissance by an Air Force Orion whose photographs made people gasp as the extent of devastation, New Zealand has provided a wide range of relief and rehabilitation assistance to Tonga.

The Government, churches, voluntary agencies and business sector have all been involved.

Right crops help

Root crops with long ground storage life, such as certain types of taro, can relieve food shortages for island communities of the South Pacific who run the risk of cyclone devastation.

Rebuilding Schools

Schools on the west side of Fiji's main island which suffered major damage in four cyclones in January and March this year, are slowly being rebuilt and re-equipped with New Zealand assistance.

Figure 1.2.23 Newspaper clippings

Case Study – Cyclone Heta, January 2004

Cyclone Heta was a very recent tropical cyclone that affected Pacific nations such as Sāmoa and Niue. It was a very powerful cyclone but, of the two countries, Niue was the worst affected.

Study the following resources carefully.

A

To be alive a miracle for battered family

10.01.2004 by Angela Gregory on Niue, New Zealand Herald

The Mougavalu family have lost the lot. Their car has been tossed up into a tree behind their trashed house, their truck caved in and their possessions are destroyed. The once clipped green lawn draped with palm trees is an uprooted dirt and rock disaster zone.

Like other families along the road just south of Niue's capital, Alofi, they wryly note they now have a stunning sea view, previously hidden behind thick, lush foliage.

Morgan and Ida Mougavalu say their computers, microwave and furniture are destroyed beyond recognition. 'But', says Ida Mougavalu, still crying three days later on the concrete slab outside what was her home, 'just to be alive is a miracle'.

When Cyclone Heta struck on Tuesday afternoon (Monday local time), the family was sitting watching the waves roll in from their front section as they drank coffee. Now they look back and can't understand their complacency, nor that of the police who drove up and down the road telling them they would be all right.

Their house had not been in the direct path of the raging sea, but that was all to change. Suddenly huge waves gained the momentum to rush up the 30 m cliffs and wash away the seaward houses that had offered false security in front of them.

Back inside their home, a monster wave burst in, sweeping up seven-year-old daughter Ancee in its relentless grasp. Thankfully Ida Mougavalu was close by. Her arms at full stretch, she caught her daughter's hand and held on for both their lives. They were finally able to scramble behind the solid water tanks at the back of their house.

From there, with other family members, the Mougavalus sought shelter next door and huddled together in a shed, wrapped in cardboard boxes and tarpaulins for warmth.

Morgan Mougavalu, his legs bandaged from big scratches, yesterday would not return to that spot where, confronted with the invincibility of nature, he was helpless.

Ida Mougavalu was still so shocked yesterday she could not remember how old she was.

The morning after the cyclone, Ancee could talk only of wanting her Nana and her church dress.

Like most of those first affected on that stretch of land, they lived in Government-owned houses. Morgan Mougavalu, a customs agent, had spent a part of last year finishing his studies in Auckland and Ida Mougavalu was employed by a travel agency in Niue.

All Niue's residents are struggling to come to grips with the catastrophic event that has dealt a body blow to the atoll in every way. The economy, health and wealth of the country could take years to recover. The Mougavalus are now wondering if they will stay.

'It's 50/50,' says Morgan Mougavalu, his eyes downcast.

Only 1500 Niueans live on the island, compared with the 20 000 who live in New Zealand. Of those remaining, 200 have now lost their homes and are staying with relatives.

(cont.)

Alofi was the worst hit, with widespread devastation to commercial and residential areas.

Cyclone Heta left one woman dead, her baby with life-threatening injuries and a United Nations worker badly hurt. The hospital is destroyed and medicines ruined, a blow for a population with a high incidence of diabetes.

Fuel tanks have ruptured, water supplies are low and communication cut with the rest of the world, apart from a handful of satellite phones which have taken on taonga status. Power was gradually being restored, although many linesmen are holidaying in New Zealand.

The Niue Government is struggling to deal with the disaster. A lack of local expertise and heavy equipment is also hampering the clean-up.

New Zealand High Commissioner, Sandra Lee Vercoe, said this is a country in which the average wage is $5000 a year, but islanders give more money to their families in New Zealand than the reverse. The time for payback has come. Food imports are expensive and the islanders' crops have been destroyed.

Animals which thrived in the now denuded forest cover are also hungry. Wasps, bats – and soon rats – are coming out of the bush into residential areas looking for food and water. Bees at a local honey centre were 'too angry' to go near.

Many of the scenic coastal caves, the island's tourism selling points, have been destroyed.

AusAid Field Officer Ross Saunders has been driving around the island with Lee Vercoe. He has been coming to Niue for 14 years and could not believe his eyes when he saw the damage for the first time.

'I'm appalled. This makes Cyclone Ofa (which struck in February 1990) look like a baby.'

Half of Hotel Niue ended up in the sea, its swimming pool just a rocky gully. The Parliament Building was perched on a newly formed clifftop and topsoil has been sucked away, leaving a dead, cold landscape.

'It was a green diamond that jumped out of the sea. Now . . . 'Sandra Lee Vercoe trails off.

The island is tinder-dry and a fire risk. The smell of raw sewage is starting to drift on the ocean breezes. Many septic tanks were washed away.

'What do we need?' asks Sandra Lee Vercoe rhetorically. 'We need everything.'

New Zealander Mary Saunders runs a car hire business from Alofi. She lost her office, a 15-seater van and a truck.

At her inland home, as locals took refuge, she had thrown a cyclone party on Tuesday night.

It was a sombre affair as the winds got stronger and stronger. Like her New Zealand motelier friends down the road, no one was insured.

Insurance companies knew it was more than 10 years since Ofa, and another cyclone was due.

B

Battered Sāmoa mops up

07.01.2004 by Angela Gregory and Agencies, New Zealand Herald

Drenched and wind-blown Sāmoa is mopping up after Cyclone Heta swept past the island group on Monday night, leaving many areas without power or water.

But despite the effects of the storm, and the sea surge that caused localised flooding, the island communities escaped serious structural damage from the lashing by heavy rains and strong winds.

(cont.)

A large number of trees and power poles toppled, blocking roads and cutting power and telephones, and a ship ran aground at Apia Harbour.

Apia airport had closed but it was hoped it would re-open at midday today, although strong wind warnings were still in place.

An Air New Zealand spokesman said if the airport opened, the delayed flight NZ60, due to leave Auckland on Saturday evening, would be able to fly out this morning.

He confirmed that several Air New Zealand cabin crew had been stranded at Aggie Greys Hotel since Saturday and would return today if possible.

A telephone message at Polynesian Airlines in Auckland said flights to Sāmoa remained postponed indefinitely, as were inbound flights around the islands.

Communication difficulties in Sāmoa yesterday hindered attempts to obtain details of the extent of the cyclone damage.

Sāmoan Prime Minister Tuilaepa Sailele Malielegaoi had been out inspecting damaged areas around Apia.

A spokesman told the Herald by cellphone from Apia that it was too early to assess costs.

But clean-up operations were running smoothly.

Before the cyclone hit, Mr Malielegaoi led Government ministers to inspect roads, coastal areas and public infrastructure and warned locals to prepare themselves.

The Sāmoan National Disaster Council yesterday reported that some roads on the main island of Upolu had been impassable, and travel out of Apia had been blocked about 10 km to the east and 20 km to the west.

A council spokesman, Poloma Komiti, said huge rocks used for sea walls had been uprooted by the waves and deposited on the roads.

A couple of bridges had also been reported destroyed, he said.

The whole of Upolu was without power on Monday night, apart from essential services such as the hospital, radio forecast offices and the meteorological service office.

Mr Komiti said officials decided at midnight not to continue with reconnections as the weather made this too dangerous.

Yesterday was to be a public holiday to celebrate head of state Malietoa Tanumafili II's 91st birthday, but Mr Komiti said a state function was cancelled and the public holiday revoked.

That move was to ensure essential services were restored. A plea was made to hardware and food delivery shops, gas and purified water suppliers to remain open.

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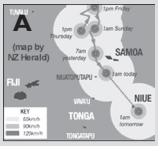
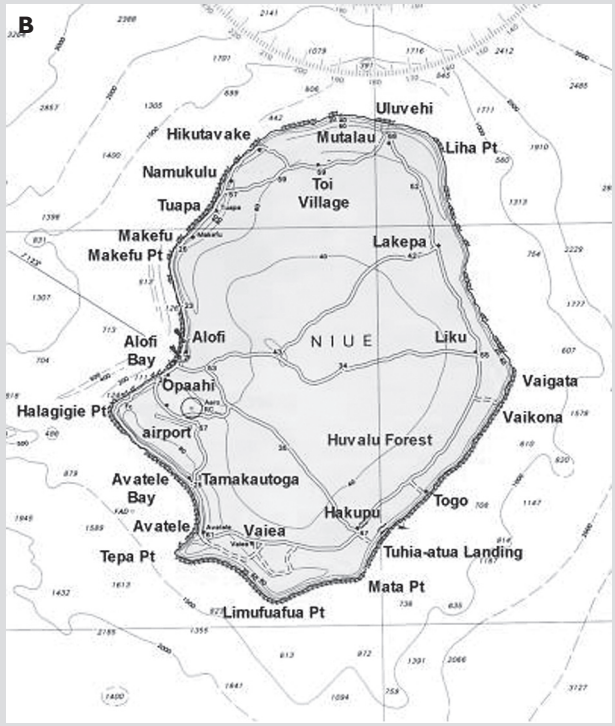


Cyclone Heta wreaks havoc on Niue Island

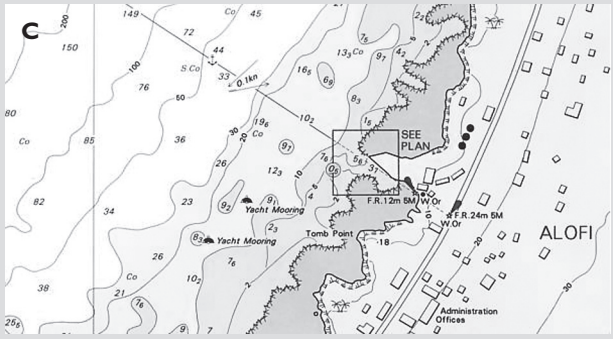
in-depth

by Dr Floor Anthoni, Seafriends Marine Conservation Centre, Leigh.

Cyclone Heta reached hurricane strength on New Year's Day 2004 in a deserted part of the Pacific Ocean. After travelling to the Tokelau Islands it retraced its track, heading for Western Sāmoa where it caused heavy damage. From 4–6 January it headed in a beeline for Niue, passing Niuatoputapu on the way while increasing in strength to the most ferocious storm known to man, a class five hurricane with wind speeds of over 250 km/h. After accelerating its speed to over 300 km/h, it turned its most devastating flank to Niue, destroying the capital village Alofi and killing a nurse who sacrificed her life to save her baby. Why did it cause so much damage to a place accustomed to storms of this nature? This article provides an in-depth account.



Situation Niue is a small independent state on top of a large sleeping volcano rising steeply from a 3000–4000 m deep ocean. Located between Tonga on the west and the Cook Islands further east, it marks the boundary of the paths taken by large tropical cyclones, which are born above warm tropical seas. Niue is only a small limestone island, measuring about 23 by 18 km with a total surface area of 250 km^2. It rises to only 68 m above sea level, with most of the island no higher than 30 m. Its population is estimated at 1400–1800, with around 200–300 tourists enjoying the clear waters, caves and calving humpback whales in winter (Aug-Oct). However, most of the 20 000 Niueans live in Auckland, New Zealand and another 2000 live in Australia. Located 19 degrees south of the equator, Niue experiences regular trade winds from the south-east, which render the coast of this part of the island inhospitable. Understandably, the north-west side of the island is more sheltered, a reason why most of its population and tourist activities reside here, and goods are landed here by ship. But this is also the side facing the path of cyclones and their most vicious winds.



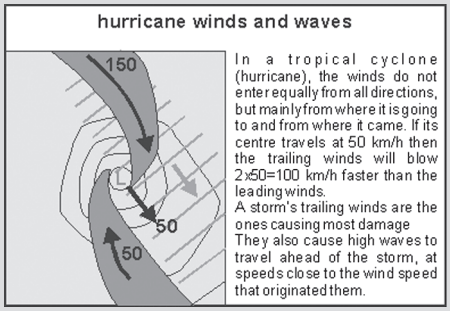
This nautical chart of Alofi and the sea (above, C) shows the centre of Alofi with buildings between the 30 m and 10 m height contours. Niue does not have a protected harbour but a shallow quay, approached by boats along the line joining two navigational lights. Locally based boats and fishing vessels need to be lifted out of the water when storms rage. Note the blue intertidal coral reefs are fringed by a shallow platform sloping from 10 to 20 m. This coral and coral sand platform dips suddenly to 30 m as the available light becomes insufficient for coral growth.

(cont.)

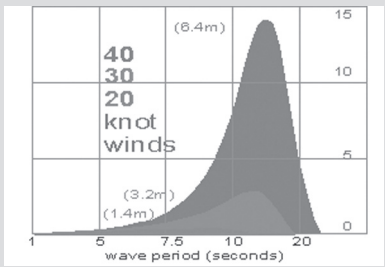
C

Tropical Cyclones

Tropical cyclones (hurricanes, typhoons) are spiralling winds which move towards a centre of low pressure. Ironically, they are spawned above warm seas in still wind conditions. The energy contained in water vapour rises, causing updrafts but at the height where the temperature drops as the air expands, the water vapour condenses to form very small droplets as cloud. These clog together to form rain, which causes a down draft. The circular rings of updrafts and downdrafts then form a powerful motor (impulse that causes movement) for drawing air from far around towards its centre, and a tropical cyclone is born. Over several days above a warm sea, such a hurricane can increase its size and strength to monstrous proportions. Likewise, hurricanes lose their strength over land or over cold seas, and as they die, they produce torrential rains.



The winds around a hurricane do not blow equally fast from all directions, and neither are the waves underneath such a rotating storm of similar magnitude (size and force). As a cyclone wanders, its centre may attain speeds of 20–50 km/h. Winds coming from behind then have to catch up with the cyclone's centre, so that they are more powerful than those coming towards it. The waves produced by the trailing winds are as a result much more powerful such that a hurricane's left flank (in the southern hemisphere) is the most damaging one. As cyclone Heta passed 70 km west of Niue, it presented its most devastating flank to the island. Should a hurricane pass straight overhead, you would experience first a wind from the right, then a period of calm (its centre) followed by winds from the left. The sea directly in front of a tropical cyclone is whipped up one way, to be neutralised by opposing winds once the tropical cyclone passes. It is the best place to be.



A property of waves is that their energy increases rapidly with wind speed, after a period of exposure. The diagram here shows the energy spectra of waves caused by 20, 30 and 40 knot winds over a long distance and after at least 24 hours to reach the maximum *sea state*. A 40 knot wind (74 km/h) produces waves 16 times more powerful (2x2x2x2) than a wind of half that speed (20 knot = 37 km/h). By comparison, cyclone Heta had winds of 140 knots (260 km/h) and gusts even stronger. Usually both wind speed and direction keep changing such that the maximum sea state is not frequently attained. Indeed, as the winds around a cyclone flow in all directions, the waves cannot easily reach their maxima, but the fact that cyclone Heta pursued a straight path for almost two days allowed waves in the forward direction to reach unusual heights.

Notice that the wave period of the most devastating waves (the peak) moves from 8 to 13 seconds, and (not shown) the wave lengths of these destructive waves widen as also the waves deepen their effect in the ocean. Cyclone Heta's most damaging waves must have had wave lengths of 400 m between crests, stirring sand down to a depth of almost 200 m.

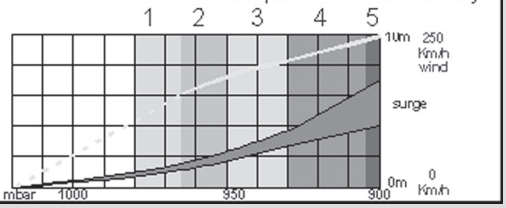
Scientists Saffir and Simpson came up with a hurricane scale which expresses the storm's damaging power in simple numbers, but each step produces twice the damage of the previous one. As one can see, the table stops at class five, which is the worst conceivable storm with waves of 10 m and a storm surge of 4–7 m. A storm surge is a bulge of water produced by the storm's low pressure centre and winds mopping the sea towards it. Notice how the storm surge increases rapidly towards class 5 (darker curve) whereas wind speeds increase more gradually (lighter curve). Together with this diagram, please

(cont.)

read the complete table describing the kind of damage caused and how (un)likely such a storm is. A storm with the strength of cyclone Heta is a once in a thousand years event where hurricanes occur, causing large overwash and extensive damage on a regional scale. In fact it has been reported that 80% of all foliage on the island has been stripped off, which included also crops and fruiting trees. Furthermore all plants have received so much salt spray that their remaining leaves may eventually turn brown and die.

Saffir-Simpson hurricane scale

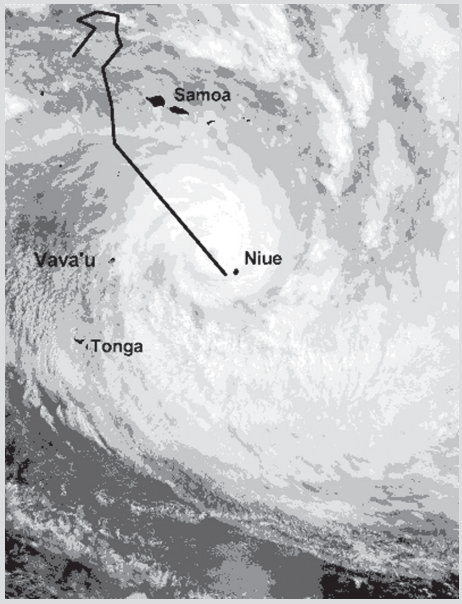
cat	wind km/h	pressure mbar	surge m	potential damage
1	152	>964	1.2-1.5	trees, shrubbery, mobile homes
2	176	>950	1.8-2.4	roofs, mobile homes
3	208	>930	2.7-3.6	trees stripped, buildings damaged
4	248	>905	3.9-5.4	extreme: flooding, major damage
5	>250	<905	>5.4	catastrophic: houses blown away



What is it like?

Experiencing cyclone Heta, as Niue did, is a most frightening experience. There is first the expectation and preparation. After all there was Ofa in 1990, and others in 1960 and 1959, which have taught people how to survive. Windows are battened down and securely shut; movable objects are stored out of the storm's way; antennas are taken down and anything else that may break; people prepare to bunker down in secure places to let the storm take its course. The weather forecast in these remote areas is not very precise because there are no weather stations that produce actual data. The weather station of Niue must have been taken out by the storm, as have all communications.

Then the storm arrives – gradually – causing more and more unstoppable damage. The sound is deafening. Water droplets propelled at 250 km/h cause lesions to the skin. Nobody can face the storm. Everywhere debris and broken goods are flung into the sky or propelled over the ground with fatal velocity. Houses start to break as their roofs become airborne. Suddenly a house breaks apart to be destroyed completely. People flee to safer spots. Some have to weather it out behind a tree, sheltering inside its roots, as they can no longer move around. Then the water comes. Wave after wave, reaching ever higher and with their enormous strength washing sheds, houses and workshops into the sea. Despair sets in: how much worse can it get and how much longer will it take? This storm is so much worse than anything experienced before! And it does get worse and the end seems so far away. Then the storm abates slowly, finally reaching a point where people, the strong people first, can creep out of their shelters to see what has happened. The place is unrecognisable. Everything has been shifted or torn down with strange objects everywhere. People have died.



Path of Cyclone Heta

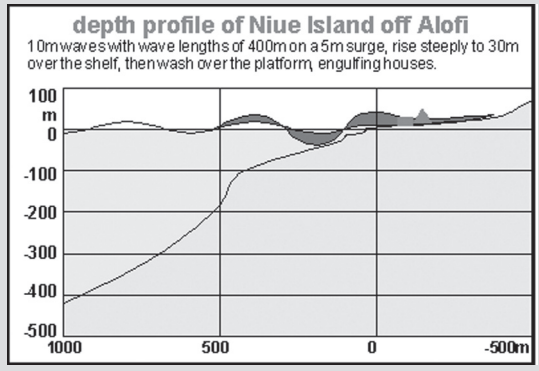
The aftermath is concerned with survivors trying to find out if there is anything left that still works. The telephones are dead and if it weren't for the recent technology of satellite phones, the news of Niue's plight might not have been able to reach the world. Electricity is down. Sewage pumps are not working. There is no running water. Everything is waterlogged – in salt water. People have nowhere to stay. They have lost all they had. Crops and future income have vanished too. It's a true disaster. How can we ever recover?

This satellite image shows cyclone Heta as it bears down on Niue. The image has been pixellated to show the storm's structure. The storm was spawned on New Year's Day 2004 in an unpopulated area of the Pacific Ocean and fortunately

(cont.)

most of its course remained over open water. First it deviated northward threatening the Tokelau Islands (2 Jan), where some damage occurred. Then it veered down and around Sāmoa (3–4 Jan), as it gradually gained size, strength and speed. Its last lap was a two day journey (5, 6 Jan) heading straight for Niue, passing about 70 km west of the island. This long, straight course of 600–700 km allowed the storm to whip the sea to its left and in front into mountainous waves accompanied by a high storm surge. After causing massive damage to Niue, it continued its journey over unpopulated areas of the Pacific Ocean where it rained out and died.

The odds against Heta happening



If a class five hurricane is a one in a thousand year event for those places where hurricanes occur, the form of Niue's coast made the event even less likely. This diagram shows the shore profile of Niue off its capital Alofi. The land gradually slopes down from +50 m to sea level, with most houses between 20 m and 30 m above sea level. Outside a coral intertidal fringe, the sea drops to 10 m until the edge of the coral fringe where it drops quickly to 30 m. Beyond a kind of continental shelf of no more than 400 m wide, the sea bottom suddenly sinks to 200 m and then more gradually to 3000 m outside the diagram with inclines of 1:7 to 1:5. Note that the vertical scale has been exaggerated only slightly. The amplitude and length of the most devastating waves is also shown to size. Because the continental shelf is too narrow, it is unable to absorb the waves' energy. Instead it slows them down while increasing their heights up to three fold (dark blue). Waves of up to 30 m high run up the natural ramp, then crash over the coral fringe, washing inland for hundreds of metres at speeds of around 100 km/h. Overwash of this nature destroys and annihilates everything in its path.

A class five hurricane is a very rare event but in the El Niño years (92–94,02–04) when the Pacific gyres (large eddies) come to a halt, the tropical warm water is no longer transported to cooler areas like New Zealand. Consequently the heat builds up in the tropics, while at the same time New Zealand experiences cold seas. In the tropics the corals suffer from coral bleaching while in New Zealand dense plankton blooms cause other threats. During such conditions one can expect tropical cyclones to become more powerful than in other years. Niue just had an exceptional dose of bad luck.

'the wrong time, wrong place, wrong shore'

What next?

Niue, the world's smallest self-governing nation, has been self-governing in free association with New Zealand since its independence on 19 Oct 1974. Its small economy is substantially bolstered by the New Zealand taxpayer, because the Niuean economy is not able to sustain the necessary infrastructure for a decent life for all. Australia provides around $900 000 a year in bilateral assistance and NZ $8.2 million. Most Niueans have chosen to live in New Zealand, thereby relieving their homeland from the potentially devastating consequences of overpopulation (5200 in 1966). But most Niueans are also determined to maintain their cultural links with their past and their language while carefully accepting some benefits of the modern world.

Private insurance is not working for low-lying islands in the Pacific as insurers cannot make profits against the perceived and real high risks. Fortunately a network of social support exists, with New Zealand taking the leading role in helping Niue after Heta. A donor team comprising representatives from Australia,

(cont.)

France, Britain, Germany, Canada, Japan and Fiji are working with New Zealand authorities to help with the relief efforts. New Zealand's 20 000-strong Niuean population has been raising funds and providing volunteers to help their homeland. About 2000 Niueans live in Australia and are also arranging assistance.

Those on the island are now trying to recover, but with so much damage the process will take time. Australia's Westpac Bank, which since 1988 has been the only commercial bank operating on the island, is providing very basic services from its damaged branch in Alofi. The European Union will provide US$766 700 to rebuild Niue after cyclone Heta.

Even so, the future looks grim for those prepared to give up easily. Niue's small economy based on tourism, and coconut and fruit tree plantations, was just showing promising returns as the cyclone hit. Both have been destroyed, as have most of the popular coral reefs and the whole dive operation that made this paradise accessible to visiting tourists. The effect of the storm on local flora and fauna can only be guessed at as fruits for fruit bats and birds, and leaves for insects, have become very scarce.

Activity 14

1 When we look at the sequence of events for a tropical cyclone, it is important we think about both the physical events that occurred and the cultural events. We should also keep in mind the timing of different events. For example:

- ❑ before the tropical cyclone
- ❑ immediately before the tropical cyclone
- ❑ during the tropical cyclone
- ❑ immediately after the tropical cyclone
- ❑ two to ten days after the tropical cyclone.

Use the resources above to reconstruct the sequence of events for Cyclone Heta.

2 Construct a detailed star diagram (or other graphic organiser) to show the processes that caused Cyclone Heta, e.g. the specific climate processes; the tropical cyclone processes; the cultural processes (e.g. the effects of people and the way they live on places that were at risk from Cyclone Heta) and the physical processes.

Part 2

Population And Settlement

Overview

This strand is not covered in this textbook. Please refer to a textbook called: *Urban Settlements* by J.Mark Hensman, Jeffery Franklin, and Morris Mear. Published by New House Publishers in 1998, and reprinted in 2003.

At the end of your study of the Population and Settlement strand, you will able to show your understanding of the following achievement objectives:

Achievement Objectives

1 The processes of settlement and patterns of settlement.

2 Consequences of urban growth and decline, and how these can be managed and controlled.

The focusing questions that this section covers are:

1 What are urban settlements and why do they exist?

2 How do urban areas interact with their hinterlands and with other urban settlements?

3 Why do urban areas grow and decline?

4 What are the different patterns within urban settlements – social, economic, structural?

5 What processes have resulted in or caused these patterns?

6 How can the growth and decline of urban areas be managed and controlled? How effective are strategies to manage and control them?

7 How do people respond to some of the challenges of urban life? (e.g. traffic, crime, leisure, developing a sense of community.)

Introduction

The *Urban Settlements* textbook will introduce you to important theories and ideas about urban settlements and their development. The main examples and case studies in that textbook have been taken from New Zealand and from Bangkok, the capital city of Thailand. Examples from other parts of the world have also been included.

There are some important terms and definitions that we need to think about before we study urban settlement.

'Urban' describes something that is either a city or a town. This word comes from the Latin word for city – which is *urbs*. Urban settlements are a creation of people – they are made by people for people. If we think about the different types of environments that surround us, then *urban settlements* are examples of *cultural environments*. The term *cultural landscape* can also be used to describe urban settlements and urban areas.

A good definition for urban settlement is *a location where there is a concentration of people living and working close together*. As a result, an urban settlement will have a range of *functions*. It will have an observable *form*. And it will also have a *focal* point. There will be a number of reasons why an urban settlement has developed at a particular *site*. Urban settlements are of different *sizes* and cover different *areas*.

Term	Definition
Form	Historically, settlements come in many different shapes. For example: ❑ Most towns and cities have grown in a haphazard way, so their overall shape is NOT smooth or even. ❑ Very old settlements may have developed within protective walls and so these walls have determined their shape. ❑ Some settlements were planned and organised before they were built and so they have a grid shape. ❑ However, most towns and cities have resulted from factors such as characteristics of the site and function, rather than planning.
Function	This is the main role or purpose of the urban area. Examples include transport, education, government, and commerce. Settlements can be classified or grouped according to the number and type of functions that they have.
Site	These are the characteristics of the actual physical place where the urban settlement is located – the characteristics that led people to build the urban settlement in a specific place. Examples include: water supply, harbour, lowland area, local resources, etc. Different groups of people may have different perspectives on what the strengths or advantages of a site are or have been.
Area	This is how large a settlement is in terms of the land it covers or occupies. Depending on the city or the country, the space that a settlement covers does not always have to be filled in with buildings. Some cities, for example Manukau City in the Auckland region of New Zealand, include large areas of farmland in the area that they cover.
Size	It is possible to classify settlements by how large they are – in terms of the population, area, number of functions etc, although different countries have different criteria for determining when a rural settlement becomes an urban one.

Here is a table or a chart to help you to 'match' the focusing questions above with the relevant chapters of the *Urban Settlements* textbook.

Focusing Questions	Main Theme	Page Reference
1 What are urban settlements and why do they exist?	*HISTORICAL DEVELOPMENT*	Chpt 2 pp 11–25
2 How do urban areas interact with their hinterlands and with other urban settlements?	*INTERACTIONS WITH HINTERLANDS* *FORM AND FUNCTION*	Chpt 5 pp 47–66 Chpt 6 pp59–65
3 Why do urban areas grow and decline?	*INDUSTRIALISATION AND URBANISATION*	Chpt 4 pp 37–46 Chpt 10 pp 86–107
4 What are the different patterns within urban settlements – social, economic, structural?	*DIFFERENCES WITHIN ZONES AND OTHER PATTERNS*	Chpt 7, 8, 9 pp 66–85
5 What processes have resulted in or caused these patterns?		
6 How can the growth and decline of urban areas be managed and controlled? How effective are strategies to manage and control them?	*GROWTH AND DECLINE PROBLEMS PLANNING AND MANAGEMENT*	Chpt 13 pp 108–118
7 How do people respond to some of the challenges of urban life? (e.g. traffic, crime, leisure, developing a sense of community)		

Part 3

Development Studies

Overview

This section of the textbook covers the Development Studies strand. At the end of this section, you will be able to show your knowledge and understanding of the following achievement objectives:

Achievement Objectives

1 Globalisation and development

2 Factors that influence national development strategies for a system of production of national significance

The focusing questions that this section covers are:

1 What are the main patterns and interactions that are found in the global economy?

2 How and why have global economic/trade phenomena impacted on Sāmoa at different levels or scales?

3 What are the key features of a national strategy for a specific system of production?

4 How and why did this strategy develop?

5 What evidence is there of this strategy in action?

6 How effective is this strategy and its management – in other words, how can this be evaluated?

Introduction

'Globalisation' is one of the most talked about concepts of modern times – but it is a concept that is not understood very clearly. Different groups of people throughout the world have a strong interest in it – from farmers, economists, politicians, trade unions and business people to environmentalists, social scientists and even human rights activists. But because some people do not have a very clear understanding of what it is, they become confused by issues that relate to 'globalisation', the 'global economy', and the importance of these issues at levels such as the global, regional and national, and the personal or individual.

Tourism is a cultural process that is based on the human activity of leaving one place in order to see and experience another place, and then return. As a cultural process, there are specific economic, social and political features which are characteristics of tourism. The basic principles of tourism are:

- It is a complex inter-relationship between people, places and products.
- Much tourism is for recreation and leisure, although it can be incorporated into a business visit or a working holiday.
- Visits are generally for short periods of time (for example 2–5 days).
- The development of inter-relationships through transporting people to a destination, and their possible stay at a particular place or destination.

Tourism is a global economic system of production because it involves the movement of people and resources across political boundaries, and the use of renewable and non-renewable resources to produce goods and services to support it.

The chapters in this part of the textbook will introduce you to important theories and ideas about globalisation, and its effects on development, and tourism development as a specific example of a global system of production.

Sāmoa has a national strategy for the development of tourism – it is in an important document called *The Sāmoa Tourism Development Plan 2002–2006: A Focused Future for Tourism*. The Sāmoa Tourism Authority is responsible for administering and implementing this plan, as well as for monitoring its progress.

In order to develop knowledge and understanding that relate to Focusing Questions 4, 5, and 6, as Year 13 geography students will you need to learn about:

- the current state of tourism in Sāmoa
- how tourism is being planned and developed in Sāmoa
- specific tourism development case studies and examples.

This could be done as a geographic inquiry. Focusing Questions 4–6 could be developed into a set of research questions as part of that geographic inquiry. The Sāmoa Tourism Authority will be the main source of information for your teachers in their efforts to develop such a research project or geographic inquiry. Instead of a student-centred geographic inquiry, Focusing Questions 4–6 can be covered by resources your teacher develops themselves, based on information from the Sāmoa Tourism Authority and *The Sāmoa Tourism Development Plan 2002–2006: A Focused Future for Tourism*.

Unit 3

Globalisation

Perceptions And Definitions Of Globalisation

There are a number of different ways to define **globalisation**. In geographical terms, it is a process that has been occurring for a very long time. It is a 'given', i.e. it is happening. Geographers often define globalisation in broad, neutral ways. However, it is possible to have different opinions about the effects of globalisation. It is also possible to disagree about the ways people can change the impacts of globalisation.

One broad and neutral way of seeing globalisation is to think of it as the way individuals, organisations and governments are influenced by ideas from outside the country where they are located, and linked into international and world-wide networks. These influences and links may be either positive or negative in their effects, and can be social and cultural as well as economic.

The economic aspects of globalisation tend to dominate the effects of globalisation.

Globalisation is the bringing together of national economies into a global economy. Economic globalisation is the expansion of trade in goods and services between countries. According to Wayne Ellwood, it is the

> . . . entanglement of diverse cultures and economies . . . [it] has been spreading for centuries and the world has been shrinking as a result. In that sense it is an old story. Peppers, maize and potatoes, once found only in Latin America, are now common foods in India, Africa and Europe. Spices originally from Indonesia thrive in the Caribbean. The descendants of African slaves, first brought to work the land of the 'new world', have become Americans, Jamaicans, Canadians, Brazilians and Guyanese.
>
> *Source:* The No-Nonsense Guide to Globalisation, *Wayne Ellwood, New Internationalist Publications, 2001*

Did You Know?

Soybeans: Originated in Asia and had been grown there for at least 3000 years. Other parts of the world did not know about soya beans until a German physician, Engelbert Kaempfer, wrote about them while he was living in Japan in the 1690s. Soy beans are now the world's leading legume crop.

Potatoes: Originated in the Andes mountains of South America. They were first brought to Europe by Spanish ships in the 1500s. They became the main source of Vitamin C in northern Europe. Potatoes were taken to Asia in the 1600s and then across the Atlantic to North America.

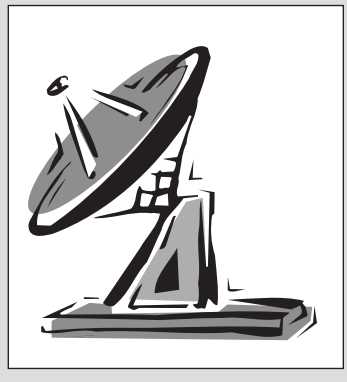
Wheat: Wheat is the world's top crop and one of the first cultivated plants in human history. Wheat was first grown in what is called the **Fertile Crescent** some 10 000 years ago (this area is in the Middle East). Over a period of thousands of years, it reached southern Europe, the Nile Valley (Egypt) and the Indus Valley. European colonists took it to the Americas, South Africa, Australia and New Zealand.

Source: National Geographic, *August 1999*

So the word 'globalisation' is new – but the process began over 500 years ago. But globalisation began to change in the 20th Century, particularly after World War II. The process has become even faster, in recent decades. This has been caused by:

- the development of computer technology
- trade barriers, which some governments had put in place to protect their economies from competition from goods and services from other places, have been taken away and so the market place across international boundaries is more 'free'.
- changes to the types of government systems in different parts of the world from socialist or communist systems to capitalist and democratic systems (e.g. the end of the Soviet Union in the 1990s)
- the growth in size, power and political influence of multi-national corporations and companies.

Did You Know?



The world's huge, intertwined telecommunication networks have re-shaped the way people see time and distance. Telephones, fax machines, personal computers, websites and cables have spread very fast around the world. This means that a grandmother on Atafu atoll in the Tokelau Islands can pick up the phone and direct dial and speak to her grandchildren in Wellington, New Zealand. The developments in technology that allow this to occur have happened quite quickly. For example, the number of phone calls from the United States to other countries in 1997 was 21 times more than the number of calls in 1980.

And what about television? In 1964 there was one TV for every 20 human beings. Now there is one for every four. The increases are highest in developing countries – for example, there are more televisions in Brazil than there are refrigerators.

There are now more than 200 functioning satellites orbiting the Earth, each capable of carrying tens of thousands of calls and several TV signals at once.

Did You Know?

- Nestlé is a multi-national food company. Its first factory opened in Switzerland, making baby formula, in 1867. It now has food factories in 80 different countries, making a range of food products from chocolate to baby formula to milk products to Asian noodles, etc.
- CocaCola began in the United States. Its first overseas factories were built in Panama, Cuba and Canada in 1906. Dozens more factories were built to supply U.S. soldiers in Europe, Africa and the Pacific during World War II. Now less than 30 % of Coke's income comes from production and sales in the United States. Its products are found right throughout the world.

The History Of Globalisation In The Pacific

Globalisation as a process is a part of the history of economic development. It is also the origin of many political, and social relationships between different countries of the world today.

Period of Time, Dates	Process and Description
Late 1700s–1800s	IMPERIALISM ❑ the nation-states of Europe began to expand their economic and political control into other countries and into the Pacific ❑ new trade routes were established; old ones were strengthened ❑ plantation agricultural systems were established
First voyage in 1769	❑ colonialism and capitalism spread ❑ Captain Cook accurately mapped much of Polynesia and Melanesia. This made the region more accessible to traders in sandalwood, sea cucumbers, whales and labour
By 1790	❑ trading networks connected Polynesia, Melanesia, China, Europe, North America and Australia
1873–1896	❑ economic downturn in many countries in Europe and North America. European powers tried to expand their empires and strengthen and secure their interests in Asia and in the Pacific
1870–1900	COLONIALISM ❑ almost all of the Pacific came under the colonial control of Great Britain, New Zealand and Australia (colonies of Great Britain), France, Germany, the USA and Chile ❑ new bureaucracies and trading systems were established ❑ local elites (important, higher ranking groups of people in the Pacific country) became a part of these trading systems and bureaucracies ❑ colonialism changed social and economic processes but many people throughout the Pacific region, in the colonised nations, continued to work as smallholders or in subsistence or semi-subsistence lifestyles

(cont.)

Period of Time, Dates	Process and Description
1870–1900	❑ as more people became wage earners and reliant on cash income (to meet all or part of their needs), the consumption of foreign products increased ❑ there was an increase in the production of indigenous products and other goods for export ❑ populations (migrant too, but particularly local) began to increase in size in many Pacific countries, due to advances in health and sanitation introduced by colonial administrators ❑ colonialism was seen as a steady force of economic modernisation and social change ❑ under colonial administration, European systems of law and order were established; the concept and system of private property introduced; basic infrastructure built (e.g. wharves, main roads); western political and legal systems established ❑ from a more critical perspective: colonialism caused destruction of the natural environment and social structures, dependency and exploitation
1930s +	THE RISE OF NATIONALISM ❑ almost all of the countries in the Pacific region were colonised by European countries, the US or Japan ❑ political organisations began to form in the colonised nations – these organisations began to question the impacts of colonisation upon their country's development ❑ such organisations and groups focus energy on: the negative pressures that the colonial administrations were placing on the people; the way the nations were being forced into unequal trading relations both within the country and with other countries ❑ before colonisation, people in these countries had allegiance to family, royalty and/or religious leaders. In reacting to the negative impacts of colonialism, political groups took on the ideology of independent, national identities. The ideology of the nation state was taken on – but such groups wanted a nation state determined by their own people and not by the colonial administration ❑ the Pacific War (World War II) had a greater impact on the Pacific Islands than any other single event and went a long way to establishing the strategic importance of the Pacific Ocean in world affairs ❑ during WWII, the US developed military bases in the Pacific. Militarisation during the war also impacted on employment and the economies of different island nations. Infrastructure during this period was also improved ❑ after WWII there was an even greater feeling of nationalism and many countries worked at achieving independence
After WWII	DECOLONISATION ❑ political independence did not necessarily mean economic independence. Independent Pacific nations found themselves heavily reliant on professional skills that their own citizens did not yet have – and therefore 'imported' the skilled labour (doctors, teachers, engineers, etc) often from their former colonising power

(cont.)

Period of Time, Dates	Process and Description
After WWII	❑ newly independent countries also found themselves with economies that were reliant on the export of primary products, and with world prices that fluctuated – and societies that had become very dependent on expensive imported goods ❑ newly independent nations came to rely heavily on former colonial powers, and on other nations with an interest in having a presence in the Pacific (e.g. China), for assistance (loans, aid and expertise) to build up the different sectors of the economy

About the Communications Technology Revolution

Computers, fiber-optics, satellites and the minaturisation of electronics have radically altered the production, sales and distribution of goods and services as well as the patterns of global investment. Coupled with improvements in air freight and cheap ocean transport, companies now tend to move their plants and factories wherever costs are lowest. Improved technology and cheap oil has led to a massive increase in goods being transported by air and sea. According to the Boeing aircraft company, world air traffic cargo tripled between 1985 and 1997 and is predicted to triple again by 2015. The global shipping business, which now consumes more than 140 million tones of fuel oil a year, is expected to increase by 85% in the next decade. And costs are falling too. Ocean freight unit costs have fallen by 70% since the 1980s while air freight costs have fallen 3–4% a year on average over the last two decades.

Source: The No-Nonsense Guide to Globalisation, *Wayne Ellwood, New Internationalist Publications, 2001*

The Most Important Changes To The Global Economy

About the Changes to the Structure of the Global Economy

A system of rules about international trade was established at the end of World War II. The world's most influential and powerful countries agreed on a system that fixed currency exchange – this happened at Bretton Woods in 1944. The system gave the world 25 years of more or less steady economic growth.

In 1980 things began to change. The governments in Britain and the United States made the free market a priority. They called for a drastic reduction in the regulatory role of the state. Corporate executives and money managers began to have a greater influence in the economies of their nations as well as the global economy.

(cont.)

The overall philosophy was that companies must be free to move their operations anywhere in the world to minimise costs and maximise returns or profits to investors.

Free trade, unfettered investment, deregulation, balanced budgets, low inflation and privatisation of publicly owned enterprises were seen as part of national plans for prosperity.

Hand-in-hand with the spread of free trade in goods and services came the deregulation of world financial markets. Banks, insurance companies and investment dealers, which had been confined within national borders, were suddenly unleashed. Within a few years the big players from Europe, Japan and North America expanded into each other's markets as well as into the newly opened and fragile financial services markets in developing countries. Aided by computer technology and welcoming governments, the big banks and investment houses were keen to invest surplus cash in anything that would turn a quick profit . . . Instead of long-term investment in the production of real goods and services, speculators made money from money, with little concern for the impact of their investment on local communities or national economies.

Source: The No-Nonsense Guide to Globalisation*, Wayne Ellwood, New Internationalist Publications, 2001*

Activity 1

Have class discussions on the following topics:

1 Talk about your favourite foods. Identify which of these foods originate from other parts of the world and which ones originate in or are unique to Sāmoa.

2 What types of goods are imported into Sāmoa? Make a list.

What types of goods are produced in Sāmoa and exported to other countries? Make a list. Compare and contrast both lists.

Which export and import products, in your view, are essential? Which export and import products are not? Think about your answers. In your view, how reliant is Sāmoa on imported essential products?

3 What types of telecommunication can be found in Sāmoa now? Which types of telecommunication did Sāmoa rely on twenty years ago? What is different now – and why?

4 What is a free market economy? What do you think are some of the advantages and disadvantages of such an economy?

5 Find out the meaning of these words: deregulation, free trade, unfettered investment, balanced budgets, low inflation, and privatisation.

Unit 4

Tourism Development

Tourism As An Example Of Globalisation

Tourism is not only the world's largest industry, but it also involves the greatest flows of people on the surface of the Earth. It is, therefore, a major agent of change in today's world. Some people see tourism as one of the most visible expressions of globalisation. Tourists and tourism development affect almost every country. They produce impacts upon communities, environments and economies, some of which are beneficial and others that can be a cause of concern. At the same time, tourism is a source of immense enjoyment and pleasure for hundreds of millions of people and creates contact and communication between people from different regions and cultures.

Global tourism will recover

Jan 23, 2002

The World Tourism Organisation (WTO) believes the outlook for the global tourist industry remains positive, despite fears the September 11 terrorist attacks would decimate the sector.

'There are signs everywhere of an improvement and there is therefore no need to revise down our long-term outlook,' said Francesco Frangialli, secretary-general of the 139-member intergovernmental organisation.

The tourism industry can expect up to one million job losses worldwide, but this was still a massive improvement on the nine million job losses originally forecast by the International Labour Organisation, he said.

In the aftermath of the suicide hijack attacks on the United States, nervous

travellers cancelled bookings and airlines fired thousands of employees.

Frangialli said his organisation would stick to its long-term projections that the number of international tourist arrivals will top one billion by 2010, rising to over 1.5 billion trips abroad by 2020.

'The tourism sector performed worse than expected in 2001. There was stagnation at 700 million travellers, or maybe some small growth,' Frangialli said.

In 2000, the tourism sector expanded

(cont.)

by 7.4 per cent to 699 million travellers, generating $476 billion, excluding airfares.

The World Tourism Organisation's crisis management group found that three areas were particularly badly hit: flights to and from the United States, intercontinental journeys, and travel to Islamic and Arab lands.

In December, the tourism sector saw turnover down by between 12 and 15 per cent compared to the same month the previous year.

'In 2002 we are convinced there will be an upturn, in the second half perhaps. It is not certain yet, but we think it is possible that the sector will come back to previous levels. Many job losses will be temporary until the sector recovers,' he said.

The ILO had been too pessimistic with its initial calculations after September 11. He cited the example of Egypt, where job losses in the sector of up to 40 per cent had been forecast but failed to materialise.

Frangialli was in the north German city of Hanover to launch a tourism trade fair which is aimed at promoting environmentally sustainable tourism and kicks off the UN's International Year of Eco-tourism.

Eco-tourism could see above-average growth levels in coming years and would provide a great opportunity for developing countries.

Globalisation meant every region in the world was now affected by tourism and this brought jobs and foreign currency to poor areas, he said, even though tourism was not without its downside.

'It is true that tourism can have negative effects, such as in sensitive areas like the tropical rain forests, or the abuse of children in sex tourism. We have to fight this and we are doing so,' he said.

The last quarter of the twentieth century saw an unprecedented rise in overseas travel, in the accessibility of previously inaccessible destinations, and in the rush for globalisation.

All national tourist authorities around the world (including Sāmoa's very own Samoa Tourism Authority) have recognised the need to work together with the industry at this time. The expertise and information-gathering ability of different sectors is very important in putting together a true picture of the global situation, and global forecasts.

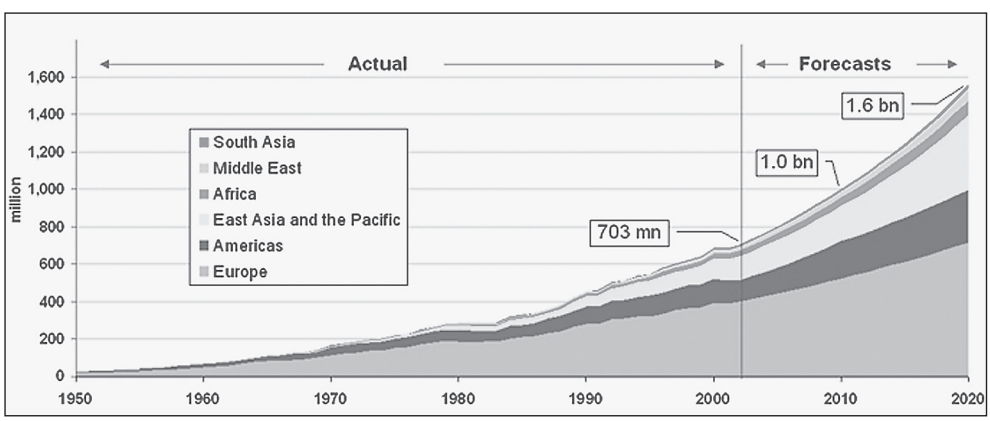


Figure 3.4.1 The World Tourism Organisation (WTO) has a special report called the Tourism 2020 Vision. The WTO has forecast that international arrivals are expected to reach over 1.56 billion by the year 2020. Of these worldwide arrivals in 2020, 1.2 billion will be intraregional (tourists moving within a region, e.g. New Zealand tourists travelling through the Pacific) and 0.4 billion will be long-haul travellers (tourists who travel long distances out of their regions, for example, someone who may travel to the United Kingdom from Sāmoa for a holiday.)

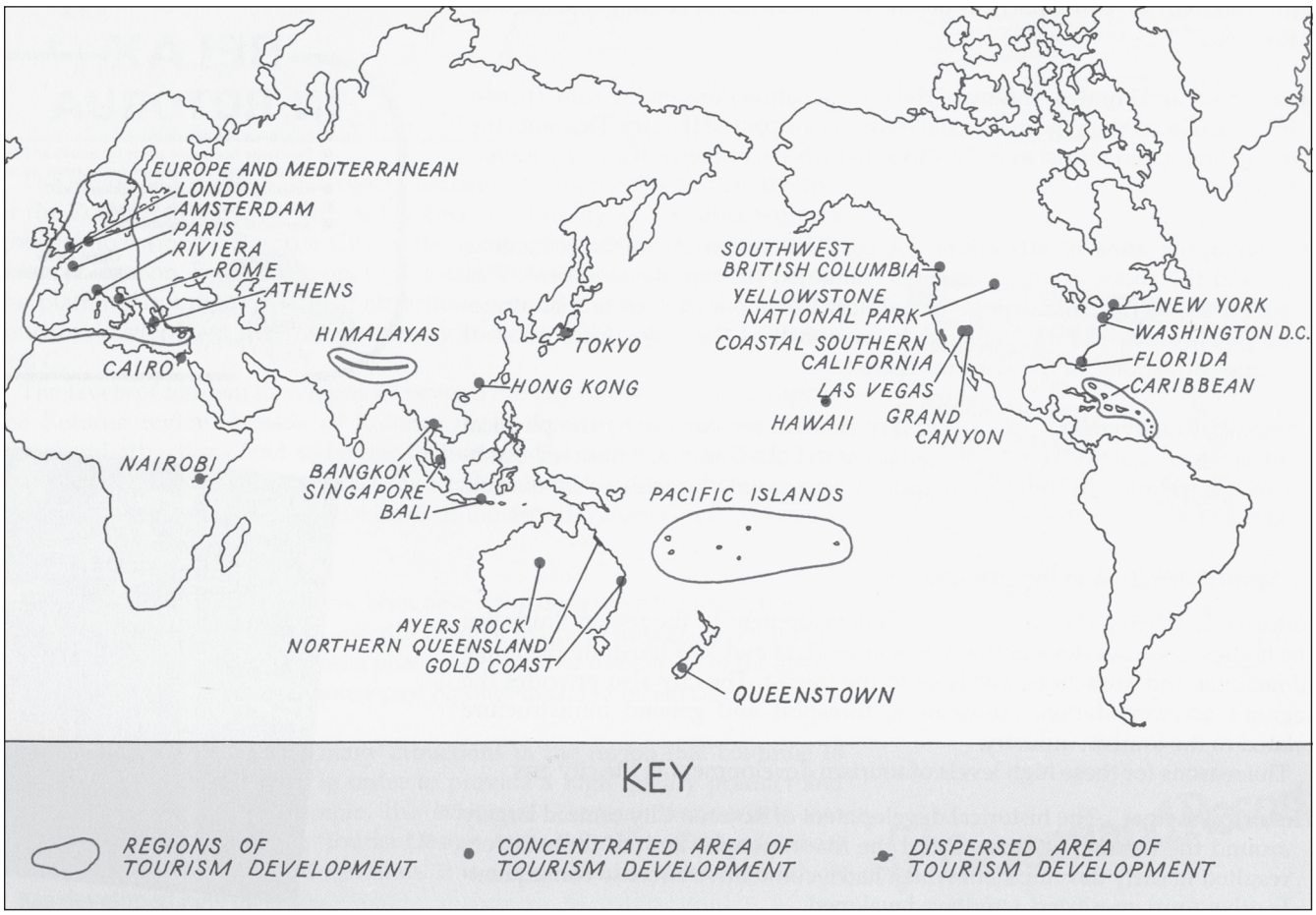


Figure 3.4.2 Major global tourism developments

- But what exactly is tourism?
- And how is tourism a system of production?
- If tourism development is a cultural process, what are the parts or elements that it is made up of?
- As a process, how does tourism operate?
- As an example of globalisation, how does tourism development affect other phenomena and the distribution of these phenomena?
- What are some of the changes that have been affecting this global cultural process?

Elements And Interactions

What are the elements and interactions involved in tourism development?

Key Ideas

- A variety of elements have resulted in the process of tourism development.
- Elements of an environment affect each other and this is interaction.
- Interaction takes place at different scales and with varying degrees of intensity and complexity.
- Change in one part of a system may lead to change in other parts.

Key Words

Domiciled
Non-domiciled
Elements
Interactions
Demand
Tourism
Components
Supply
Economic
Political
Social
Tourism development
Technology
Process
Phenomena
Dynamic
Direct contact
Indirect contact

Definitions

- **Tourist**
  - a person who travels domestically or internationally for the purpose of one or more of the following: holiday, recreation, health, mission, conference, convention, family, religion or sport.
- **Tourism**
  - the **economic** activity from which the **process**, Tourism Development, flows.
  - the **phenomenon** that creates inter-relationships between people (**domiciled** and **non-domiciled**) and places. Those inter-relationships involve movement from one location to another by various modes of transport, mainly for the purpose of recreation, leisure and sightseeing.
  - the basic principles of tourism are shown in Figure 3.4.3.

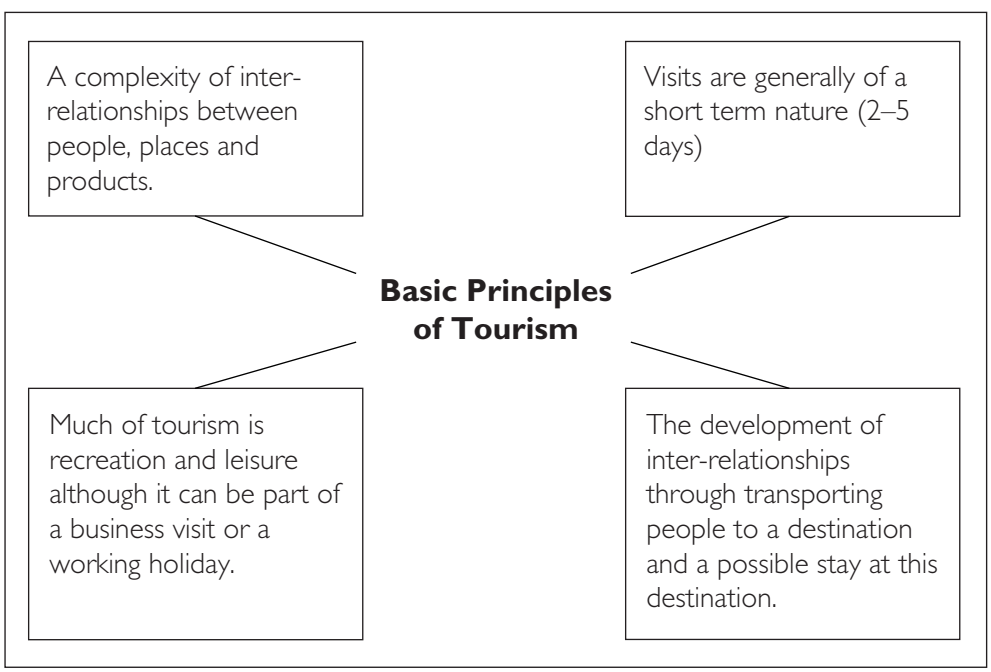


Figure 3.4.3 Tourism: the basic principles

- **Tourism development**
  - a study of tourism development involves observing and analysing the changes that occur in the tourism industry (i.e. accommodation, retail outlets, tourist attractions) over time, whether they grow or decline. The emphasis lies on growth and continued and increased change or evolution. Tourism development means providing or enhancing facilities to meet the needs of tourists and the associated impacts.

Activity 1

1 State in a paragraph, using examples you know of, the differences between 'tourism' and 'tourism development'.

2 With reference to Figure 3.4.4 below, add to the lists of examples for each element.

3 **a** Select one geographic idea from the KEY IDEAS that can be applied to Figure 3.4.5.

b Show this idea in a diagram.

c Explain your diagram in paragraph form.

4 Redesign Figure 3.4.5 using an alternative format. Indicate major **interactions** as opposed to minor interactions. You may change the names of the elements or introduce new **elements**.

5 State possible examples of the following interactions taken from Figure 3.4.5.

Natural ⟷ Political
Cultural ⟷ Environmental
Demand ⟷ Supply
Demand ⟷ Facilities
Facilities ⟷ Spatial patterns

Model of tourism development

For tourism development to occur, five base elements are necessary

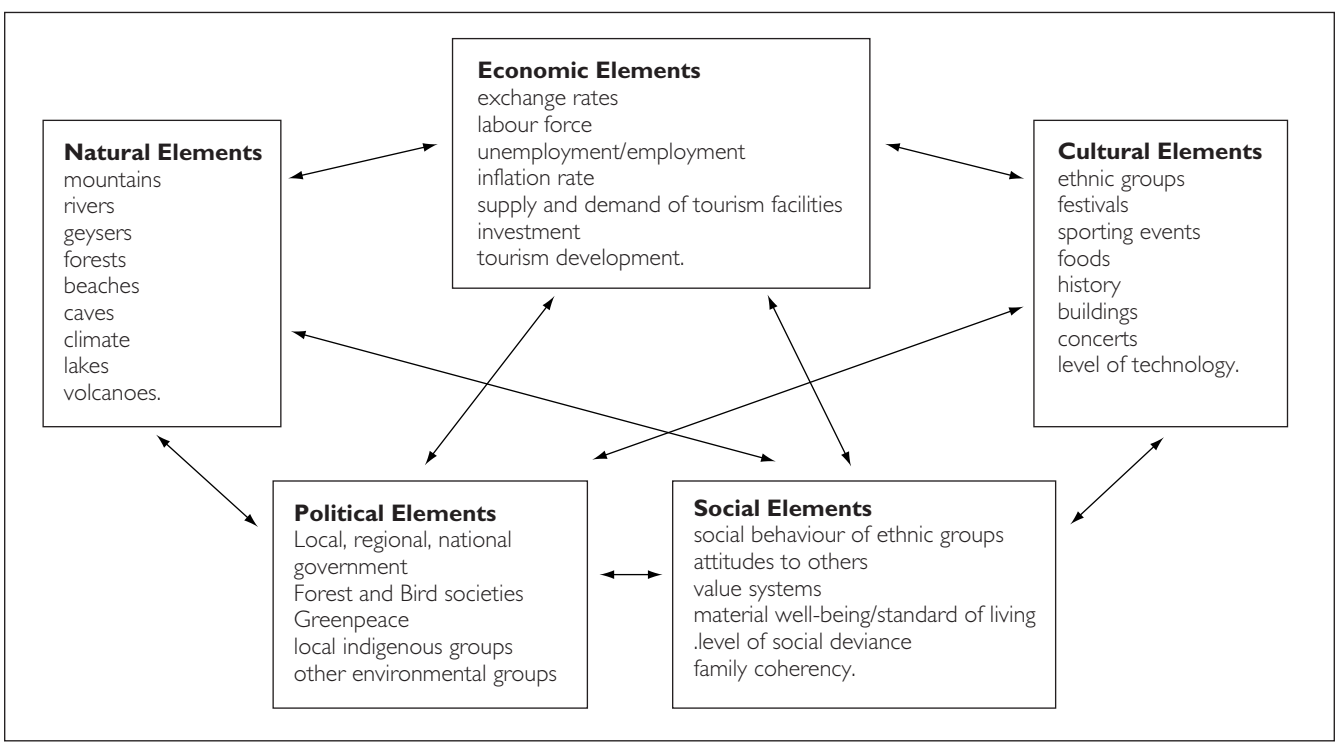


Figure 3.4.4 Tourism development: The elements and Interactions

It is the interaction of these elements that produces the process of tourism development. Figure 3.4.5 takes Figure 3.4.4 a step further, showing how the process of tourism development arises out of the interaction between those elements.

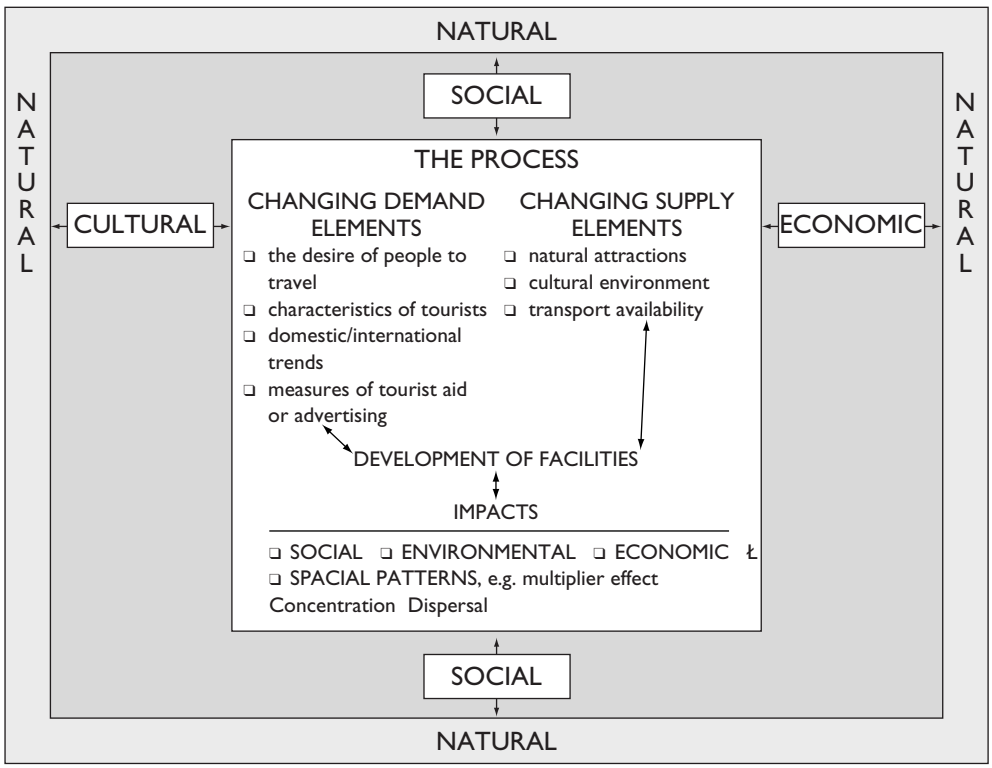


Figure 3.4.5 Tourism development: The process

The tourism development model explained

The natural environment always provides the context for geographical studies. The case of tourism development is no exception. For example, a beach can encourage tourism development. The road to the beach, and toilet facilities are human constructions but the site is provided by the natural environment. The natural environment is an essential element of tourism development.

Table 3.4.1 Natural elements and their interactions in New Zealand

ELEMENT	INTERACTION	ELEMENT
Natural Native forest	The presence of such a natural resource has been a contributing factor to the existence of protection societies. These societies exert pressure to preserve such features.	**Political** Forest and Bird Society
Rain forest		
Geysers	The diminishing activity of major geysers over the years due to local thermal water usage can prompt governments to limit water usage in order to ensure that geyser activity is preserved.	Government
Mangroves		
Ski fields	The degree of snowfall or favourable weather determines whether, in a particular community, there is full employment, unemployment or under-employment on ski fields, e.g. Whakapapa field in New Zealand and its influence on employment in the National Park area. Conversely work on such fields can have a direct effect on some natural processes, e.g. road gangs have an impact on natural drainage patterns.	**Economic** Levels of local employment
Beaches		
Off-shore islands	Recreational behaviour patterns of family groups can be influenced by the sea and islands off shore. The attraction will always pull people to an area, and the behaviour of such visitors will determine the level of environmental impact, e.g. Bay of Islands.	**Social** Family
Apolima, Manono		
Underground caves	The existence of such features has developed a spiritual response from people, like the Maori, who turn their respect for such natural phenomena into determined conservation.	**Cultural** Local iwi (tribes)
Waterfalls		

The cultural process of tourism development operates as a sub-system within a total system (Figure 3.4.5). The major elements in this total system are natural, social, economic, political and cultural. These five elements influence supply and demand elements, which in turn influence the development of these facilities, which in turn affect spatial patterns and social, environmental and economic factors.

Most important in the process is *the relationship between supply and demand because this influences how much development will occur in tourism in a particular place*. One change in the supply elements will have a direct bearing on the demand elements (and vice-versa). See Table 3.4.1.

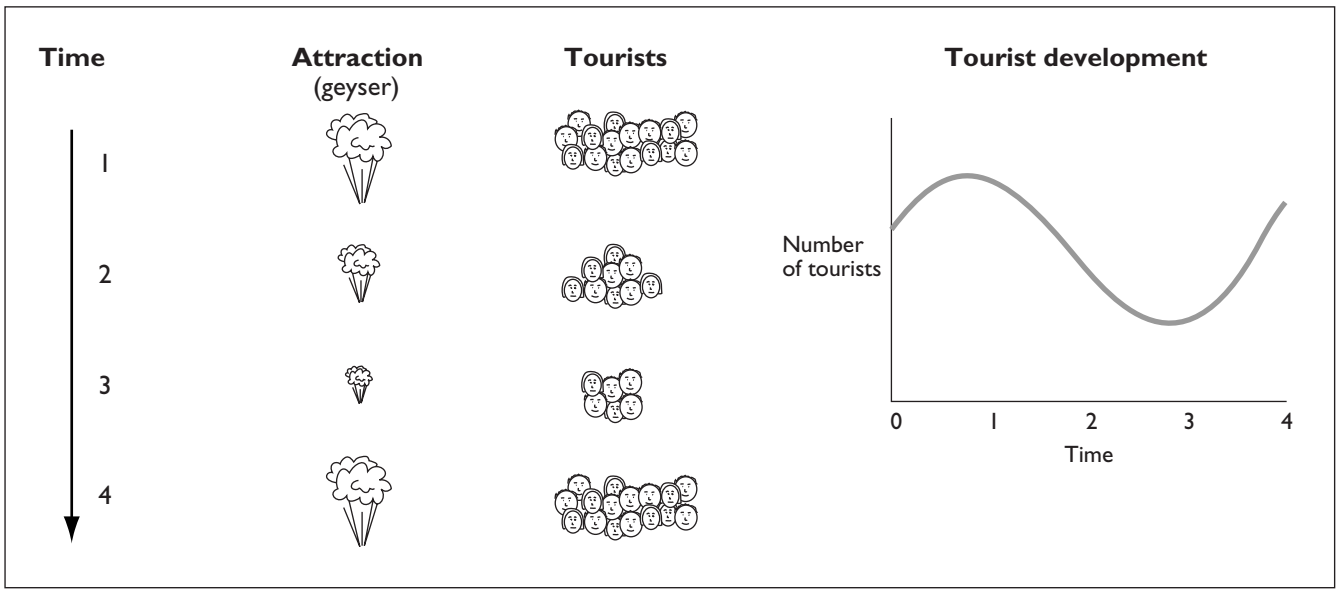


Figure 3.4.6 Changes resulting from a fluctuating geyser

Activity 2

1 With reference to Table 3.4.1 and using the same structure, find more examples of elements interacting with each other.

2 Describe how supply and demand affect each other and tourism development by referring to Figure 3.4.6 above. Describe:

- **a** the effect of decreasing supply (geysers) on the number of tourists
- **b** the effect of decreasing demand (tourists) on tourism development
- **c** the effect of increasing supply (geysers) on the number of tourists
- **d** the effect of increasing demand (tourists) on tourism development.

3 Select **one** organisation involved directly or indirectly with tourismin Sāmoa, e.g. ole siosiomaga Society. Research written material and interview members about their perception of the role the organisation plays in tourism development.

4 Use the phone book, business directory or other local body publications and note examples under the headings in the following table to show a range of participants involved in tourism development.

Social/cultural	Economic	Political

Supply and demand elements

There are two elements which are very important for the tourism development process: a *supply* element and a *demand* element.

❑ **Tourist demand**

– Without tourists there is no tourism development. Tourists tend to be in one of four categories:

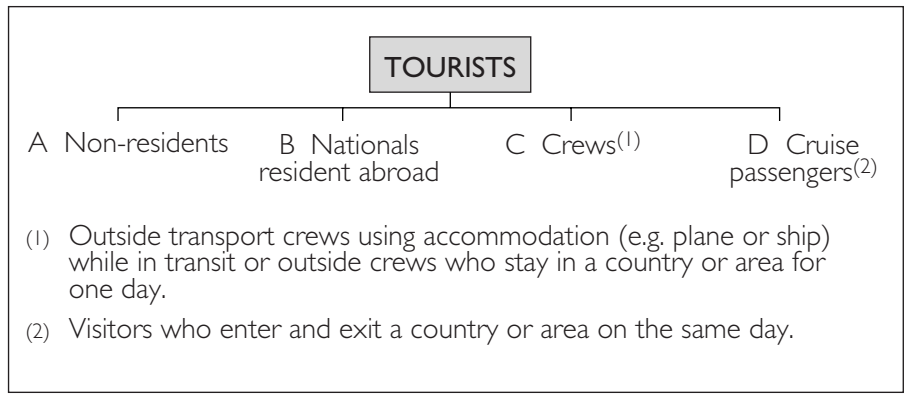


Figure 3.4.7 Tourist categories

– Most tourists travel for one or a combination of the reasons listed below**.**

holiday/recreation	health	conventions
family	relatives	missions (short term)
conferences	religion	sport

– These reasons in themselves do not ensure tourist development. However, when combined with other **dynamic** variables, tourism development intensifies or grows (see Figure 3.4.9).

❑ **The supply (availability) of facilities (for example, transportation)**

– there will be no tourism development if people have the desire (demand) to go somewhere but have no means of transport. Hence transportation is the crucial link between people and places (see Figure 3.4.8.)

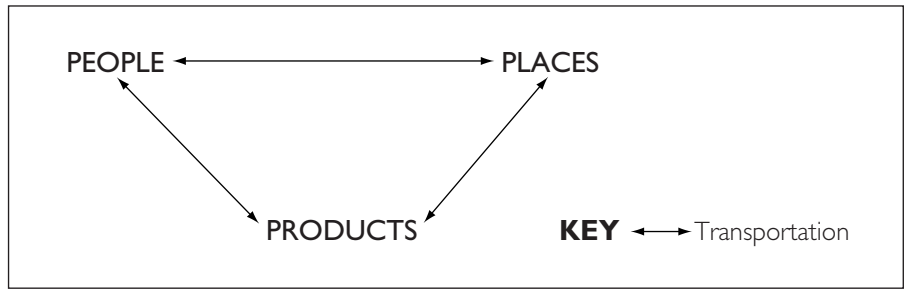


Figure 3.4.8 People, places, products

– The speed and efficiency with which people are now able to travel increases the likelihood of continued usage.

– A tourist needs transport for three reasons:
  i a return trip from source to destination
  ii transport while at the destination
  iii transport between multiple destinations.

– The demand for transportation provides the motivation for operators to increase their supply and efficiency of service. Both increase the level of tourism development.

Activity 3

1 Using Figure 3.4.7 and the list of reasons for travelling, on page 108, create four tourists. Construct profiles for them using the table below.

2 Which of your tourists (**A**, **B**, **C** or **D**) is most likely to make the greatest contribution to tourism development? Why?

3 Based on Figure 3.4.6, design and carry out a research exercise. Seek information from your local community as to the main purpose for tourism. Explain your results by analysing the nature of the local community.

	A	B	C	D
NAME				
Reason for travel				
Method of travel				
Destinations				
Length of stay				

Activity 4

Using Figure 3.4.9

a Write one generalisation that summarises the trend shown in (**i**)–(**vii**).

b For *each* trend sequence write a short paragraph to describe: (**i**) the trend shown (**ii**) how this trend could help tourism development.

c Select any one or a number of graphs and attempt to collect relevant information to illustrate the trends shown.

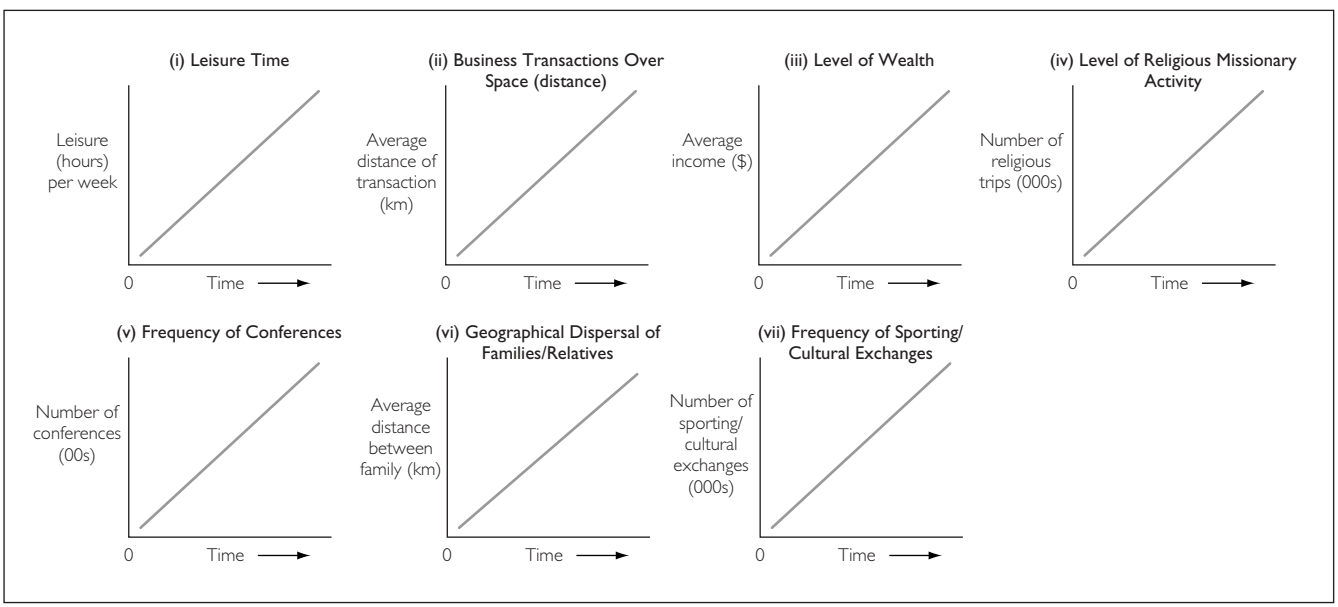


Figure 3.4.9 Trend sequences in tourism development

Activity 5

1 Complete the Figure 3.4.10 (below) giving examples of the transport types most likely to be used by tourists at each scale listed.

2 For each type of transport you list in Figure 3.4.10, state why tourists would choose that particular mode of travelling.

3 Would any of these forms of transport be any more or less helpful for tourism development than others? Explain why.

LOCAL	NATIONAL (e.g. Sāmoa)	GLOBAL

Figure 3.4.10 Modes of transport

Case Study – The Gold Coast

The Gold Coast is a 42 km stretch of Australia's Queensland coast. It runs from the New South Wales border up to 74 km south of Brisbane. There are 23 suburbs in all, including Southport, Coolangatta, Surfers Paradise and Burleigh Heads. This is Australia's mani tourism region (see Figure 3.4.11.)

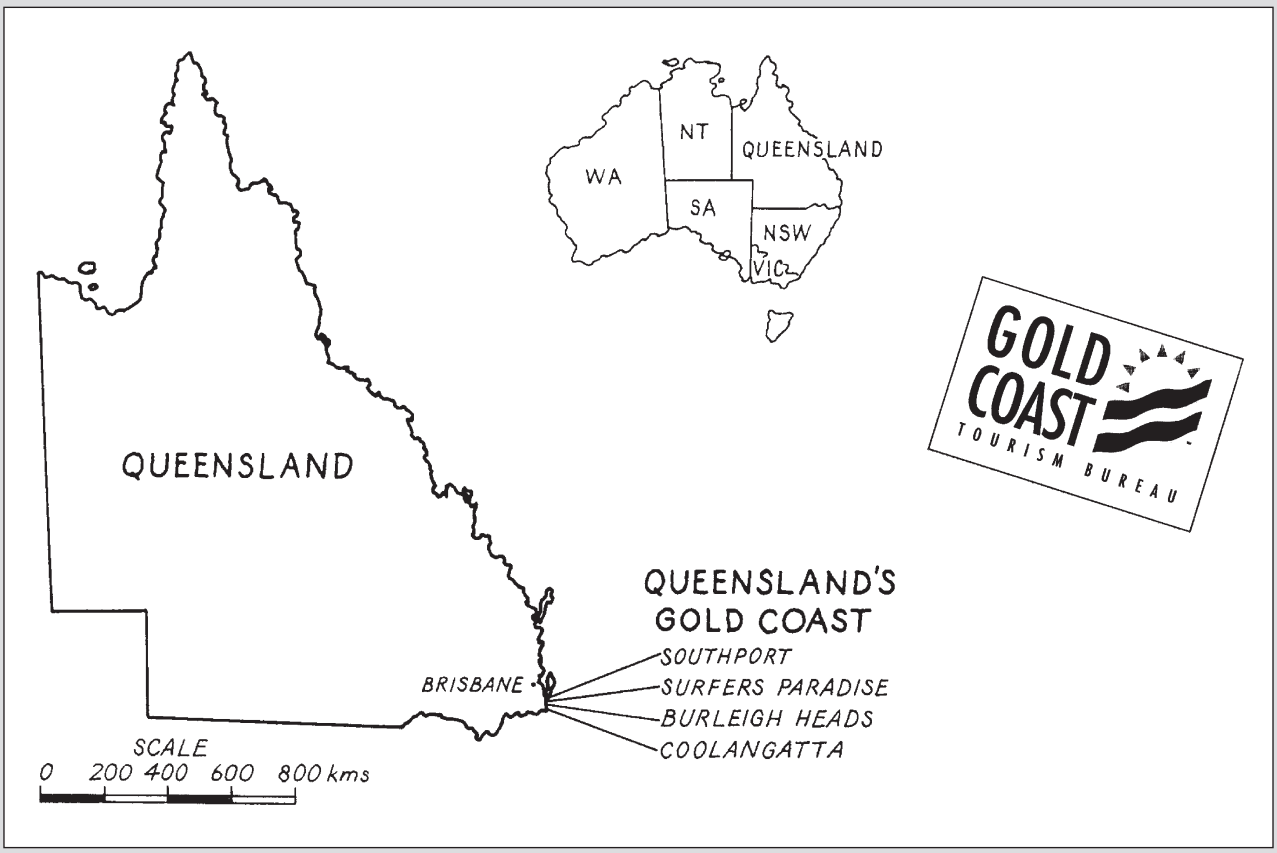


Figure 3.4.11 Queensland – the Gold Coast region

(cont.)

Supply elements

Figure 3.4.12 shows the supply of some tourist facilities on the Gold Coast.

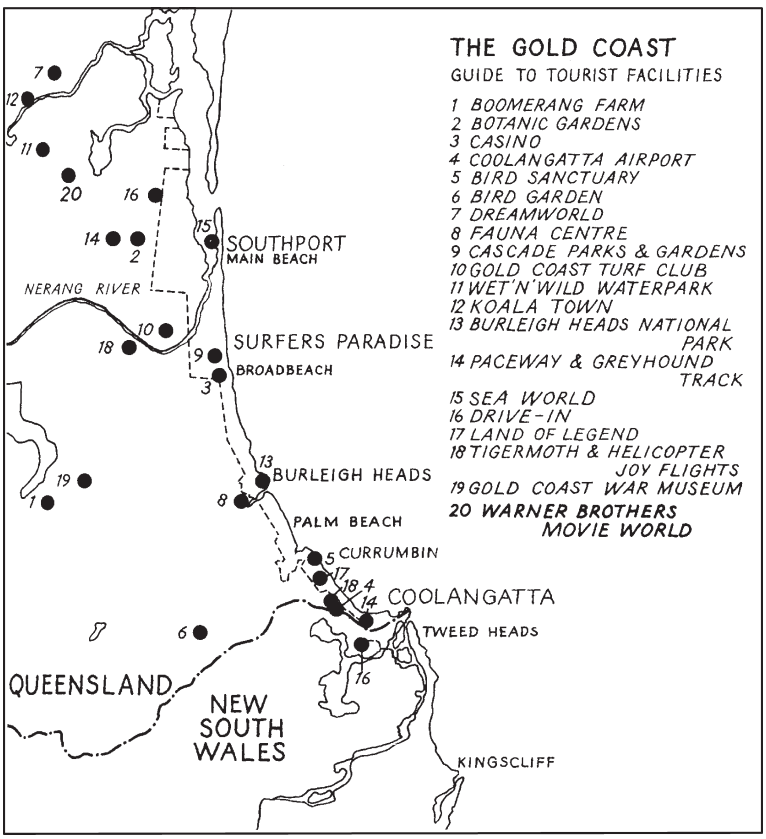


Figure 3.4.12 Gold Coast tourist facilities

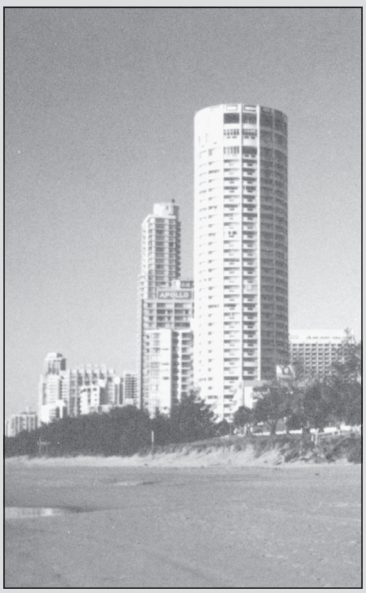


Figure 3.4.13 Surfers Paradise

Activity 6

Compare the supply elements of the Gold Coast to those of Apia and Sāmoa. Given the elements, why would Sāmoans want to holiday on the Gold Coast?

Demand elements

Domestic tourists

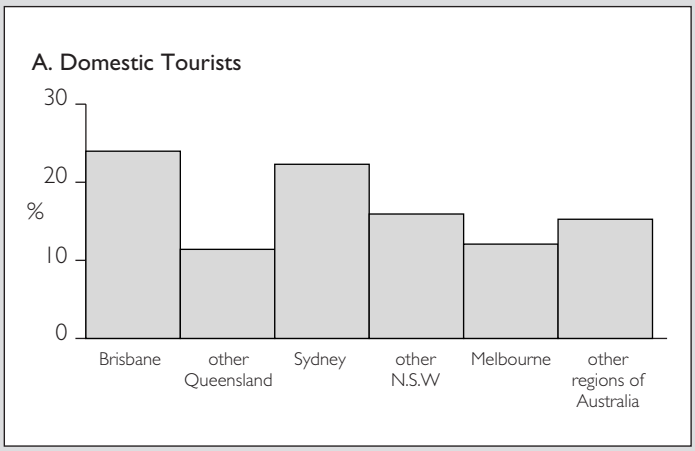


Figure 3.4.14 Bar graph – origin of visitor nights 1993/94

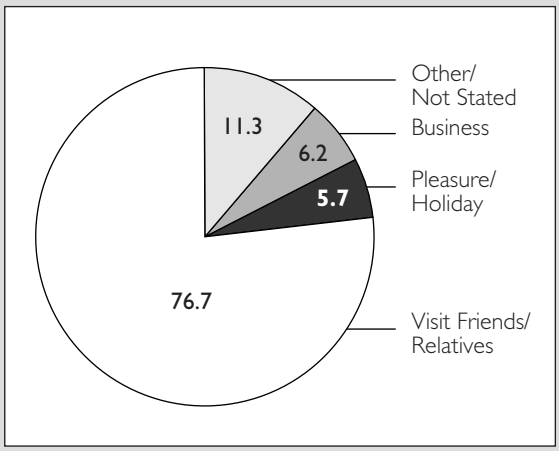


Figure 3.4.15 Pie graph – main purpose of trip

(cont.)

Mode of transport	% of visits
Plane	14.0%
Bus/coach	9.5%
Private vehicle	69.8%
Rented/hired vehicle	1.7%
Train	1.2%
Other	3.8%

Figure 3.4.16 Statistics – main mode of transport

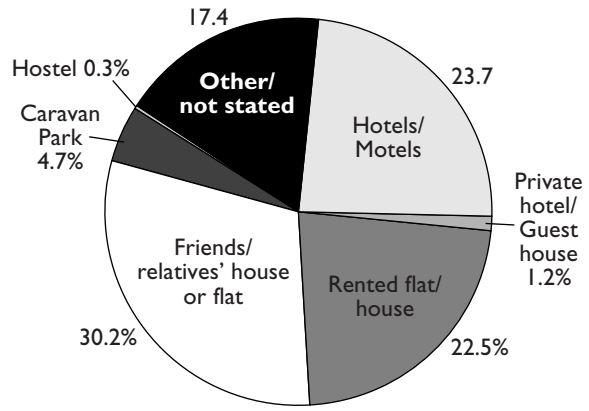


Figure 3.4.17 Pie graph – accommodation

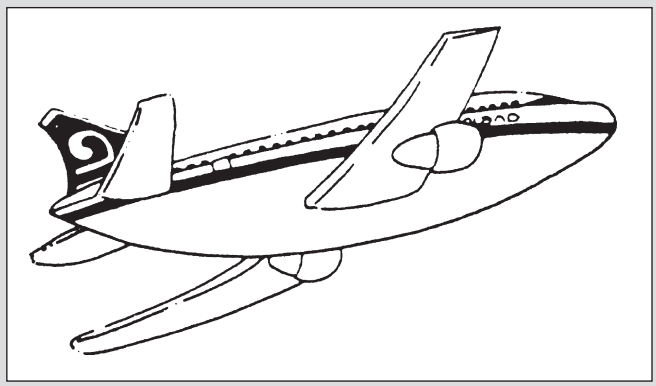
International tourists

Table 3.4.2 Age of visitors

	% of Visitors 1986	% of Visitors 1988	% of Visitors 1993
15–24	22.2%	22.7%	17.4%
25–34	28.9%	32.7%	28%
35–44	17.3%	17.2%	21%
45–59	16.4%	15%	22%
60+	15.2%	12.4%	11.6%

Table 3.4.3 Main purpose of visit

	% of Visitors 1986	% of Visitors 1988	% of Visitors 1993
Holiday	70.6	79.5	75
Visiting Relatives	19.0	8.4	12.5
Business	4.0	6.1	4
All Other Reasons	6.4	6.0	8.5



(cont.)

Table 3.4.4 Country of residence of international visitors to the Gold Coast region

	% of Visitors 1986	% of Visitors 1988	% of Visitors 1993
UK & Ireland	9.0	6.6	4
Europe	12.6	9.5	6
New Zealand	31.0	25.0	14
Japan	16.3	35.9	44
Asia (other)	8.0	7.9	25
United States/Canada	19.8	13.1	5
Other Countries	3.3	2.0	2

Summary

Table 3.4.5 Gold Coast tourist statistics

1993 Gold Coast	**Visitor Numbers** (000)	**Visitor Nights** (000)	**Expenditure per night** ($)
Domestic Visitors	1432	7035	$111
International Visitors	605	2420	$208

Activity 7

1 **a** Transfer the data in Figure 3.4.14 onto a proportional circle map.
b Summarise and explain the resulting pattern.

2 By referring to Figures 3.4.15 and 3.4.17, state the relationships between the two figures.

3 By referring to Figures 3.4.16 and 3.4.14, state the relationships between the two figures.

4 Graph the data shown in Table 3.4.4. Describe and analyse the resulting pattern.

5 Refer to Figures 3.4.15 and Table 3.4.3. Compare the reasons why domestic and international tourists go to the Gold Coast.

6 **a** What trend in the age of international tourists to the Gold Coast is shown in Table 3.4.2?
b What are the implications for tourism development?

7 Refer to Figures 3.4.14–3.4.17 and Tables 3.4.2–3.4.4. If you were a planner, what implications would this data have for you?

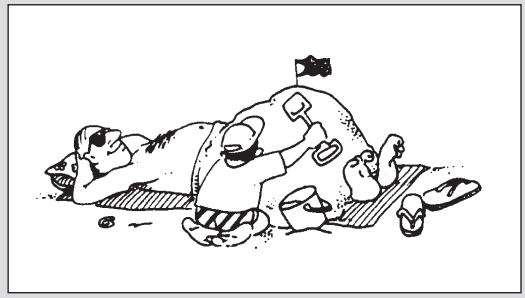
Activity 8

1 Using Table 3.4.5 calculate the average number of nights each type of tourist says

2 Should tourism development strategies be mainly aimed at the domestic or the international tourist? Give reasons for your answer.

(cont.)

Social element



There was little opposition to tourism development in the Gold Coast. The population was relatively small (250 000 in 1988), but people could see the potential that existed in tourism. The majority of local residents welcomed the development. Each new project or building meant jobs, not only during the construction phase, but later in setting up and servicing the enterprises and their occupants. Residents liked the local body policy that permitted and encouraged high-rise development (tall buildings) – especially those who sold their land to developers for high prices.

However, some people changed their minds, particularly after high-rise buildings had been completed. This made the local council change its policy on high density, high-rise development. Such intensive development was not to be repeated.

Political element

The first political body was established in the late 1920s and was made up of keen local residents and was called Surfers Paradise Progress Association. This organisation is still in existence today. Other political bodies involved in the business of the Gold Coast Tourism Development are:

- Australian Tourist Commission
- Queensland Tourist and Travel Corporation
- Australian Federal Government
- Queensland State Government
- Gold Coast Visitors and Convention Bureau
- Gold Coast City Council
- Surfers Paradise Chamber of Commerce

Figure 3.4.18 Surfers Paradise

Economic element

The Gold Coast has a wide variety of industries but it is well-known particularly for the manufacturing of:

- beach mining equipment
- plastic and fibreglass products
- clothing
- furniture
- sporting goods.

There is also a well-established construction (building) industry supporting the residential, industrial and tourism-related 'building boom'.

Activity 9

Refer back to Table 3.4.1. Construct a table similar to Table 3.4.1 that shows a sample of the interactions indicated on this page.

Tourism In Operation

How does the process of tourism development operate?

Key Ideas

- Sequences of related actions which modify or maintain the environment are known as processes.
- Processes vary in time and space.
- People, individually or collectively, through their decisions and actions may bring about change.
- Over time tourism development has occurred in particular areas.

Key Words

Push/pull
Development
Cumulative
Management
Management plan
Diseconomies of scale
Travel-orientated tourist
Leisure-orientated tourist

Figure 3.4.5 gives a structure by which you can understand tourism **development**. Each element is very important in the total process. The most important factor is tourist demand: if increasing numbers of people want to travel and have the resources to do so, tourism development will occur.

Push and pull factors

The factors motivating people to travel for pleasure can be divided into two categories: **push** and **pull** factors:

- **Push factors** – factors at home that make a person want to get away from it all for a while (see Figure 3.4.20). They reflect a desire for a change in daily routine, culture and lifestyle: an exchange of the routine for something different.
- **Pull factors** – factors in a different location that draw people to it because of the attractions if offers, particularly natural attractions, e.g. sun, surf and sand (see Figure 3.4.20).

Both factors motivate people to travel and encourage tourism development. What ultimately determines which location is the most desirable for each tourist is his/her perception of needs and objectives. For some people a cold, snowy mountain region will have a PUSH influence while for others it will have a PULL influence. The same can be said of a tropical island (see Figure 3.4.19).

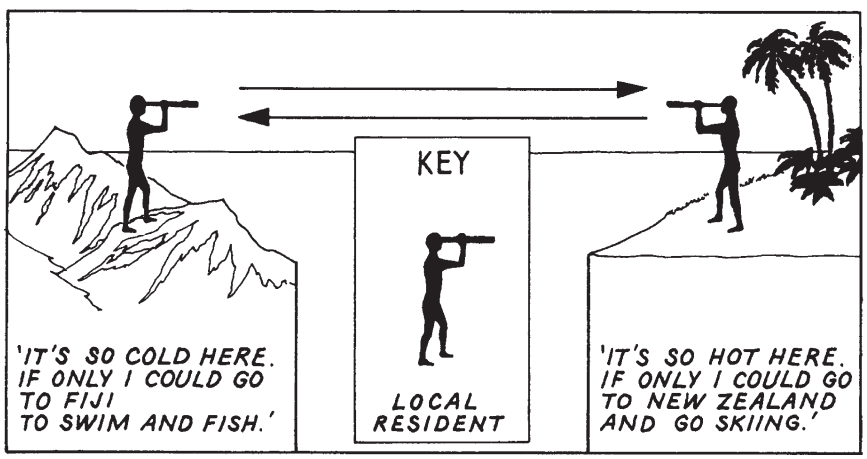


Figure 3.4.19 Push and pull factors

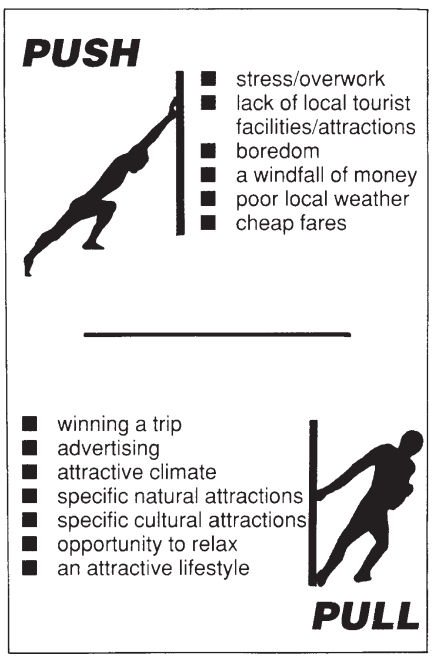


Figure 3.4.20 Push and pull factors

Activity 10

Refer to Figure 3.4.20 and Figure 3.4.19. Think of examples of contrasting perceptions (as illustrated in Figure 3.4.19) for each pull factor listed in Figure 3.4.20.

Travel or leisure-orientated tourists

Tourists whose main reason for leaving home is to travel and see as much as possible of other places clearly have different needs from those who want to go somewhere to take time out and relax. Both therefore have different impacts on tourism development because they place different demands on travel, accommodation, natural and leisure facilities.

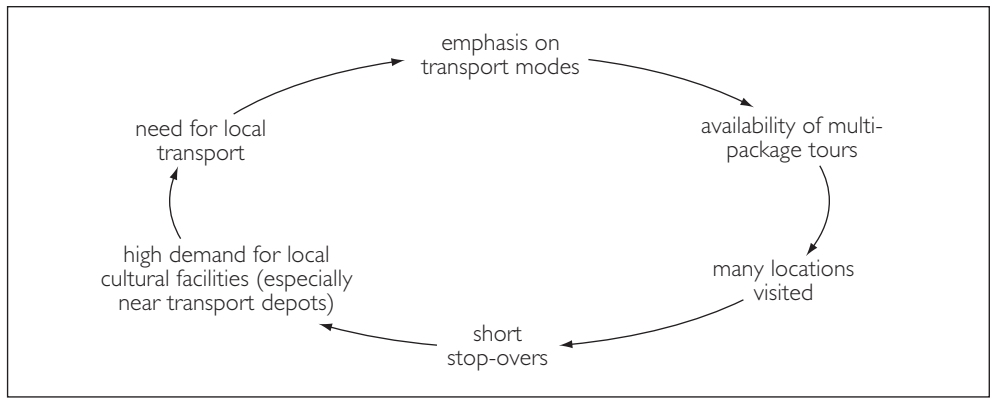


Figure 3.4.21 Travel-orientated tourists

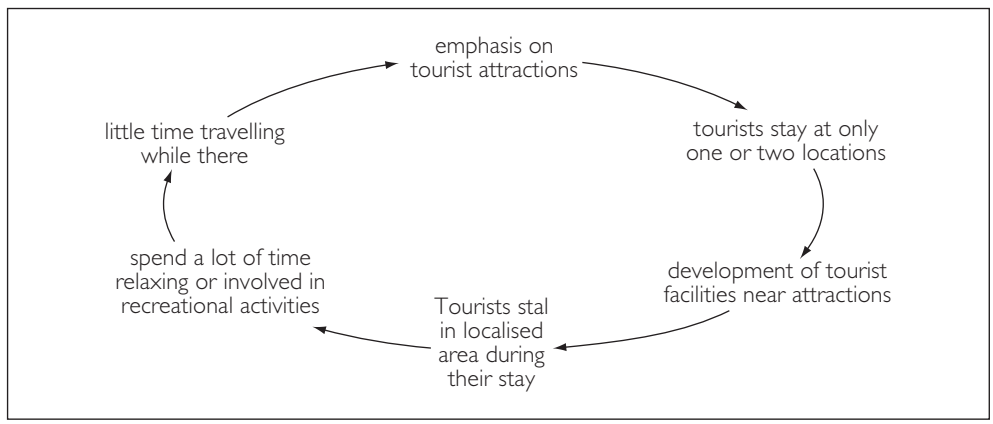


Figure 3.4.22 Leisure-orientated tourists

Activity 11

1. Refer to Figure 3.4.20. Head up two columns: TRAVEL-ORIENTATED; LEISURE-ORIENTATED. Reclassify the lists in Figure 3.4.20 under these two headings.
2. In a paragraph explain the differences between travel-orientated and leisure-orientated tourists.
3. State the different transport, accommodation, tourist attraction type and services/facilities each would need.
4. List examples of how tourism development in specific locations reflects the nature of tourist demand under the headings provided.

Travel-Orientated (Apia, etc)	**Leisure-Orientated** (a resort on Upolu's southern coast)

5 Study your own local area.

a What are the natural and/or cultural attractions it has?

b What is the range of facilities supplied to meet the demand for these attractions?

6 Redraw Figure 3.4.23 so that it is based on the needs of the leisure-orientated tourist rather than the travel-orientated tourist. Note any changes you may make to the diagram and explain them.

The cumulative effect

When enough people decide they want to travel to a particular location, tourism development occurs. These places respond with a **cumulative** growth phase. Figure 3.4.23 illustrates how the demand for tourist facilities establishes certain local characteristics but with an increase in demand, cumulative pressure is exerted which demands a response. That response is tourism development.

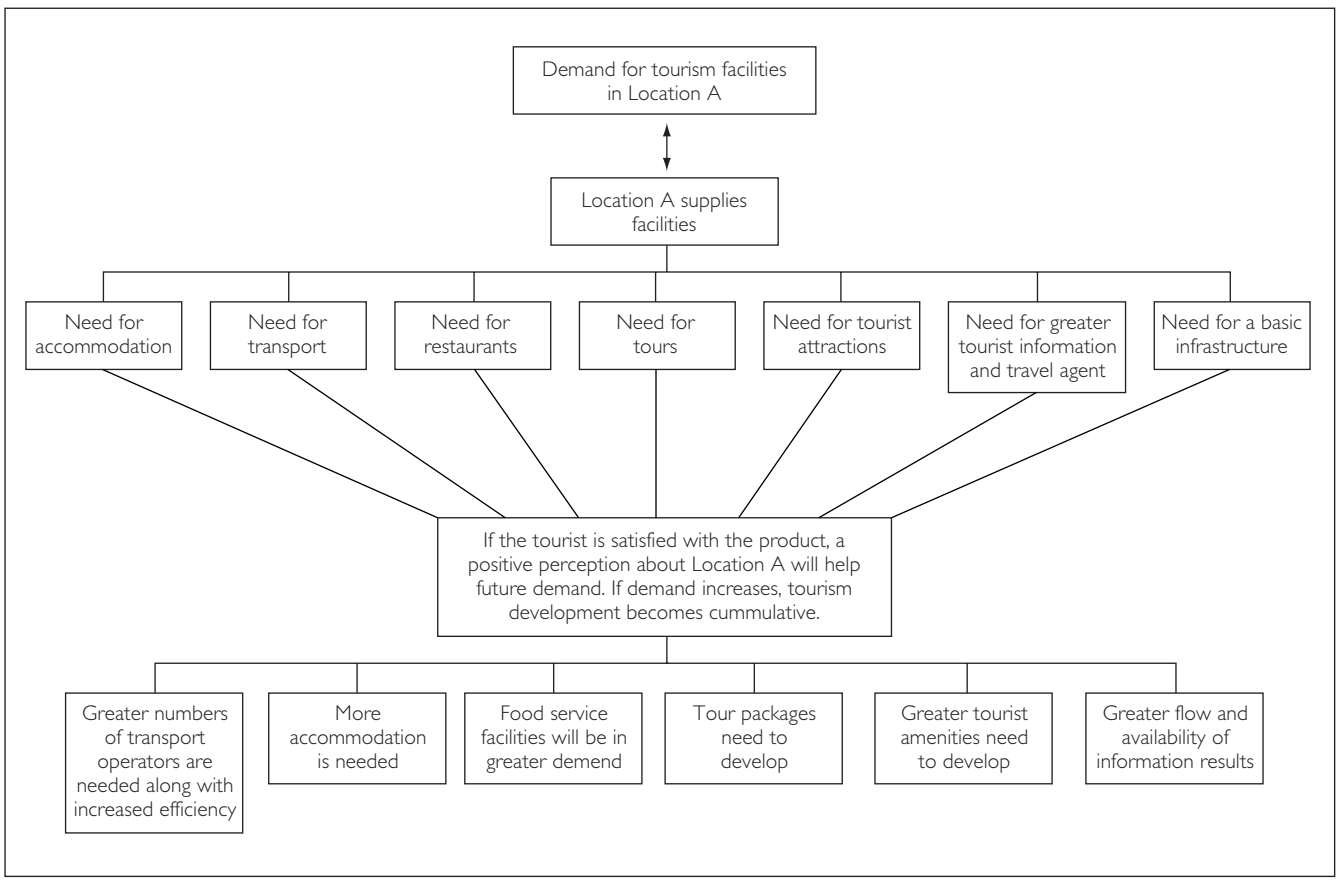
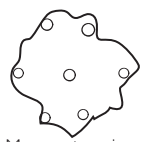
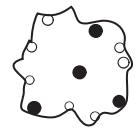
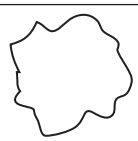
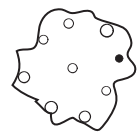
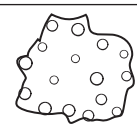
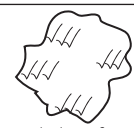
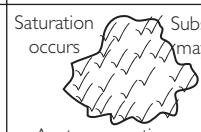
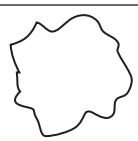
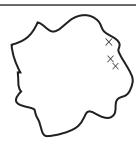
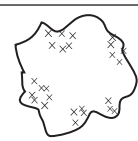
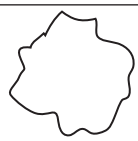
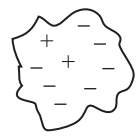
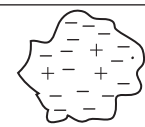
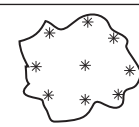


Figure 3.4.23 The cumulative effect of tourism development in the host community (based on the needs of the travel-orientated tourist)

PHASES / FEATURES	1	2	3	4
Accommodation	 No development	 First enterprise	 Many enterprises	 saturation Hierarchy specialisation
Tourist attractions	 No development	 First attraction	 Many attractions	 Hierarchy specialisation
Transport	 No network	 One link	 Increased linkage	 Internal maximum network established
Tourist perception	 No knowledge	 Some knowledge	 Full knowledge of many areas and some knowledge of others.	 Saturation occurs Substitution may result Acute perception – some businesses struggling
Service industries	 No development	 Small number of enterprises	 Many enterprises	 saturation Competition strong some businesses struggling
Attitudes of local population to tourist development	 Non-existent	 Indifferent	 Becoming negative	 Management plan needed to encourage negative people
Environmental impact	 No impact	 Little impact	 Increasing levels	 Management plan needed to reduce impact

Explanation

This Table Illustrates how tourism development evolves in a hypothetical situation. Changes occur over time relative to space and structure.

No development phase

The region/country is totally isolated from the outside tourist and tourism developer. Local residents have little perception of tourism in their environment.

Pioneer phase

Tourism development begins with developers showing an interest. As the tourist industry develops, associated activities grow. The perception of the place by outsiders becomes more positive and demand increases. Local resident attitudes to the development may vary.

Mature phase

Tourism and associated activities are booming. Local people become increasingly negative except for those whose livelihoods depend on the tourist industry. This results in management plans to ensure a balance between local and tourist needs, and avoid affecting tourist perceptions. Management plans are also needed to ensure environmental impact is minimal.

Saturation phase

A hierarchical pattern emerges in accommodation and attractions. Competition is keen and fierce. Expansion slows down. Some potential tourists will go elsewhere as diseconomies of scale are occurring. Expansion over space is replaced by rationalisation and specialisation. Cost structures are more efficient.

KEY


Hypothetical tourist area

Figure 3.4.24 Tourism development over time

Figure 3.4.23 illustrates the relationships between the supply and demand elements and the development of tourist facilities (refer to Figure 3.4.5). *Demand influences supply* which in turn has a direct relationship on the growth of facilities, i.e. attraction facilities.

The reverse can happen. *The supply of a natural attraction can create demand*. These interactions can be understood by the pull factor. The nature of a natural attraction and its associated perception by the world and local tourist sectors will decide the level that tourism development reaches. Tourism development often works in pull factor situations with a major natural attraction as the main reason a tourist wants to visit.

Figure 3.4.24a Tourism in operation

Cumulative development of other tourist activities may be set up to capture the market attracted by the natural attraction. Both Queenstown and Rotorua are examples of this in New Zealand. The cumulative effect of tourism development over time is illustrated in Figure 3.4.24.

Activity 12

1 You can test Figure 3.4.24 by setting up a research exercise. Establish a clear set of tasks that would need to be carried out in order to determine the practical value of the model.

2 Referring to Figure 3.4.24.

- **a** Write four paragraphs that summarise the phases of tourism development in the model. Give each phase a title.
- **b** Make a hypothetical bar graph which shows what the annual number of tourists might be for each phase.
- **c** Outline how life would change for locals through the four phases. Refer to the effects on social, economic, cultural and political aspects.
- **d** How might the changing attitudes of the local population affect tourism development?
- **e** Contrast the type of tourist who would prefer to visit the place when it is in phase 2 with the type who would prefer to visit it in phase 4.
- **f** Find the meaning of the term '**diseconomies of scale**'. See an economics textbook. How might this term explain what happens in phase 4? How might tourism development change direction in phase 4?
- **g** Discuss in class: *'Tourism development has been good for this location'*.

Case Study – Worldwide

Tourism development has been occurring worldwide since early times.

B.C.

Business travel and religious pilgrimages.

SPAS (18th and 19th Centuries)

Established in Britain and Europe based on those of Roman times.

EDUCATION (18th and 19th Centuries)

Wealthy British people travel to the Continent to visit cultural centres, e.g. Venice, Florence and Paris.

TRANSPORT REVOLUTION (19th Century)

1820 – steamboat services across the English Channel to the Riviera in France.

– steamship services to India and Far East.

1838 – P & O begin operations to India and Far East

1841 – Thomas Cook begins chartered train trips.

1850 – excursions to the beach by train become popular in Britain.

1867 – Thomas Cook develops package tours

1869 – completion of the Suez Canal 1870.

– rapid growth of resorts at rail heads

– resorts on the Continent develop, e.g. Monte Carlo.

LITERATURE REVOLUTION 1890–1918

1890s – travel documents in guidebook form appear.

– WW1 results in the use of passports and identification for all independent states.

1918 – widespread mass communication in the western world results in a boom in foreign travel.

NEW TRANSPORT REVOLUTION 1920–1970

1920s – increasing use of private motor car opens up opportunities for travel and threatens the rail industry on the continent of Europe.

– an associated boom in holiday camps aimed at the low income market.

1940s – WWII revolutionises aviation and therefore tourism to countries across the sea.

1950s – private motor car increases in significance resulting in the development of stopover accommodation and rental cars.

– jet aircraft introduced.

– Boeing 707 introduced and big ocean liners begin to phase out

1960s – mass market package tours dominate international travel.

NEW DESTINATIONS 1970s–2000s

1970s – Asian and Arab countries enter the tourist market.

– leisure time increases, more people take holidays

– Jumbo Jet aircraft lower travel costs.

– tourists travel further because of speed of travel.

1980s/90s – rising incomes throughout Asia bring huge increases in Asian tourists.

– growth in business tourism, conferences and conventions.

– many more cost efficient/imaginative package deals from highly competitive tourist industry.

2000s – return of cruise ships and their package tours

– rise in 'movie' tourism (to see places that were used in films), e.g. New Zealand for Lord of the Rings fans.

Activity 13

Map the significant events and their locations in the development of tourism on the global scale.

Case Study – The Gold Coast

Table 3.4.6 Chronology of tourism development

Development Projects	Building Projects	Tourist Numbers
1930 – Land reclaimed by pumping sand from the Nerang River.	1925 – First hotel established at Elston.	
1933 – Elston changed its name to Surfers Paradise.		
1939 – Coolangatta airport opened.		
1956 – Ansett Airlines move main office to Surfers Paradise.		
1957 – Canal estates were created (on Florida model).		
1958 – Australian Airlines opened its office in Surfers Paradise.		
	1960 – First high-rise completed (11 storey Kinkaboo).	
	1964 – Paradise Towers opened.	
1965 – Gold Coast bridge opened linking Surfers with Brisbane more efficiently.	1966 – The Sands, Suntower and Sahara Court high-rise accommodation units opened.	
	1967 – Garfield high-rise opened.	
1968 – Surfers Golf Club established.	1968 – Panorama Tower high-rise opened.	
	1969 – 'Ten the Esplanade' high-rise opened.	1969 – 61 563 passengers through Coolangatta airport.
	1970 – The Shore and River Bank Tower opened.	
1971 – Sea World opened.	1971 – Apollo and Iluka high-rise buildings opened.	
	1972 – Chateau and President opened.	
	1973 – The Anchorage and Allawah high-rise buildings opened.	
	1974 – Batina and Pacific Plaza high-rise buildings opened.	
1975 – Visitors Bureau established.	1975 – The Breakers and Condor high-rise buildings opened.	
	1976 – Narrow Neck Court, The Grosvenor, and Focus high-rise opened.	
	1977 – Golden Gate, Sunseeker and Westernways high-rise buildings opened.	
	1978 – Thorton Tower, Yachting Towers and Surfers International high-rise opened.	
1979 – Queensland Tourist and Travel Corporation established.		
1981 – Coolangatta Airport upgraded.	1979 – Seven high-rise accommodation blocks opened.	
1981 – Dreamworld opened.	1981 – 19 high-rise buildings opened.	
1984 – Direct rail link between Brisbane and Surfers commissioned.	1982 – 18 high-rise buildings opened.	
	1985 – Conrad International Hotel opened (largest in Australia).	1987 – 930 354 passengers through Coolangatta airport.
1985 – Jupiter's Casino opened.		
1991 – Warner Bros Movie World opened.	1989 – Ocean Place Pan Pacific Hotel complex opened.	1994 – 1 747 298 passengers through Coolangatta airport.

(cont.)

The Gold Coast attracts the largest amount of tourism investment in Australia with approximately $1410 million recently completed, $1583 million under construction, $2365 million committed and $3151 million proposed as at 30 June 1990. Refer to Figure 3.4.7.

Table 3.4.7 Tourism Development on the Gold Coast (early 1990s)

1		2		3		4		2+3+4	
Recently completed		**Under construction**		**Firmly committed**		**Proposed**		**Total**	
$M	Rooms	$M	Rooms	$M	Rooms	$M	Rooms	$M	Rooms
1410	3621	1583	2432	2365	3249	3151	4408	7099	10 089

Note
These developments include not only accommodation but infrastructure, theme parks and relevant marina developments, with capital costs of over $5 billion.

Activity 14

1 From Table 3.4.6 state which element has been dominant in the Gold Coast's tourism development.

2 Construct a table comparing the main elements in the tourism development of Sāmoa, the world, and the Gold Coast.

3 What do Table 3.4.7 and Figure 3.4.25 suggest about the future of Tourism Development on the Gold Coast?

The photograph series illustrates how the process has taken place over time with bare land converting to high-rise, high density buildings, or large leisure facilities for tourists.

Figure 3.4.25 Sea World site 1978

Sea World 1988

(cont.)

Activity 15

1 Construct a précis map of the 1988 photograph. On it locate Sea World as it was in 1978.

2 What features shown on the 1988 photograph were there in 1978?

3 Refer to photographs 3.4.27.

a Count the number of high-rise buildings in the 1975 photograph. Repeat for the 1988 photograph.

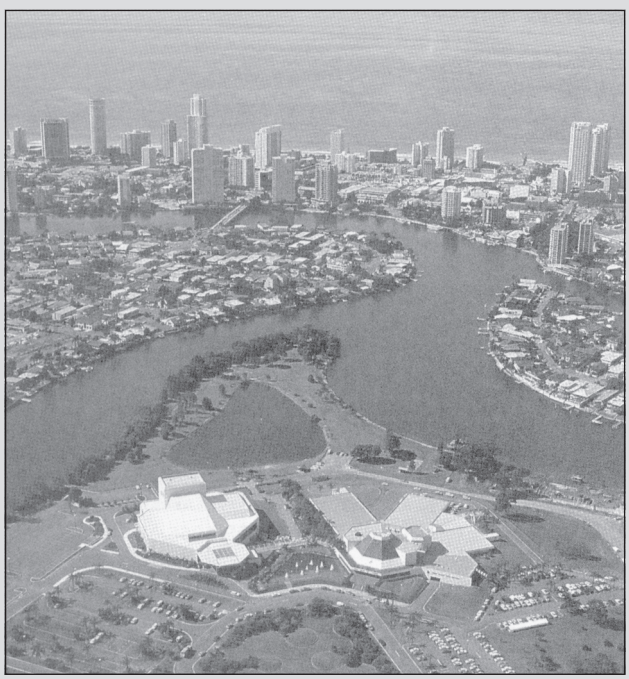
b What percentage increase in high-rise buildings occurred in this 13 year period?

c How many buildings per year on average were constructed in this time period?

Figure 3.4.26 Conrad Hotel and Jupiter's Casino site 1978

Conrad Hotel and Jupiter's Casino 1988

Figure 3.4.27 Surfers Paradise 1975



Surfers Paradise 1988

(cont.)

Activity 16

1 Refer to photographs 3.4.28.

a Draw a sketch map of the 1956 photograph.

b On your sketch map locate and label the land-use changes as shown by the 1988 photograph.

2 If the photographers were facing north when the two photographs in Figure 3.4.29 were taken, in which direction were the photographers facing when the photographs in Figures 3.4.25 and 3.4.28 were taken?

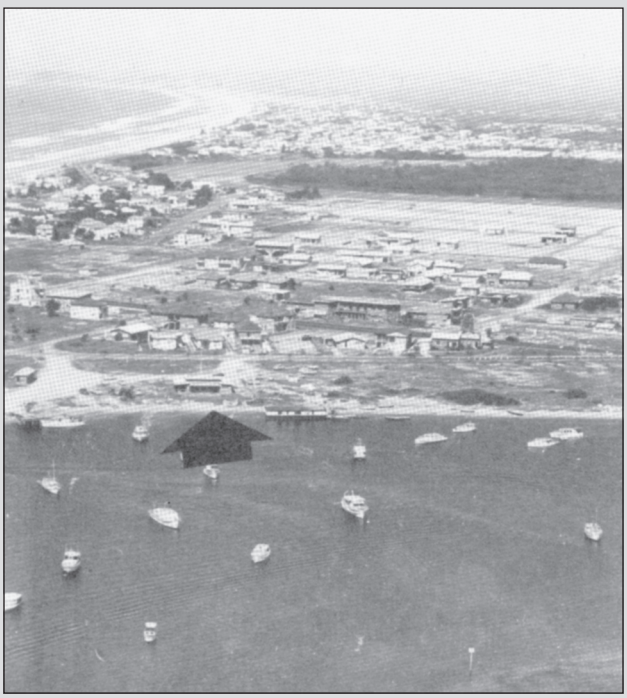
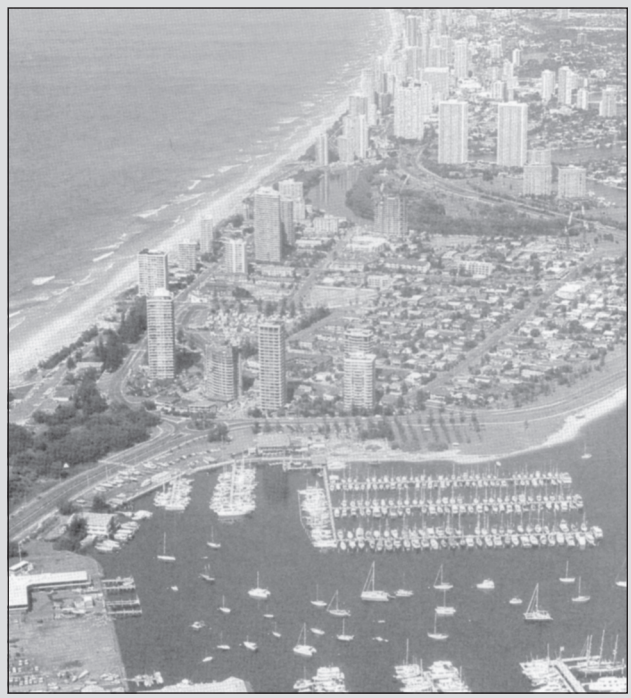
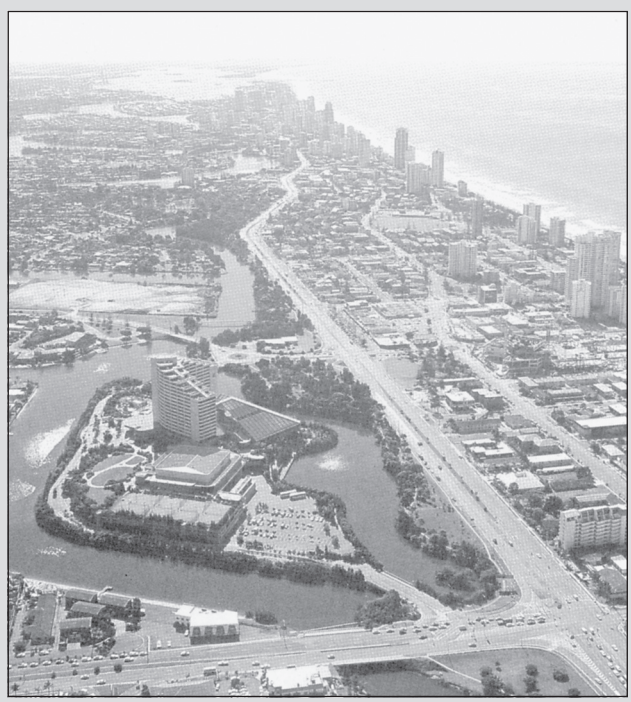


Figure 3.4.28 Broadwater to Broadbeach 1956



Broadwater to Broadbeach 1988

Figure 3.4.29 Broadbeach to Broadwater 1956



Broadbeach to Broadwater 1988

The Impact Of Tourism

How has tourism development affected the distribution of other phenomena?

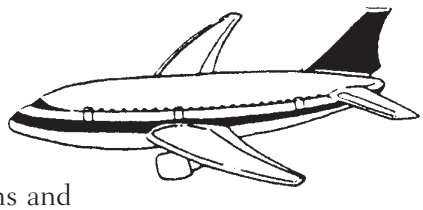
Key Words

Distribution
Phenomena
Space
Direct contact
Indirect contact
Induced jobs
Environment

Key Ideas

- Phenomena which are inter-related form patterns in **space**. Such patterns can be identified and interpreted.
- All spatial patterns are the result of processes.
- Some spatial patterns are the result of people's organisational structures, either social, economic or political.
- The distribution of many geographic features has been influenced by tourism development.

Tourism development affects the **distribution** of economic, socio-cultural and environmental **phenomena.** Tourism development on each of these elements can act positively or negatively, directly or indirectly.



Economic phenomena

Transport systems

As transport is an integral part of tourism, the patterns of transport systems and the volume of flow will be directly affected. Figure 3.4.30 illustrates the effect tourism development can have in terms of volume, road quality and the pattern of roading.

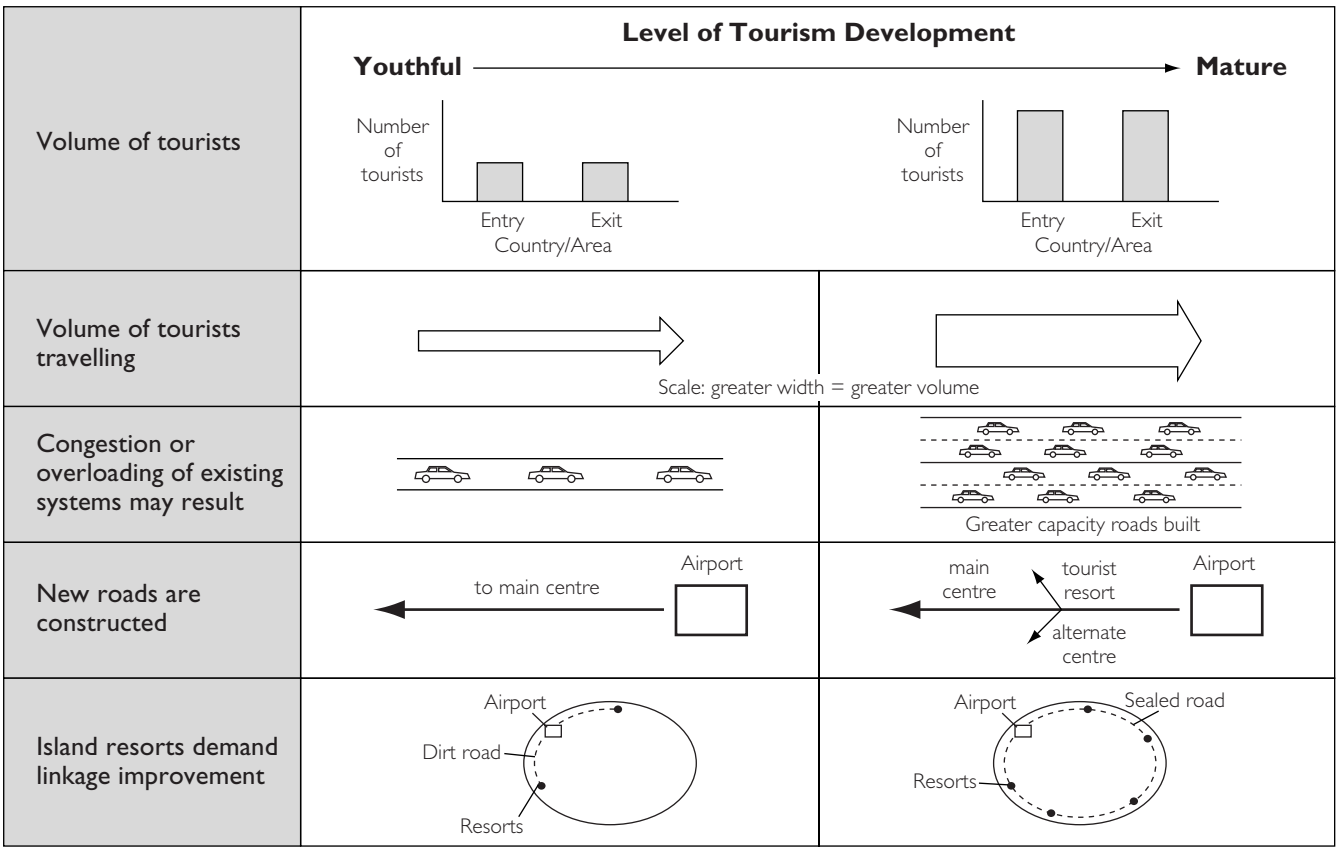


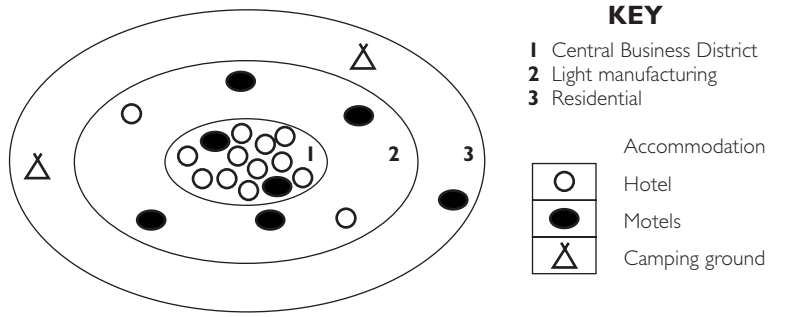
Figure 3.4.30 Effects on transportation systems

Accommodation

Tourism development means that more tourists will want more different types of accommodation. Accommodation facilities tend to be concentrated close together although there are some exceptions. Figures 3.4.31–3.4.34 illustrate how tourism growth influences the pattern of accommodation in a range of locations.

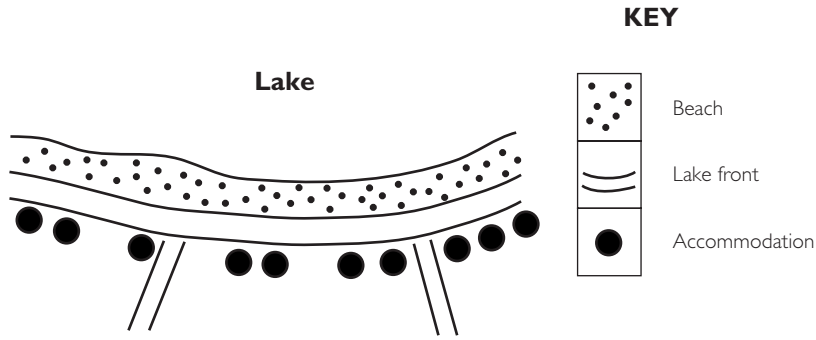
3.4.31 Urban areas

In urban areas that receive high volumes of tourist traffic accommodation types concentrate in the Central Business District and their frequency decreases as the distances from the Central Business District increase.



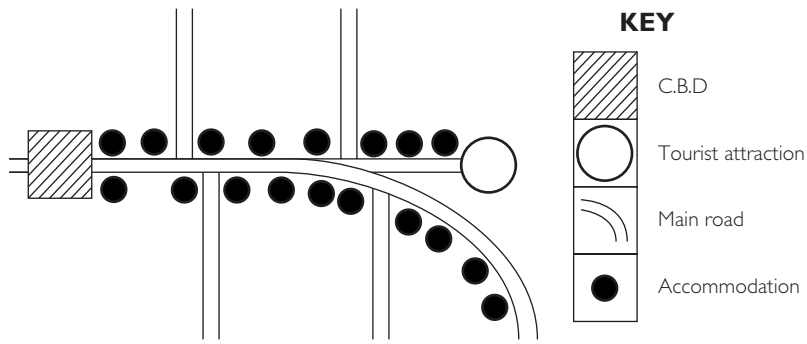
3.4.32 Near a physical attraction

A natural attraction can encourage the development of accommodation to concentrate. The primary motivation is the demand of tourists for accessibility and a view.



3.4.33 Adjacent (near and joined to) to a transport link

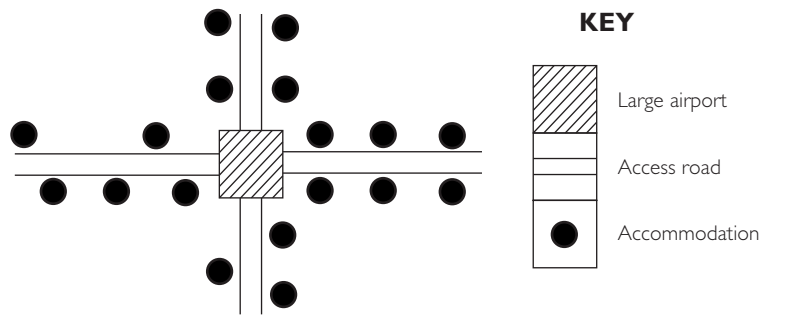
Accommodation is also attracted to major access routes that link a Central Business District to a tourist attraction. Accessibility saves time and money for the tourist.



3.4.34 Near a major transport node

The dramatic rise in air travel in the last 20 years means vast numbers of people are mobile and therefore in transit. These people require:

- overnight accommodation while awaiting connecting flights
- 2–3 days' accommodation during a stop-over en route to another location.



Figures 3.4.31–3.4.34 Effect of tourism development on accommodation location

Activity 17

1 Refer to Figure 3.4.30.

- **a** What happens to transport systems as the number of tourists increases?
- **b** How can planners tackle these problems?
- **c** As tourism development increases, what happens to transport networks?
- **d** How do locals benefit from this aspect of tourism development?
- **e** Construct a table similar to Figure 3.4.30 for a beach resort that is a long way from the airport
- **f** How does this type of tourism development affect the distribution of transport networks?

2 Trace Figure 3.4.31. Add to it the likely location of main transport links.

3 Refer to Figures 3.4.31 and Figure 3.4.35. Account for the pattern of accommodation on Figure 3.4.31 using Figure 3.4.35. Refer specifically to the differences in location of the three accommodation types.

4 The pattern of accommodation in Figures 3.4.32, 3.4.33 and 3.4.34 can be called *linear*. Describe and explain this.

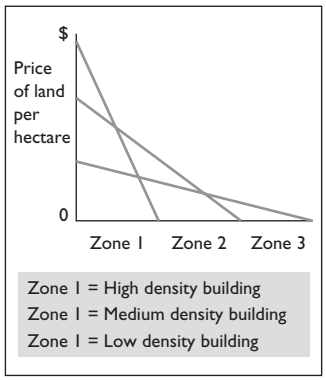


Figure 3.4.35 Changing morphology

Retail sector

Tourism development has a direct influence on the distribution of the retail sector in areas of distinct tourist activity.

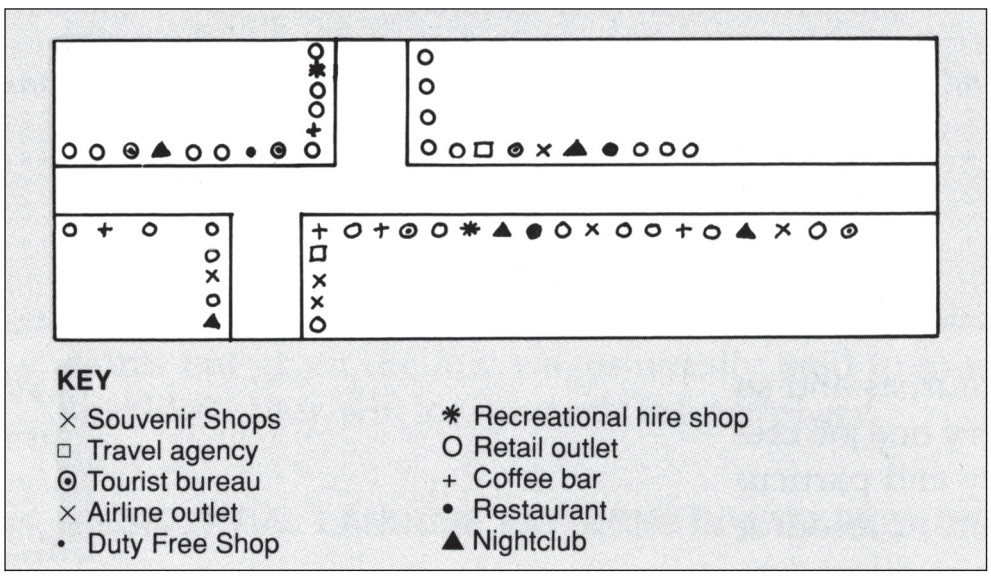


Figure 3.4.36 Central Business District – linked retail activity

Tourism development can affect the distribution of retail activities in two ways:

- ❑ if a CBD already exists and is near to tourist attractions, tourism development will cause *clustering together* of retail activities
- ❑ where a CBD is not in existence close to the attractions, a Retail Business District can grow, providing shops and services purely for the tourist trade.

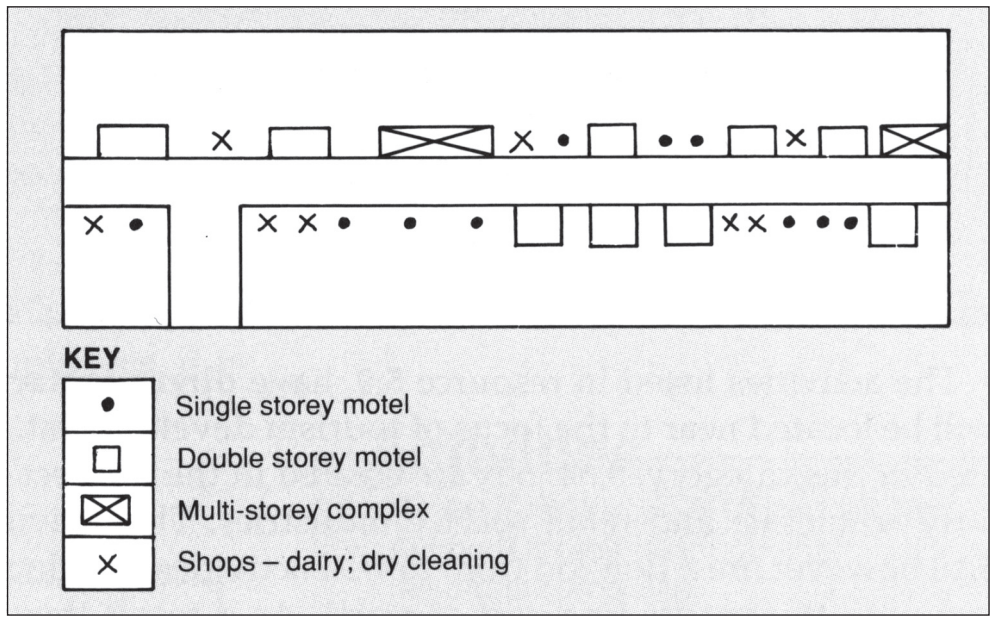


Figure 3.4.37 Accommodation-linked retail activity

If tourism development results in a demand for accommodation, it can also create a need for retail and service outlets. At the same time tourists who stay in motels and hotels may need retail shops which sell food and various personal needs, and they may need the services of a laundry and hairdresser. A concentration of accommodation produces a pattern of retail and service outlets spread out in small clusters between accommodation businesses.

Support services

Without certain support services there would be no tourism development. Some of these services depend directly on tourism development, others depend indirectly. This interdependence influences their distribution.

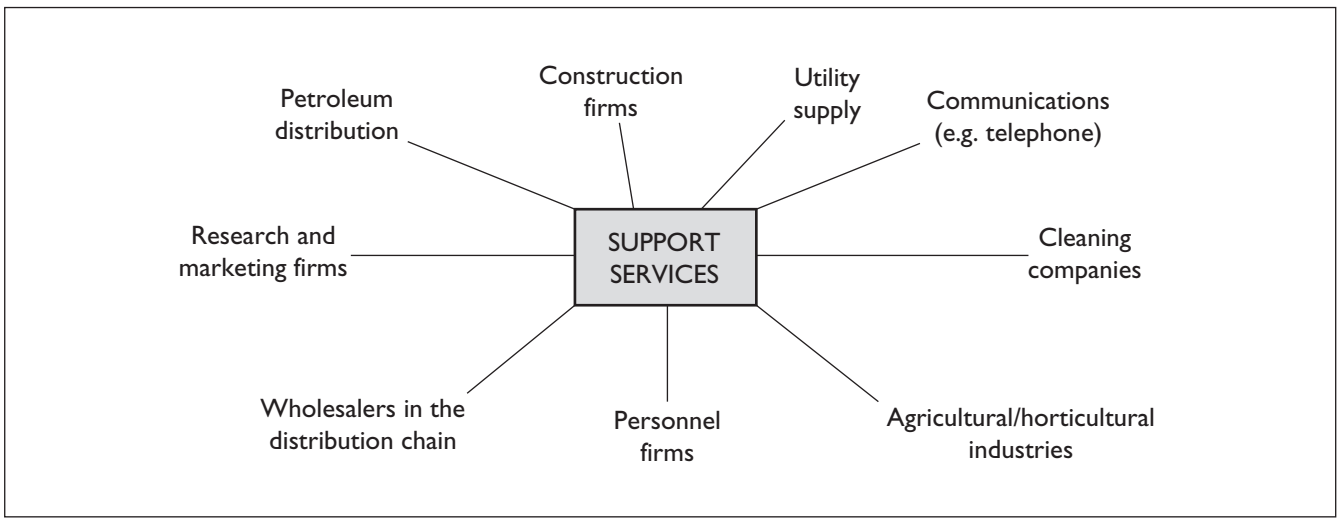


Figure 3.4.38 Support services

Because tourism development implies growth and increasing demand it affects the distribution of these phenomena in three ways. It:

- ❑ consolidates or strengthens the location of these activities accessible to tourist activities
- ❑ creates a corresponding growth from services which may expand and need more space
- ❑ may attract more enterprises which offer the same services and create competition for the best locations. This can create an expansion of the retail business district (RBD) or an intensification of land use within it (e.g. multi-storey buildings).

Activity 18

Construct a cumulative causation model for Figure 3.4.36 or Figure 3.4.37 that shows the cumulative effect tourism development has on the distribution of accommodation and retail activities.

Activity 19

1. Construct your own version of Figure 3.4.36. Add support services such as banks, another duty-free shop, etc. This may need intensification of land use (e.g. multi-storey buildings).
2. Give reasons for your siting of the duty-free shop.
3. What would be the impact on the existing duty-free shop?
4. What would happen to the distribution of retail and service activities with the addition of new activities?

Employment

Some areas of employment are directly influenced by tourism development, others only indirectly.

- ❑ Travel agencies, e.g. agents, secretaries
- ❑ Accommodation facilities, e.g. managers, cleaners
- ❑ Transport companies, e.g. van drivers, taxi drivers, bus drivers
- ❑ Souvenir shops, e.g. shop assistants
- ❑ Tour companies, e.g. guides, drivers
- ❑ Souvenir manufacturers, e.g. machinists
- ❑ Entertainers and cultural group performers

Figure 3.4.39 Jobs directly created by tourism development

- ❑ Construction and decorating, e.g. painters
- ❑ Agriculture, e.g. farmers, labourers, tractor salespeople
- ❑ Wholesale trades, e.g. clothing salespeople, food stockists
- ❑ Professional services, e.g. accountants, bank managers, lawyers

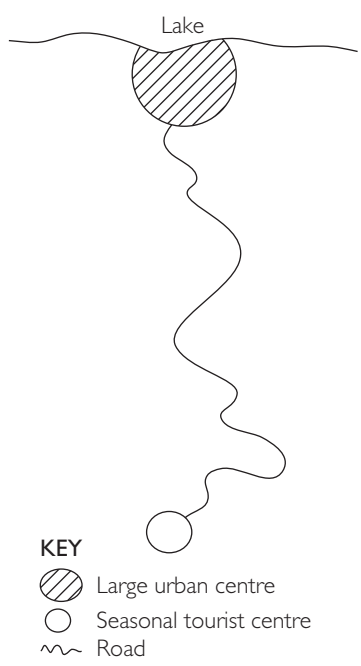
Figure 3.4.40 Jobs indirectly created by tourism development

The activities listed in Figure 3.4.39 have **direct contact** with tourists and so will be located near to the focus of tourism development. For every one job created in this category, 0.64 jobs are created in the indirect category and particularly wholesale and retail service industries. The activities listed in Figure 3.4.40 however are a flow-on from tourist activities and do not require direct contact with the tourist (**indirect contact).** As a result they can be located away from the RBD (retail business district), even in another location altogether.

The relative importance of the tourist industry to a location's economy determines the impact of tourism development on influencing where people work.

Table 3.4.8 Tourism-related employment

Economic Activity	Number of jobs produced by the tourist sector		
	Location A	*Figure 3.4.41*	**Location B**
Souvenir shops	III		III
Motels	IIIIIIII		IIIIIIIIIII
Tour operators	IIIII		IIII
Ski-field operators	IIIIIIII		
Amusement park operators	I		III
Bus/taxi drivers	III		IIIIIIIII
Travel agents	III		IIIIII
Photographic labs	III		IIIIIII
Tearooms	III		IIIIIIII
Restaurants	II		IIIIII
Foodstuff retailers	I		IIIIIIIIII
Shoe/clothing retailers	I		IIIIIIII
Mechanics	II		IIIII
Liquor wholesalers	I		IIIII
Fast food outlets	II		IIIII



Activity 20

Refer to Table 3.4.8 and Figure 3.4.41.

1. Identify which locations on Figure 3.4.41 are locations A and B from Table 3.4.8.
2. Which location has the highest *proportion* of jobs directly created by tourism development?
3. Which location will provide the greatest number of job opportunities?
4. Which location will produce the greatest concentration of tourist-related jobs?
5. What type of person is most likely to seek employment at the seasonal tourist centre?
6. How might a tourist resort area located some distance from a major urban area promote regional development?

Socio-cultural phenomena

Residential areas

As tourism development occurs, more jobs are created and more people move into the area.

Where tourism development creates a demand for hotel/motel accommodation, the price of land will rise in certain preferred locations. This combined with possible zoning regulations will make these locations inaccessible for the average house buyer.

Workers employed in the tourist industry will desire to live near tourist centres but given the low wages usually paid to tourism employees, it is more likely they will live towards the periphery.

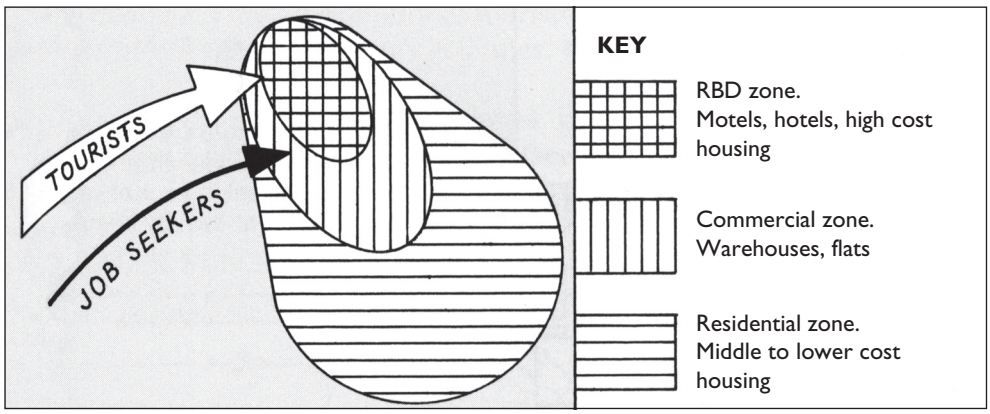


Figure 3.4.42 Residential landuse patterns in a tourist centre

Recreation and leisure

The process of cumulative causation ensures that where tourism development occurs, existing recreational resources will be developed (particularly natural) and new ones created. The location of the former is largely determined by the location of the resources themselves (e.g. beaches) whereas the location of the latter is largely determined by the availability and cost of land (e.g. sports park).

Attraction → Amenities → Tourists → More attractions
- other natural attractions
- cultural attractions

Figure 3.4.43 Cumulative causation

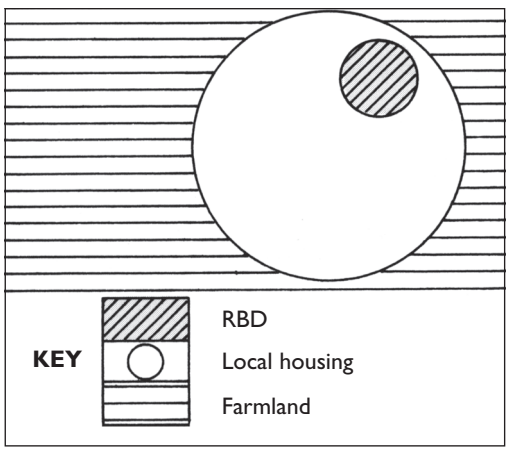


Figure 3.4.44

Activity 21

1 Refer to Figure 3.4.42 and Figure 3.4.35. Account for the distribution of residential land use.

2 How are the choices of locals both widened and limited by tourism development?

3 If Figure 3.4.43 were to be constructed as a cycle, where would the next arrow go?

4 Imagine you are a planner. Where on Figure 3.4.44 would you locate a park for children? Why? Refer also to Figure 3.4.35.

Cultural interaction

The degree of interaction between tourists and locals, particularly if they are of different cultures, can create variations in the distributions of cultural interaction.

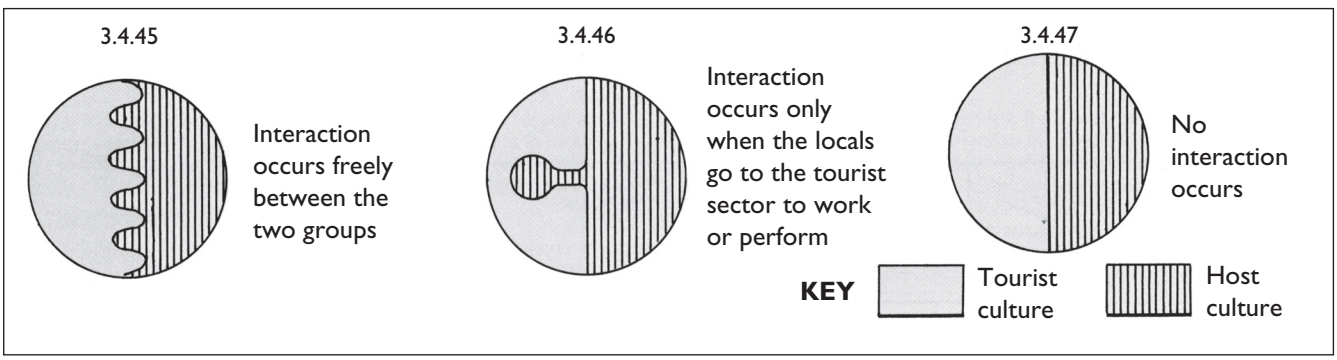


Figure 3.4.45–3.4.47 Variations in cultural attractions

While tourists and locals are accommodated in separate areas (see Figure 3.4.42), in Figure 3.4.45 the boundaries are fuzzy and the two groups interact freely. In Figure 3.4.46 however the interaction is indirect, only occurring because the locals work in tourist-orientated occupations. In Figure 3.4.47 the local culture remains totally separate, protecting itself from outside influences.

Tourism development can on the one hand be seen to be preserving local culture and on the other destroying it, depending on one's perception. If the local culture is part of the tourist attraction, historic art forms, sites, villages and burial grounds are protected. The danger of this is that the local culture is hijacked by tourist and commercial demands and ceases to be a spontaneous expression of local life. Either way, the preservation of local culture for tourist purposes ensures that the distribution of these activities remains fixed.

Environmental phenomena

Pollution

As tourism development occurs the potential for more pollution increases, e.g. visual pollution (Figure 3.4.48).

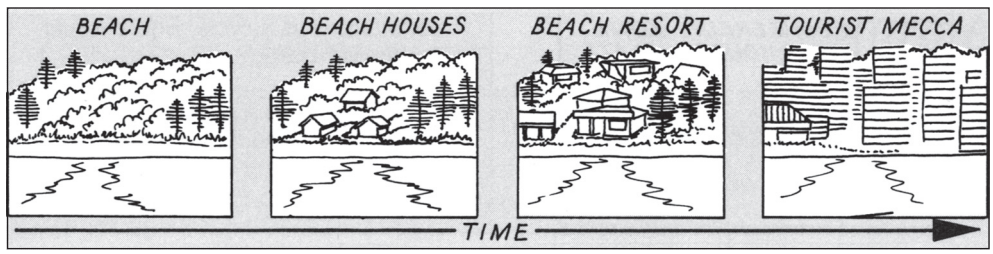


Figure 3.4.48 The development of visual pollution

Pollution is likely to be focused in areas where tourist attractions and related activities are concentrated (Figures 3.4.49, 3.4.50, 3.4.51, 3.4.52).

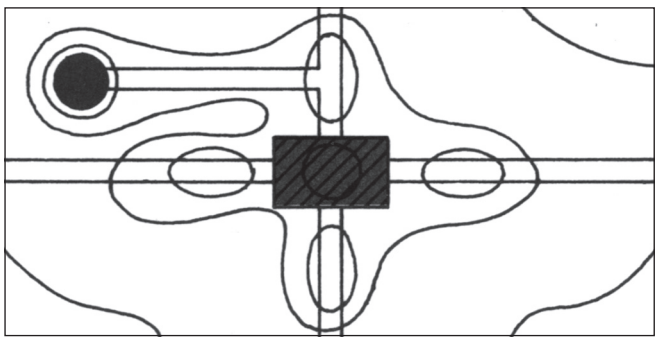


Figure 3.4.49 Air pollution

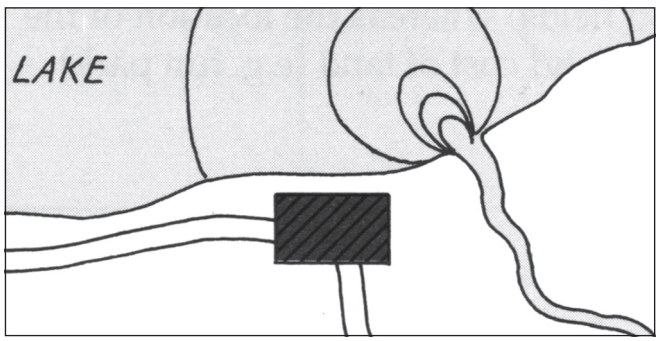


Figure 3.4.50 Water pollution

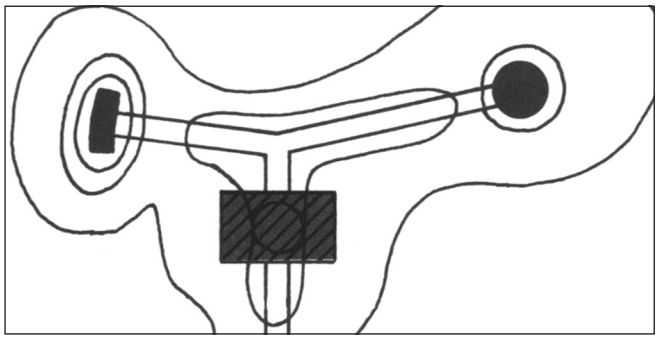


Figure 3.4.51 Noise pollution

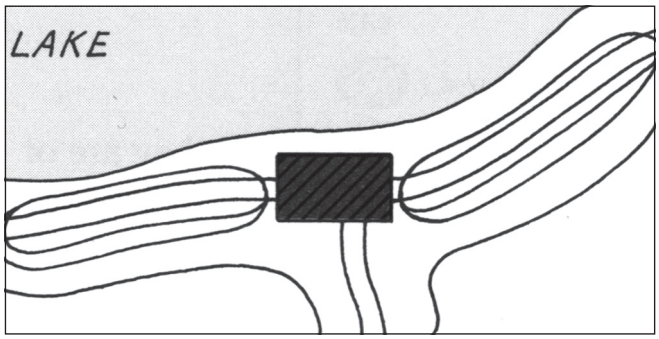
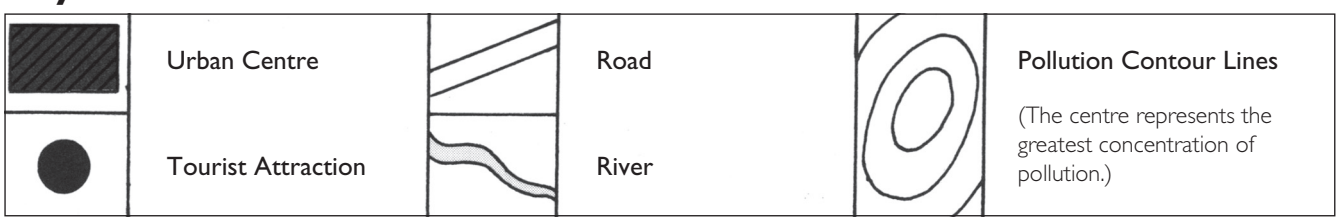


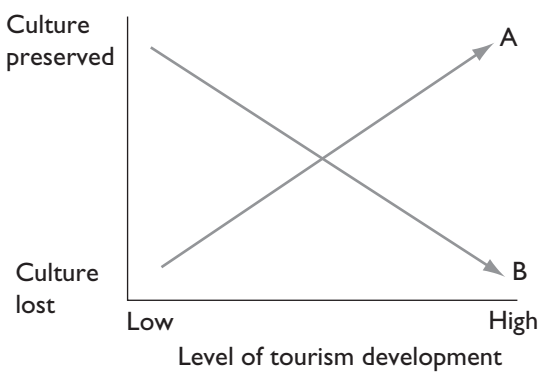
Figure 3.4.52 Visual pollution

Key



Activity 22

1. Analyse the relationship between two cultures that you are familiar with. Decide which of the cultural interaction models your examples fit.
2. Is there any evidence of cultural interaction patterns similar to Figures 3.4.45, 3.4.46 or 3.4.47 in your community? Discuss in class.
3. Look at the Figure below.



Choose a cultural tourist attraction in your community. Decide whether tourism development in your area has had the effect shown by line A or by line B.

Activity 23

1. Refer to Figure 3.4.48 and Figure 3.4.53. Locate on Figure 3.4.53 where each stage in Figure 3.4.48 would be found. What are the implications for tourism development at this beach location?
2. Refer to Figures 3.4.49–3.4.52. Where the pollution lines are close together, pollution is greatest.
   - **a** Describe the patterns of pollution for each resource.
   - **b** Account for the patterns.
3. Apply Figure 3.4.53 to the following scenarios.
   - **a** Vegetation damage on a famous bushwalk.
   - **b** Disintegration of artefacts touched by tourists in a museum.
4. Refer to Figures 3.4.48 and Figure 3.4.54. Construct a conflicting perceptions diagram for the beach in Figure 3.4.48.

Different locations experience different levels of pollution as illustrated by the pollution continuum (Figure 3.4.53).

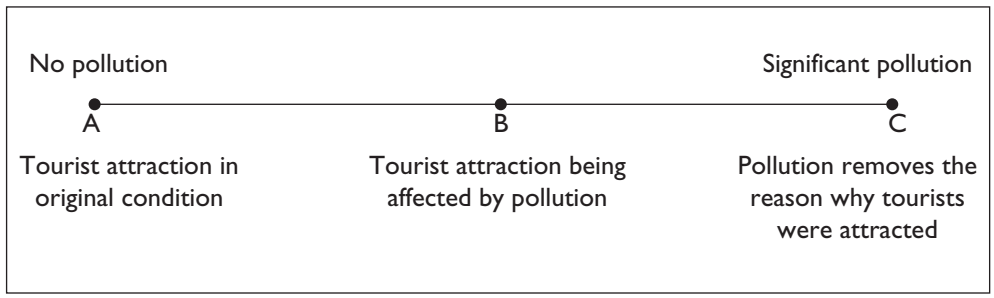


Figure 3.4.53 Pollution levels

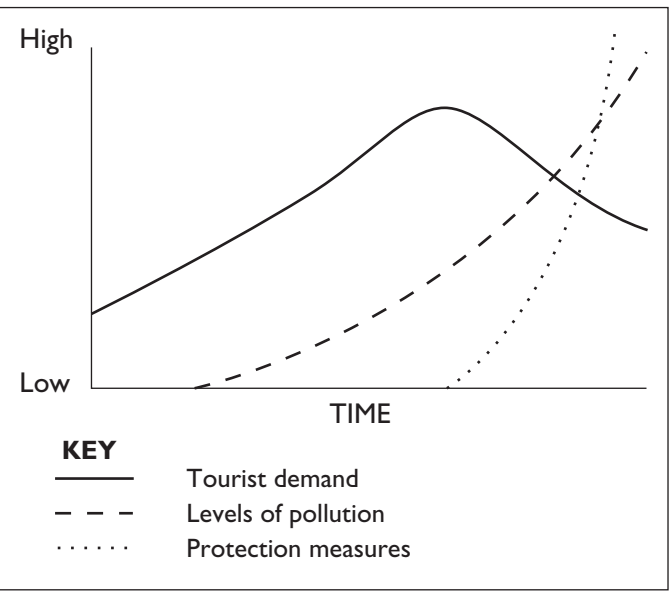


Figure 3.4.54 Tourism development and pollution

If pollution reaches excessive levels the basis for tourism development in a particular location can be removed. If this happens, the phenomena caused by tourism development collapse and move out. The other alternative is for local bodies to take over control of the attraction and allow recovery by limiting tourist access, or by prohibiting access altogether (Figure 3.4.53).

Any change to the access for tourists to certain attractions would clearly affect the distribution of many activities.

If damage to an attraction continues, conflict between interested parties with opposing perceptions is likely (see Figure 3.4.54). This may possibly result in distribution changes, depending on the outcome of the conflict.

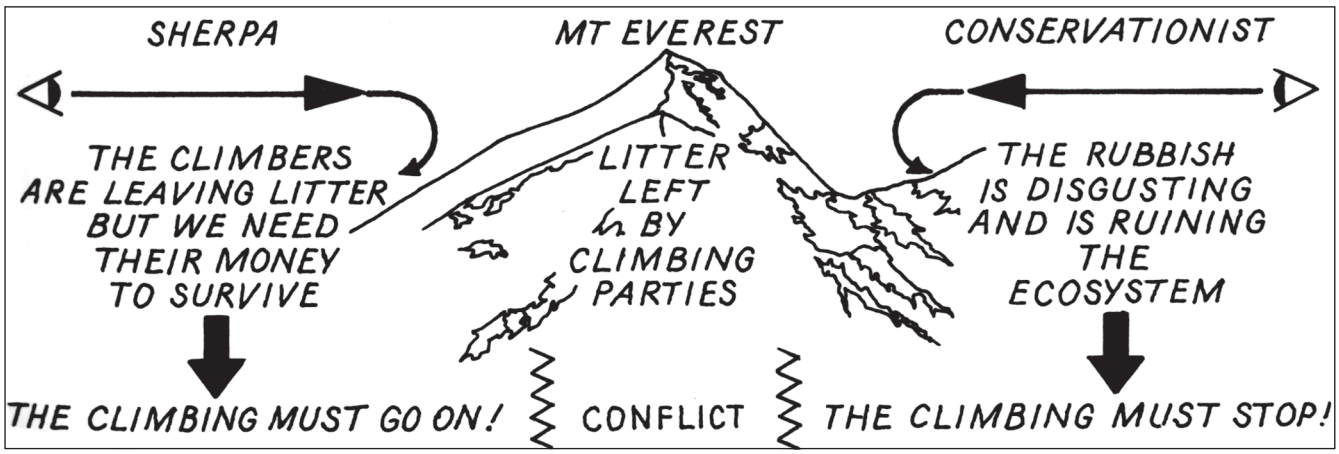


Figure 3.4.55 Contrasting perceptions

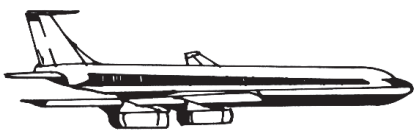
Case Study – Gold Coast

Economic phenomena

Transport

Air

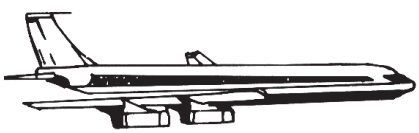
Domestic Tourists



BRISBANE AIRPORT
(55% increase 1988–1993)

COOLANGATTA AIRPORT
(53% increase 1988–1993)

International Tourists



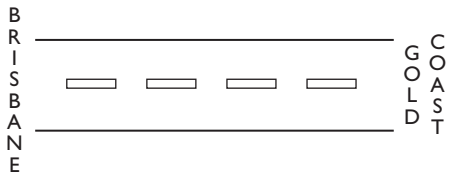
BRISBANE AIRPORT

1984	430 419
1986	527 341
1988	788 444
1990	1 019 289
1992	1 274 048
1994	1 599 086

*Largest absolute increase of any Australian airport

Road

More and more people using existing facilities



- widening of the roads
- one way streets
- more efficient control mechanisms (e.g. roundabouts)
- improved residential access (e.g. bridges)

Figure 3.4.56 The Implications for transport of more tourists

Accommodation

Figure 3.4.12 on page 111 illustrates that the distribution of available accommodation on the Gold Coast has two patterns:

- linear pattern along the coastline from Coolangatta to Surfers Paradise because tourists demand to be near the beach
- concentration between the beach and Nerang River because the tourist-related activities are located close together.

(cont.)

Retail sector

Tourism development has influenced the distribution of the retail sector in two ways:

- the linear pattern of roading along the coast affects where people build takeaway outlets, small shops, dry-cleaning outlets, banks and basic services needed along these routes
- the oval-shaped Central Business District in the heart of the Gold Coast with its vast range of outlets yet high degree of specialisation.

Employment

Table 3.4.9 Estimated employment generated by tourism in Queensland

	1987/88	**1988/89**
Domestic Market		
Direct and Indirect Employment	66 423	80 539
Induced Employment	32 813	39 787
Employment Generated by Domestic Tourism	99 236	120 326
International Market		
Direct and Indirect Employment	31027	20 989
Induced Employment	14 839	35 635
Employment Generated by Domestic Tourism	45 866	56 624
Total Market		
Direct and Indirect Employment	97 450	118 946
Induced Employment	47 652	58 004
Total Employment Generated	**145 102**	**176 950**

(cont.)

Tourism-Generated Employment Using Another Popular Tourist Destination As An Example (Rotorua, New Zealand)

Calculate the International Multiplier using formula A

A International:

680 international person nights create	1 direct job
	0.69 indirect jobs
	2.83 induced jobs

Calculate the Domestic Multiplier using formula B

B Domestic:

2770 domestic person nights create	1 direct job
	0.61 indirect jobs
	2.83 induced jobs

[The large difference between the international and the domestic markets (680 to 2770) reflects the very different spending patterns between these groups.]

Combine A and B to develop a regional multiplier

This regional multiplier can be applied to Rotorua as follows:

International tourists

International tourists visiting Rotorua City	325 931
Multiplied by average length of stay	2.3
International person nights	749 641
Divided by number of person nights to generate	
1 direct job	680
Number of direct jobs	1102
Number of indirect jobs (0.69 x 1102)	760
Number of induced jobs (1102 x 2.83)	3118.66

Domestic tourists

Domestic tourists visiting Rotorua City	621 000
Multiplied by length of stay	2.7
Domestic person nights	1 676 700

(cont.)

(cont.)

Divided by number of person nights to generate	
1 direct job	2770
Number of direct jobs (0.61 x 605)	605
Number of indirect jobs	369
Number of induced jobs (2.83 x 605)	1706

Based on these calculations the employment generated by tourism in Rotorua would be in the region of:

i 1700 direct jobs

ii 1130 indirect jobs

iii 4800 induced jobs

Figure 3.4.57 Tourism-generated employment using Rotorua, New Zealand as an example

Activity 24

1 The Gold Coast had 32% of Brisbane's total visitor nights in 1988/89. Tourism therefore supported a total of 38 929 employees.

The average length of stay in the Gold Coast region for the same period was 7 nights.

Given this data plus Table 3.4.9, refer to Figure 3.4.57 and calculate the direct, indirect, and induced employment resulting from tourism on the Gold Coast.

2 Compare the results of your calculations above to those for Rotorua (Figure 3.4.57).

3 On the basis of the distribution patterns of transport, retail and employment (see the text), make conclusions on the likely pattern of employment distribution from tourism development on the Gold Coast.

Socio-cultural phenomena

Residential areas

Tourism development has directly affected where residential suburbs have been built on the Gold Coast (see Figure 3.4.58 and Figure 3.4.59).

Leisure areas

Tourism development meant leisure facilities were largely confined to the coastal strip along the Gold Coast. Originally the beach was an attraction and leisure activities were set up for the tourists to have more access to the beach. Now that the Gold Coast has a clear accommodation and retail sector the associated agglomerative effect means that most leisure activities are in or close to this strip with the main concentration being in or near to Surfers Paradise (see Figure 3.4.58 and Figure 3.4.59).

(cont.)

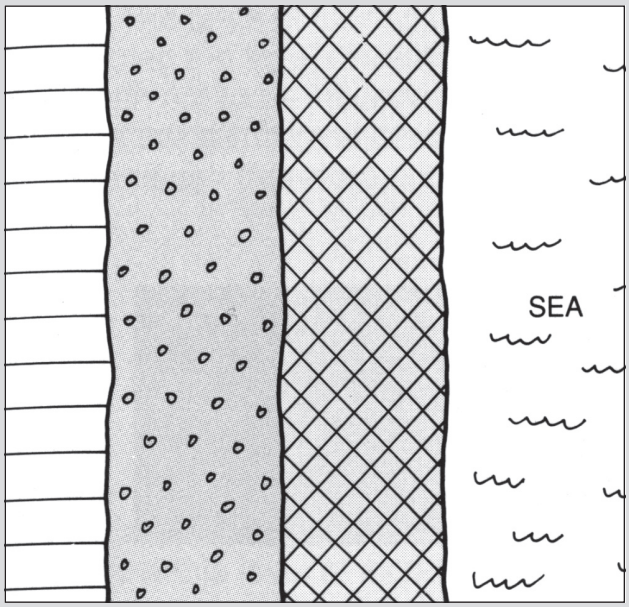


Figure 3.4.58 Location A: land use

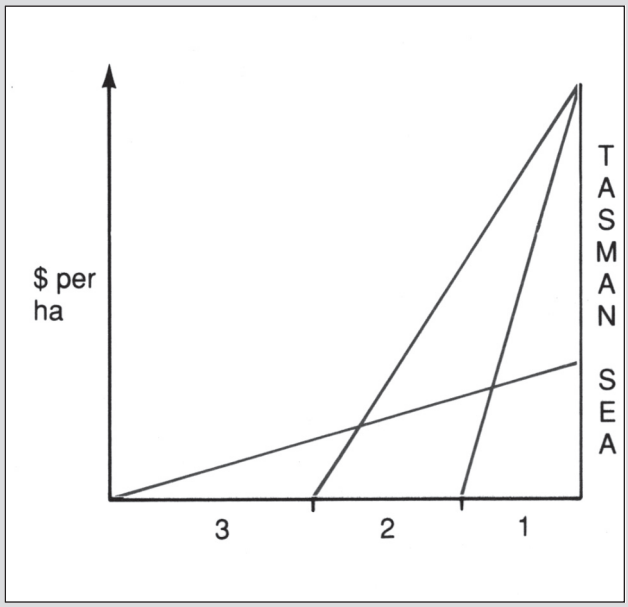


Figure 3.4.59 Cost of land

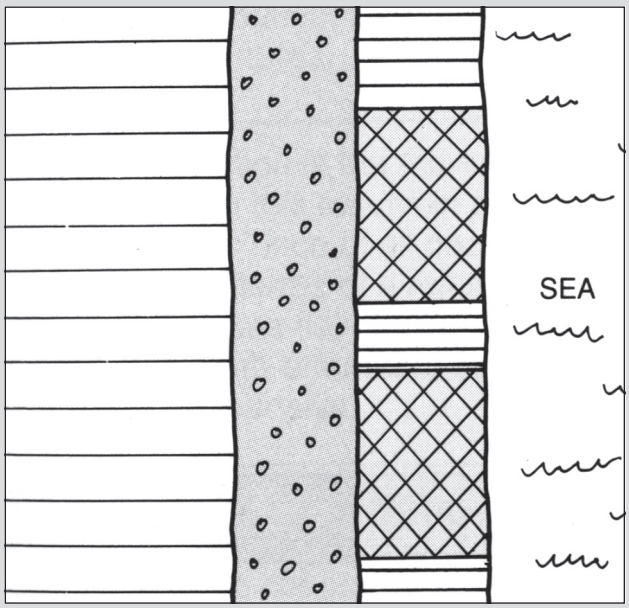


Figure 3.4.60 Location B: land use

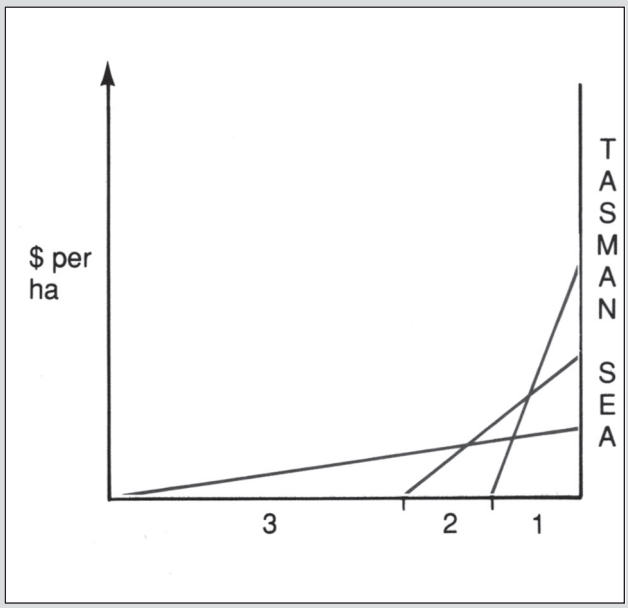
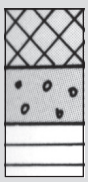


Figure 3.4.61 Cost of land

KEY



High-rise tourist accommodation

Retail/leisure sector

Single local residences

Activity 25

1 Refer to Figure 3.4.42.

a Why do Figures 3.4.58 and 3.4.60 fail to agree with the model in Figure 3.4.42?

b What does this suggest is the dominant factor determining the distribution of activities on the Gold Coast?

(cont.)

2 Explain Figures 3.4.58 and 3.4.60 on the basis of the data in Figures 3.4.59 and 3.4.61.

3 Compare Figures 3.4.58–3.4.61

a Why would the cost of land overall be less at location B?

b Why would the beach-front location include both high-rise accommodation and local residential accommodation at Location B, but only high-rise accommodation at Location A?

4 Refer to Figure 3.4.62. Construct similar sketches that illustrate Location A and B's likely density of land use.

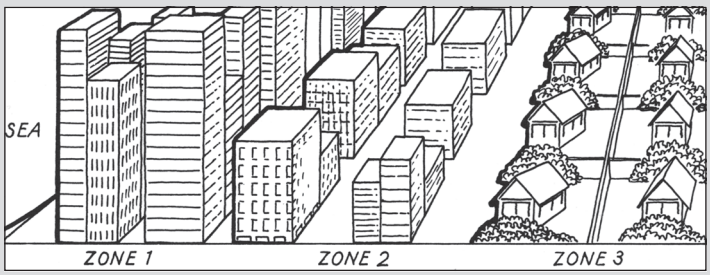


Figure 3.4.62

5 Conclude by stating the effect tourism development has had on the distribution of residential areas on the Gold Coast.

Environmental phenomena

Tourism development on the Gold Coast has influenced the distribution of environmental phenomena in two categories of pollution:

- visual pollution
- spatial compactness.

Activity 26

1 Refer to Figures 3.4.48, 3.4.28 and 3.4.29

a Describe the visual pollution resulting from the construction of high-rise buildings at Surfers Paradise.

b Describe the visual pollution resulting from the construction of canal estates and marinas along the Nerang River as it enters Southport and Surfers Paradise. Would a planner agree that construction of these facilities has resulted in visual pollution or visual enhancement? Justify your answer.

2 Refer to Figures 3.4.48 and 3.4.58–3.4.61.

a Compare the degree of visual pollution that would exist at Location A and Location B.

b Construct your own version of Figure 3.4.48 that would apply to each location.

c Explain the differences.

3 Refer to Figure 3.4.28–3.4.29.

a What type of tourist would have gone to the Gold Coast in 1956? What kind of tourist goes there now?

b Approximately how close to the beach would you need to be to see the beach in 1956 compared to 1988?

c How have the changes to the 'sleepy' resort of 1956 created a 'pollution of landuse density'?

Changes In Tourism

What factors have brought about changes in tourism development?

Key Words

Per capita
Utilisation
Effluent
Geothermal
Perception
CPI

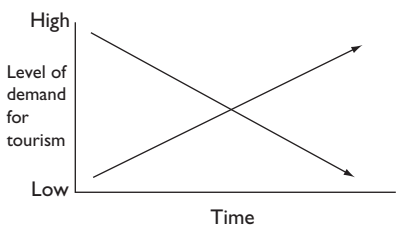
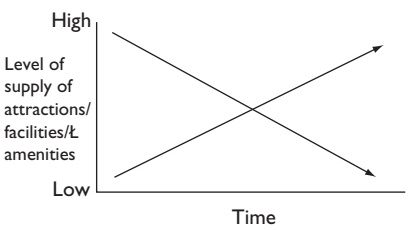
Key Ideas

- People individually or collectively, through their decisions and actions, may bring about change.
- Decisions and actions, either through intention or ignorance, may destroy elements of the natural environment
- Some changes are predictable, recurrent or cyclic, while others are unpredictable or erratic.
- Change in one part of a natural or cultural environment may induce further changes.

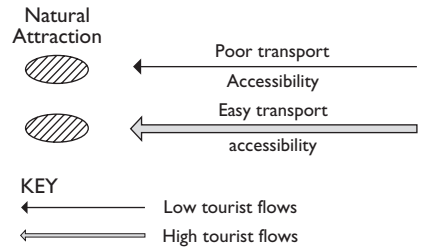
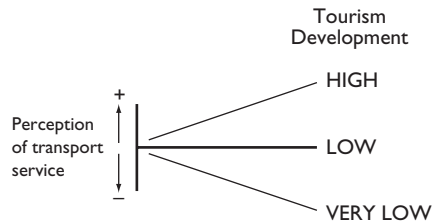
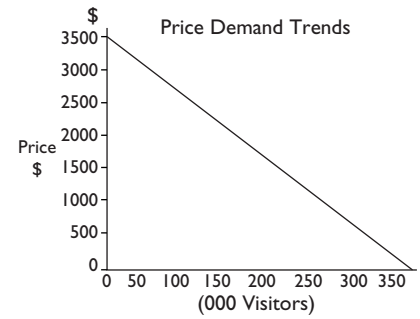
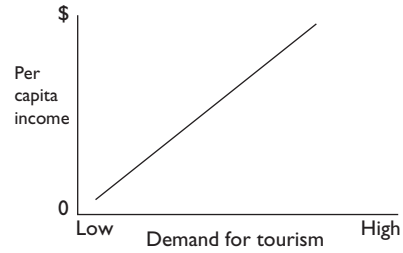
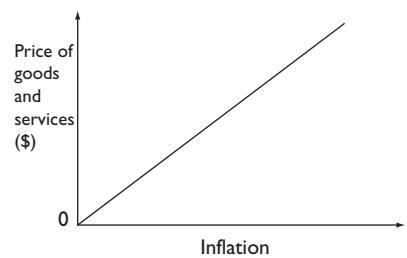
The factors that bring about changes to tourism development will be analysed using the major elements in the Model of Tourism Development (Figure 3.4.5):

- economic
- socio-cultural
- political
- environmental.

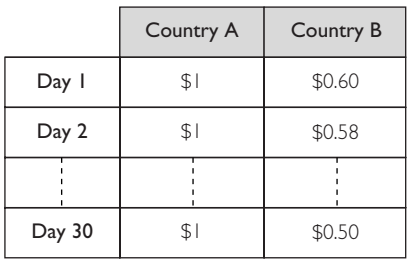
Economic factors bring about change

Factor and Function	Nature of the Change
Demand Demand for tourism is a key element in the determination of tourism development. All the economic factors that follow have a direct influence on the level of demand. The demand for tourist facilities, amenities and attractions will be a key as to whether there is any future growth.	 *Figure 3.4.63*
Supply The supply of tourist facilities, amenities and attractions is also an integral part of tourism development. If these phenomena are not available this will influence the level of demand. Business confidence (which is related to the overall political and economic climate) will determine the role tourism developers play in the supply of tourist facilities.	 *Figure 3.4.64*

(cont.)

Factor and Function	Nature of the Change
Transport Transport is the linkage element that allows tourist to link with the destination(s). Air, sea, rail and road are the modes of transport, and are subject to changes. Transport can overcome perceived distance barriers (e.g. when a remote attraction becomes accessible by air). ❑ Any transport disasters that occur may create tourist resistance to an airline or shipping company. This has a direct effect on tourism development at the destination(s). ❑ Top quality transport services can enhance tourism development (Figure 3.4.66). If people are aware of quality service to particular destinations they have no hesitation in supporting the service. Tourism development is likely to happen as a result of this. The frequency of a transport service can alter levels of perception (three flights a week to a resort means it is perceived to be more accessible than a resort that only has one flight per week).	 *Figure 3.4.65*  *Figure 3.4.66*
Price The price of touring or visiting a destination plays a significant role in determining the level of demand. Few people have the wealth not to be influenced by price. Business-orientated tourists may not have the same level of choice, but the holiday tourist has a high level of choice and can therefore decide not to travel or select an alternative destination. Either option is likely to influence tourism development.	 *Figure 3.4.67*
Income The **per capita** income of people within a nation determines how much **disposable income** can be spent on tourism. In Western nations particularly, this level of income spent on tourism determines how much tourism development will take place. It is the profit that determines the success of a business and its ability to reinvest for further development. The per capita income may reflect the overall income of a nation. If the income of a nation is high, there is a greater likelihood of money being used for tourism development because local people can finance their own tourism ventures.	 *Figure 3.4.68*
Inflation This is the movement in the value of a nation's currency. If the value drops, this results in a rise in the prices of market commodities. Inflation will increase the price of all goods and services related to tourism. Inflation can be offset by a relative rise in the income of an individual. If, however, this does not happen, inflation decreases a nation's competitiveness with other tourism-orientated countries as tourist products become increasingly expensive.	 *Figure 3.4.69*

(cont.)

Factor and Function	Nature of the Change
Exchange rates The exchange rate is the ratio of the value of one currency to the value of another. This ratio changes from day to day if the two currencies being compared operate on a floating exchange. The ratio is determined by supply and demand. When international tourists enter a country the difference between the exchange rates will determine how much money they will have to spend. If there is a ratio difference that benefits the tourist then their spending power is increased, and this has a positive effect on tourism development.	

	Country A	Country B
Day 1	$1	$0.60
Day 2	$1	$0.58
⋮	⋮	⋮
Day 30	$1	$0.50

SCENARIO: International tourists from Country A visit Country B

Figure 3.4.70

Activity 27

1 Refer to Figure 3.4.63. How does tourism development respond to changes in demand for tourism?

2 Refer to Figure 3.4.64. How does tourism development respond to changes in the supply of tourist attractions, facilities and amenities?

3 Refer to Figure 3.4.65. What is the effect of accessibility on tourism development?

4 Refer to Figure 3.4.66. How does tourist perception of transport services affect tourism development?

5 Refer to Figure 3.4.67.

- **a** If the price were to rise from $1500 to $1750 what effect would that have on the number of tourists?
- **b** What does this tell you about the effect of prices on tourism development?

6 Refer to Figure 3.4.68. What is likely to happen to the economy of a country, particularly its tourism development, as per capita income increases?

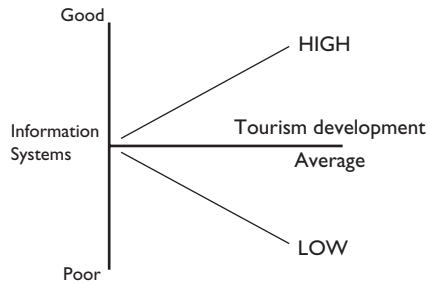
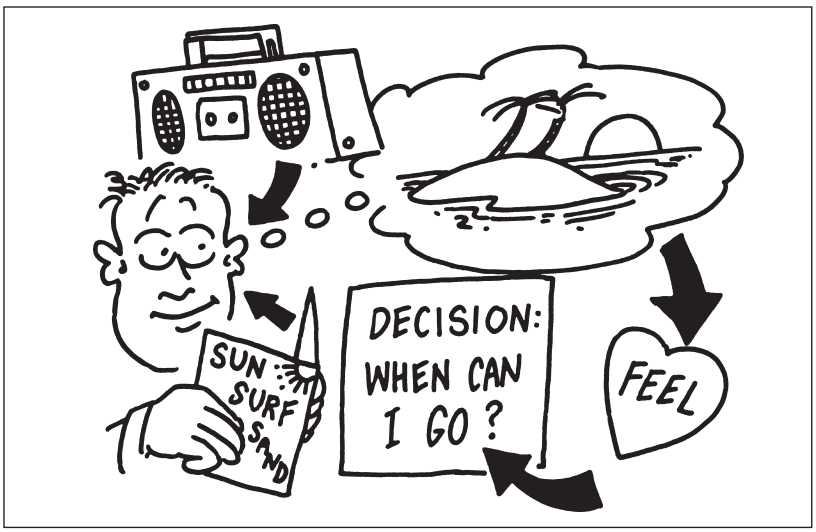
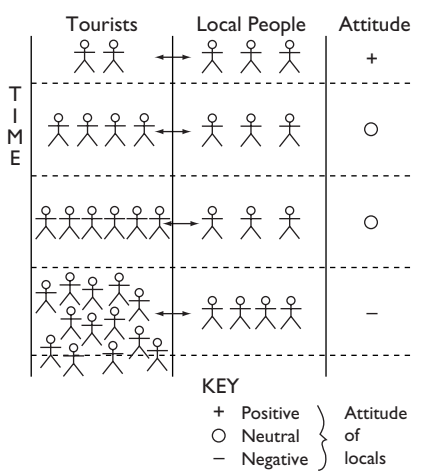
7 Refer to Figure 3.4.69.

- **a** What effect will a rise in inflation have on the price of goods?
- **b** How will this affect the total number of purchases made?
- **c** How will this affect tourism development?

8 Refer to Figure 3.4.70.

- **a** What is happening to the spending power of a tourist from country A over the 30 days?
- **b** How would this affect tourism development?

Socio/cultural factors bring about change

Factor and Function	Nature of the Change
Perception The type of **perception** a potential tourist has of a destination is brought about by what they read and hear. Information systems and personal experience are important factors. Even if a particular location is outstanding in terms of what it offers, this does not guarantee a healthy supply of tourists. Good advertising and information help to influence the tourist to choose to go to the site. Poor information systems will limit tourism development. (See Figure 3.4.72.)	 *Figure 3.4.72*
 *Figure 3.4.71 Perception*	
Potential tourists become aware of crime and unemployment, so problem tourist areas have to overcome this type of perception whether it is real or imagined. Problem destinations only attract a certain type of tourist (predominantly younger people). It is rarely the younger traveller who spends a lot. This limits tourism development in locations where there is less money flow and volume. (See Figure 3.4.73.)	Crime + Unemployment = Negative Perception ⇩ Limits Markets (Younger Tourists) ⇩ Lower Levels of Tourist Development (Less spending) *Figure 3.4.73*
Attitudes A possible function of the host population is to be hospitable and to meet the needs of the tourists. In many tourism locations this is the situation. Some people, however, have very negative attitudes towards visitors, become discourteous and can attempt to act in a manner that will not encourage any future visits. This resentment can result from the growth in numbers of foreign visitors, their outnumbering locals, and from years of domination by tourists. It can exist even though the hosts depend on the visitors for their livelihood. Cultural values may also bring this about. Some Australian Aboriginals in do not allow tourists on certain sacred grounds and there is increasing controversy about such attractions as Ayers Rock (Uluru). Value systems and local cultural ways of life can change the nature of tourism development. Few tourists wish to travel to destinations where there is overt ill-feeling.	 *Figure 3.4.74*

Activity 28

1 **a** Refer to Figure 3.4.71. How does the potential tourist feel about the resort he/she is imagining?

b How does advertising affect tourist perception? (see Figure 3.4.72.)

c Refer to Figure 3.4.73. Reconstruct Figure 3.4.73 using the structure given in Figure 3.4.72.

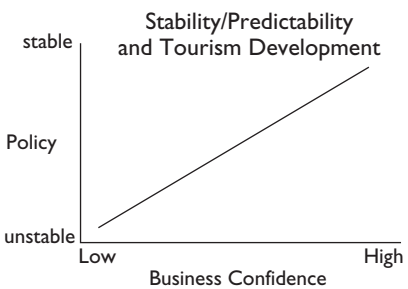
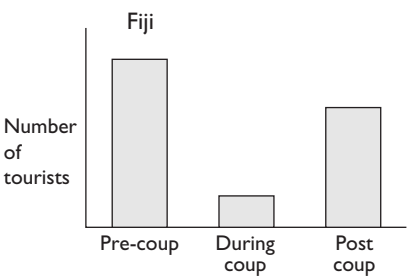
d Refer to Figure 3.4.72. How does information affect tourism development.

2 Refer to Figure 3.4.74.

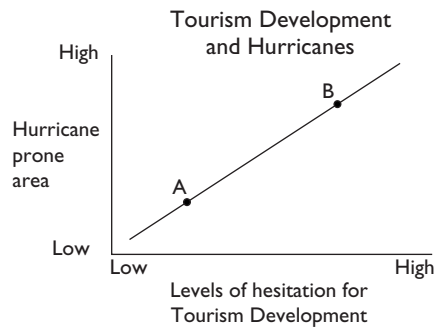
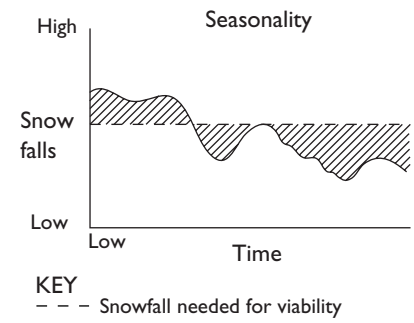
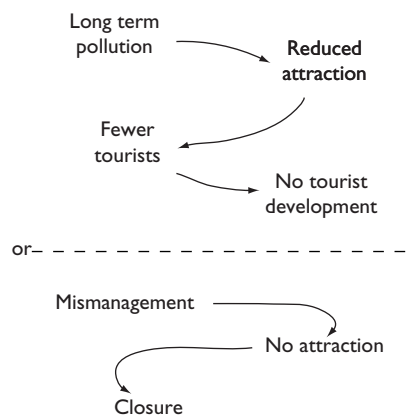
a Why could local attitudes become negative?

b How can this affect tourism development?

Political factors bring about change

Factor and Function	Nature of the Change
Government stability The government provides a significant platform for tourism development, as it gives the signals for what is to happen in the future in terms of policy. Economic policy enables the tourism developers to establish their short or long term objectives. It is the tourism developers who supply the facilities and amenities and who develop natural attractions. If a government changes its policy, business decisions will change accordingly. Predictable policies provide a climate for growth and development.	 *Figure 3.4.75*
Political conflict When countries experience political turmoil, their tourism development stops. No developer would invest money in a nation that may change its total way of government, e.g. from democracy to dictatorship. No investor will invest in a country undergoing civil war or violent civil disruption – the risks are too high. Such a 'political' environment ensures a decreased tourist demand and the tourist sector struggles to maintain profitability during such times and often for lengthy periods afterwards (e.g. Fiji after the 1988 coup).	 *Figure 3.4.76*

Environmental factors bring about change

Factor and Function	Nature of the Change
Natural disasters Disasters that occur rarely hinder tourism development in the long term (e.g. earthquakes). Those that occur regularly, such as hurricanes, can cause problems for tourism development. This is seen in two ways: ❑ Some people are reluctant to visit hazard-prone areas. ❑ Developers know about the risks and may be reluctant to invest. In hurricane-prone areas there are tropical resorts that are invariably close to the coast and require vast sums of money to be repaired if hit by a hurricane. Some developers consider the risks worth it, but there will always be others who prefer to invest elsewhere.	 *Figure 3.4.77*
Seasonality Many tourist areas develop on the basis that there is a high and low season. In these situations there is **under-utilisation** of resources and then maximum utilisation. Tourism development takes place in such areas. The activity levels and monetary investment fluctuates. A major problem may arise in areas that rely on environmental factors such as snowfalls. In ski resorts unusually low snow falls can threaten the profitability of operations in the short term. If low snow falls continue over a number of years, tourism development will be severely limited.	 *Figure 3.4.78*
Pollution and resource management ❑ Short term pollution (e.g. oil spillage in a small confined beach resort) may not ruin an isolated resort and its future development. ❑ Long term pollution however, may eventually limit future tourism development. ❑ Beach resorts that are over-built and mismanaged can be under constant threat of coastal erosion. ❑ Fragile flora areas may be damaged by human mismanagement. In the extreme case a natural attraction may be completely ruined which removes any tourism potential.	 *Figure 3.4.79*

Activity 29

1. Refer to Figure 3.4.75. What political and economic climate is most conducive to tourism development?
2. Refer to Figure 3.4.76. What does the Fiji experience suggest about the relationship between tourism development and political stability?
3. Refer to Figure 3.4.77. Which location, A or B, is most likely to reach its potential in tourism development? Why?
4. Refer to Figure 3.4.78. What happens to patronage and therefore profitability of tourist facilities in years of low snowfall?
5. Refer to Figure 3.4.79. Construct a similar diagram for a short term pollution situation.

Case Study – Worldwide

Figure 3.4.80 illustrates the major factors that have brought about change in tourism development throughout the world in recent years.

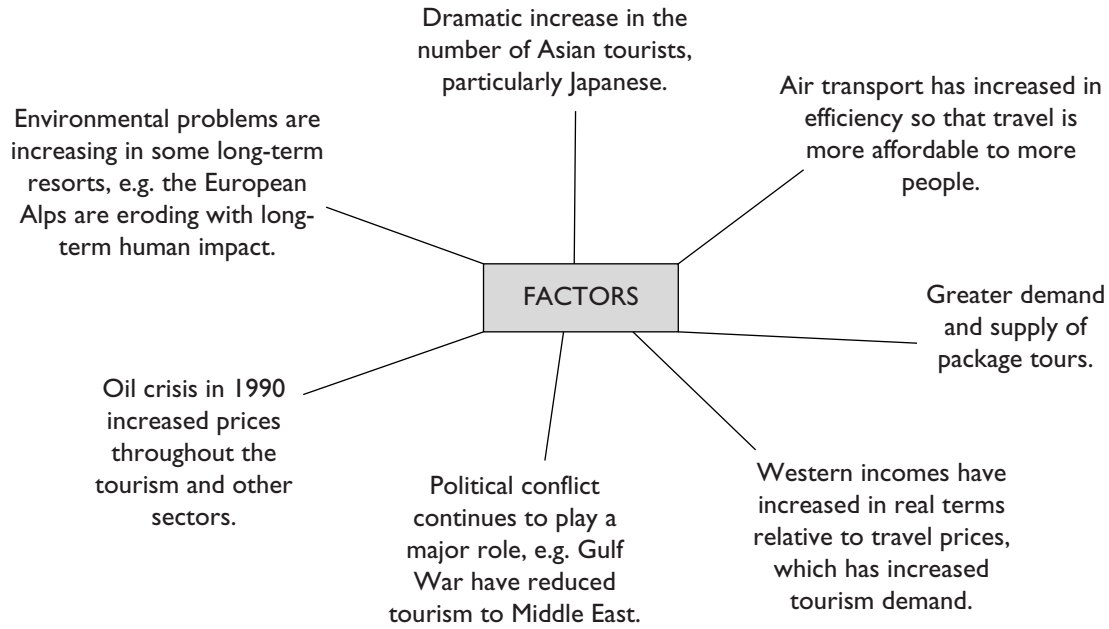


Figure 3.4.80 Factors that have brought change

Case Study – Gold Coast

Economic factors that changed tourism development on the Gold Coast

Factors	Nature of Change
Demand	

Table 3.4.10 Gold Coast tourists

Domestic visitors		International visitors	
1987	1993	1987	1993
1 965 000	1 432 000	152 837	605 000

These statistics reveal that overseas visitors to the Gold Coast increased significantly after 1987. The following table supports the trend experienced by Queensland, which has a direct bearing on the Gold Coast.

Table 3.4.11 International visitors to Queensland (000's)

Origin				
International	**1991**	**1992**	**1993**	**2000**
	1069	1231	1422	2398

(cont.)

Factors	Nature of Change
Supply	Increasing the supply of facilities promote tourism development. ❑ From 1985 to 1988, five star room stock on the coast went from 0 to 2355. ❑ In 1988 a $12 million Koala town attraction at Coomera was built. ❑ $25 million Marina Mirage with 80 specialty shops and 125 berths associated with the $250 million Sanctuary Cove development, which began in 1988. ❑ The Pan Pacific International Hotel and 250 shops in the joining Oasis Shopping Mall was opened. ❑ Major extensions to Sea World in 1988 as well as 402 room Sea World Nara resort. ❑ A major golfing complex was being constructed at Ashmore.
Transport	**Aviation dispute** ❑ The Australian Federation of Air Pilots filed a notice of 14 claims on the Australian Internal Airlines for up to a 29.4% wage claim on 26 July 1989. ❑ On 23 August 1989, after restrictive work practices, rolling stoppages and unsuccessful negotiation, airlines locked out pilots and domestic air services stopped. ❑ By 8 November 1989 the Australian Tourism Research Institute estimated that the tourism industry had lost $560 million in direct spending up to the end of October. ❑ Late March 1990 the airline pilots had returned to work. The overall impact of this transport dispute had a dramatic influence on tourism development in Queensland and on the Gold Coast. ❑ The total cost of the dispute in visitor expenditure to Queensland between 23 August and 30 December 1989 was estimated to be $473 402 000 when direct, indirect and induced expenditure are taken into account. **Accommodation** **56% of major establishments and 27% of smaller ones offered discounts to attract tourists. Occupancy rates declined by 15%.**

Figure 3.4.81 Gold Coast example: effects of strike

(cont.)

Factors	Nature of Change

Employment

Employment in motels/hotels				
	Full Time		Part Time	
	1989	1990	1989	1990
hotels	5190	4882	2583	3111
Employment in holiday units				
motels	497	482	761	694

Air Transport

Seat capacity in Queensland was down 12% compared to the pre-dispute levels but flights were down 38%. These figures indicate that, while there were fewer flights operating than before the dispute, the planes operating had the capacity to hold a greater number of passengers per flight.

The aviation dispute influenced tourism development by:

- ❑ reducing income
- ❑ threatening short term investment
- ❑ threatening employment stability
- ❑ creating a short term negative perception by foreigners of Australia
- ❑ resulting in under-utilisation of resources.

Visitor Spending

The rapidly rising expenditure patterns of visitors to the Gold Coast enhanced the process of tourism development. This expenditure, spread around the local community, ensured increasing enterprise incomes, which increased the likelihood of investment.

Table 3.4.11 Expenditure by visitors staying in commercial accommodation

Gold Coast	1985	1989	% Change	Average Annual % change
	$332/person	$1148/person	245	49

(cont.)

Factors	Nature of Change
Creation of More Land – Reclamation	In the Broadwater of the Nerang River estuary, much land has been reclaimed over the last 35 years in order to utilise the river potential to a greater extent. Reclaimed land is added to tourism development by land being put to the following uses: ❑ marina development ❑ tourist water tour depots ❑ luxury accommodation ❑ tourist attractions, e.g. Sea World ❑ residential canal estates.
Government Influence	Establishment of the Queensland Tourist and Travel Corporation. ❑ In the mid 1970s Queensland was beginning to realise its potential in the tourism industry. As a consequence, in 1979 the Queensland Tourist and Travel Corporation was established. Its primary **function** was to foster the State's tourism industry. **Results** – there has been significant growth in visitation and substantial expansion and upgrading of infrastructure. – Queensland's tourism has been growing at twice the rate of the rest of Australia ❑ Federal Loans. Severe cyclones in the early 1970s removed most of the sand from the Gold Coast beaches, which threatened the most vital tourism asset. Restoration, financed by Federal loans, has resulted in aesthetically pleasing reclamation of the beaches.

Social factors that changed tourism development on the Gold Coast

1988 World Expo	The World Expo in Brisbane in 1988 had a dramatic influence on tourism development on the Gold Coast as tourists made it the next destination after visiting Expo. Tourism developers used the package tour concept to lure the potential tourist to Queensland. Accommodation was stretched at times and attractions were heavily patronised while Expo was operating.
The Asian Tourist and Local Attitudes	❑ Between 1984 and 1994 Asian visitors to the Gold Coast increased by over four times. ❑ Asian tourists tend to visit for shorter periods of time than domestic visitors but spend large amounts of money. On the Gold Coast they spend a lot on quality accommodation, restaurants, transport, duty-free retail outlets, and souvenir shops. Development has been significant, especially in food businesses, car rental firms and the accommodation industry. ❑ From mid-1987 warning signs appeared that local attitudes to the Asian tourist invasion were becoming negative. Japanese were beginning to experience abuse and unfriendliness from growing numbers of people who resented their presence.

(cont.)

The Olympics Effect	Before the Sydney 2000 Olympics, tourism development could not really estimate the full effect the Olympics would have on Queensland. It was estimated however that 15 000 journalists and an additional 2.1 million tourists would visit Australia over a 10 year period as a result of the event. The critical factor was maximising the level of media coverage Queensland received as a result of the increased international media exposure. The focus of the Games was on Sydney, but strategies were developed to maximise the impact on Queensland of pre and post Olympics touring and the media exposure surrounding it. A Queensland Olympic Taskforce examined this issue.
Low Crime Rate and High Security	The Gold Coast is known rate internationally by Asian and North American tourists for its low crime. There are very few incidents of criminal acts committed against tourists, which is not the case in competing destinations such as Hawaii. One contributing factor to the low crime rate is that the population of the Gold Coast is relatively aged, i.e. 22.6% in 1987 were 60 years or over compared to the national average of 13.9% Many of these retired people are financially comfortable and security systems are widespread. Another factor is the emphasis placed on security in the area by tourism promoters.

Activity 30

1 Using the data under the headings 'Demand' and 'Supply', construct a diagram of cumulative causation for the Gold Coast in recent years.

2 Using the data under the heading 'Transport', construct a diagram showing how cumulative causation can reverse.

3 Using Figure 3.4.71 as a model, construct a diagram that illustrates a possible Japanese perception of the Gold Coast if the current attitudes of some local people continues.

4 Where on Figure 3.4.74 would the Gold Coast fit?

Part 4

Resources And Their Uses

Overview

This section of the textbook covers the Resources and Their Uses strand for Year 13. At the end of this section, you will be able to show your knowledge and understanding of the following achievement objectives:

Achievement Objectives

1 Systems of water and hydro-energy supply

2 The management of water supply and Hydro-Electric Power (HEP) energy systems

The focusing questions that this section covers are:

1 How is water (supply and renewal of water) distributed globally?

2 What is the hydrological cycle and how and why is it important to water supply and HEP systems in Sāmoa?

3 What are water supply and HEP systems of production?

4 What are the different parts of these systems and which resources are involved?

5 How do we manage these systems in Sāmoa? What are the consequences for each system of the management practices that we use?

6 Why is the management of water supply and HEP power in Sāmoa important?

7 How do people perceive water, and these systems of production as a resource (for a specific case study in Sāmoa)?

Introduction

This part of the textbook introduces you to important theories and ideas about water supply and development. Not all of the focusing questions will be addressed in this textbook. You can develop focusing questions 5, 6 and 7 into a research assignment project, which combines fieldwork techniques (e.g. guided observations, surveys and interviews) and guest speaker presentations, to gather data that students can analyse and use for answering FQ 5–7. You can also develop your geographic investigation and research skills through such an assignment.

Fresh Water – A Fragile Resource

Fresh water is vitally important for human beings. It is essential. There are no substitutes for water. Water is needed first and foremost for drinking – and then it is needed for food preparation, and personal and domestic hygiene.

Did You Know?

- Most of the planet Earth is covered by water – but only a very small proportion of that water is fresh water.
- The amount of water that people can access is different for different parts of the world.
- There are differences, between countries and within countries, in the amount of water that people can access. In other words, the distribution of fresh water throughout the world is very uneven.
- As the world's population has grown, so has the demand for water. The World Resources Institute estimates that water use has increased between 4-8% each year since 1950.
- The percentage of people who received improved water supplies went up from 79% (4.1 billion) in 1990 to 82% (4.9 billion) in 2000.
- Despite the increases, one-sixth of the world's population still does not have access to improved water supply.

Life on planet Earth would be impossible without water. All life forms, from the simplest bacteria to human beings to plants, contain water and would die if they did not have water for a long period of time. Human beings are 70% water (in terms of our body weight).

Human beings rely on water for:

- cooking food
- cleaning and washing themselves as well as for keeping clean and hygienic homes and other material belongings
- travel on water.

We also rely on or need huge amounts of water for:

- agriculture
- manufacturing
- energy production
- waste disposal.

Properties Of Water

Can you remember what you learned in Science about water and what it is like?

Here are some important scientific facts about water:

- Water is a compound of hydrogen and oxygen in the portion of one hydrogen atom to two oxygen atoms.
- Water can exist in three forms – solid, liquid and vapour (or gas).
- Water has a high melting/freezing point, and a high boiling point.
- Water can absorb a tremendous amount of solar heat without its temperature rising unduly. This is called a high heat capacity.
- A high heat capacity means that large masses of water (e.g. the oceans) do not have temperature fluctuations, the way land masses do.
- Water freezes from the top down – this means that when lakes freeze in winter time, water life (fish and other cold-blooded marine creatures) can survive underneath the frozen top layer.
- When water temperature drops below four degrees Celcius, the water becomes less dense and is able to float on slightly warmer liquids or even another body of water, e.g. ice can float on liquid water.

As you work your way through the chapters of this part of the textbook, you will learn about the global distribution of water and the hydrological cycle. You will revisit the concept of systems, and particularly systems of production, when you look at water supply systems and hydro-electric power supply systems.

Unit 5

The Hydrological Cycle And Water Distribution

The Hydrological Cycle

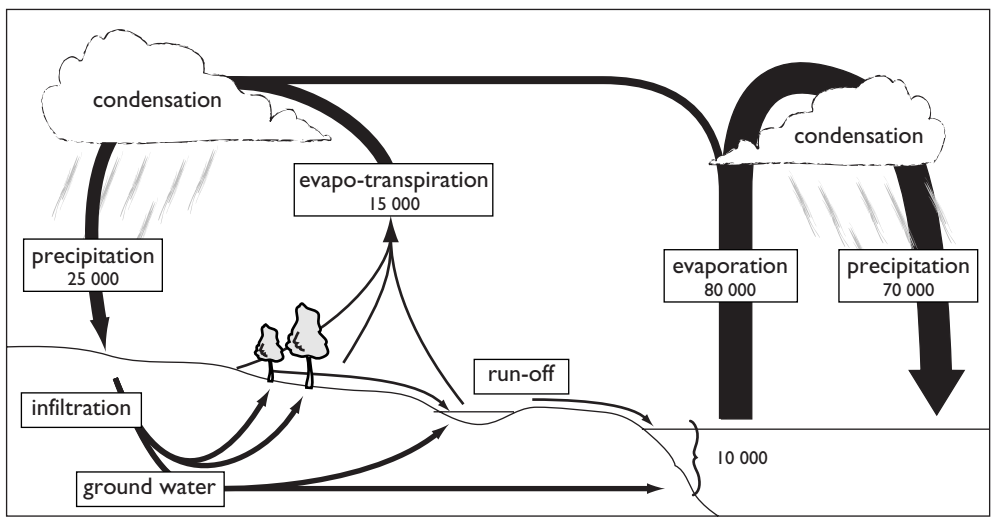


Figure 4.5.1 Hydrological cycle

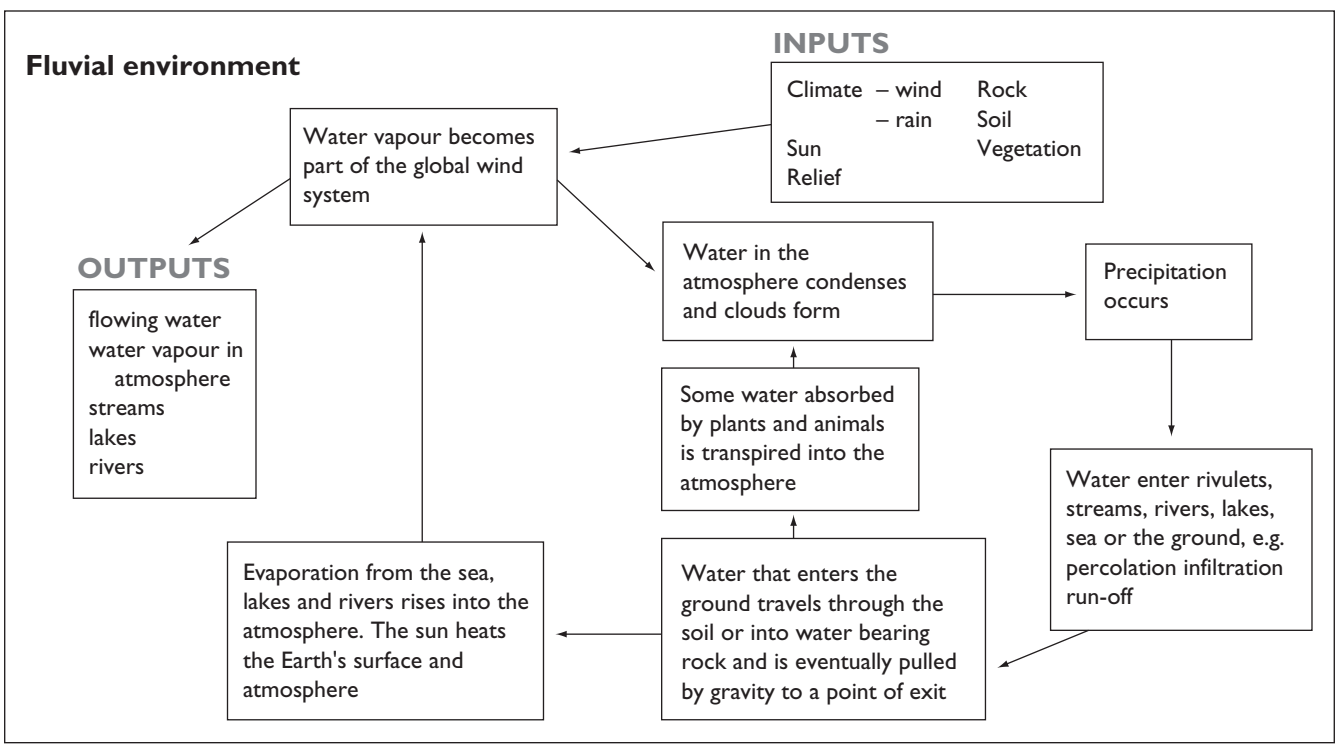


Figure 4.5.2 Hydrological processes

Global Water Distribution

Scientists have shown that there is enough fresh water throughout the world for human beings. However this water is NOT evenly distributed throughout the world. Some areas of the world are water-deficient (the natural environments have minimal precipitation – for example, deserts) and other parts of the world have a water surplus (the natural environments have very high levels of rainfall – for example, rainforests). If we take the distribution of human populations into account, water is a very important issue. For example, Bahrain is an island nation in the Persian Gulf. It is mainly desert and does not have a fresh water supply. The people of Bahrain rely on desalinisation – which is the process of treating salt water from the sea until the salt is taken away. This leaves water that is fit for drinking.

Remember that water is important for human beings for drinking, sanitation and hygiene. In order to live in a place, human beings also need enough fresh water to meet the needs of producing food – agriculture. Perhaps less importantly, different industrial and commercial activities also need water. South America and Asia are the continents with the greatest water supply – they receive more than half of the world's renewable fresh water supply through precipitation. However, although South America has more available water per capita than the continent of Asia, it cannot support as many people because the Amazon region (a large physical environment on the continent) has very poor soils. The soil around the Amazon River is too infertile to support agriculture, although it is an environment with regular and large amounts of precipitation (rainfall). In Asia, large areas of land are good for agriculture and therefore, combined with the good water supply, these areas can support the settlement of large populations of people.

So water distribution is important for both global and national water supply. Other factors of the physical environment are important – such as relief and soils. These combine to determine whether or not water supply is sufficient.

Source: World Water Day 2002 'Water for Development' Fact Sheet, *SOPAC (South Pacific Commission) 2002.*

Factors of water supply

Stable run-off

This is the portion of run-off (from precipitation) that is available throughout the year. It can be low even though total run-off is high. For example, in India, 90% of the annual rainfall is during the wet season (June–September). Most of the water that falls in this season quickly drains away into rivers and is unavailable during the rest of the year. Thus, in India, the stable run-off is low.

Annual water supply

This is the total amount of water that is available in a year for a place. In some parts of the world there are dry years (little or no rainfall) and wet years (higher levels of rainfall). The different patterns of rainfall from one year to another affects what groups of human beings are able to plan for and do in the following year.

When surface water is an international resource

In some parts of the world, water supply is affected by who owns and manages it. In many parts of the world, the water supply does not 'belong' to just one country. For example, the Rhine River in Europe, and the Nile River of Africa, are sources of water that flow through several different countries. If a country up-river decided to create a dam for hydro-electricity, or for irrigation systems, it would reduce the amount of water that flowed down the river to other countries. This could seriously affect water supply for drinking and agriculture for other groups of people. In such situations, countries need to work together to ensure everybody's needs are met. Water is an international resource in these situations. International co-operation is vital (or there could be serious conflict).

Did You Know?

The river basin for the River Rhine is in Switzerland, Germany, France and the Netherlands (Holland). Switzerland, Germany and France use water from the Rhine for industry. Polluted water was discharged into the river. The Netherlands did not pollute the Rhine, but was downstream so it suffered from pollution. It had to clean up the water so it was good enough for drinking. All the countries on the Rhine have since agreed to co-operate not only to ensure that the supply is constant, but also to take responsibility for the quality of that water.

Did You Know?

- The percentage of people who received an improvement in water supply rose from 79% (4.1 billion) in 1990 to 82% (4.9 billion) in 2000.
- However, 1/6 (or 1.1 billion people) of the world's population do not have access to improved water supply and 2/5 of the world's population (2.4 billion people) do not have access to improved sanitation.

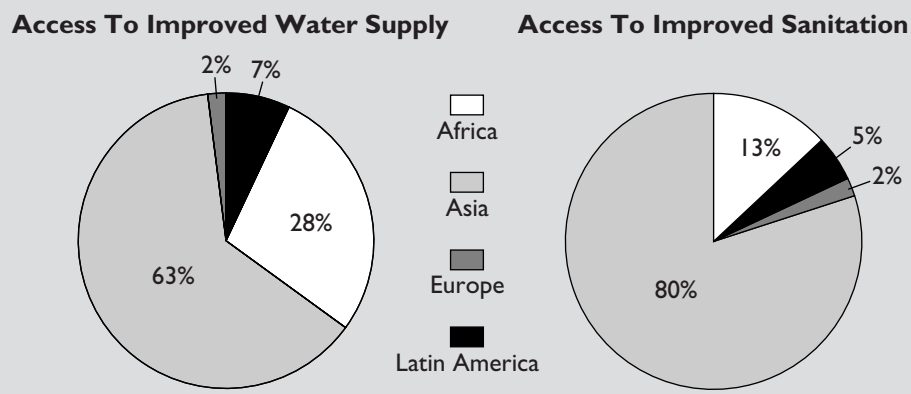


Figure 4.5.3 Distribution by region of the global population not served with improved water supply and sanitation

Sustainable Development Of Water

In 1992 the United Nations held a conference called the Conference on Environment and Development (UNCED). This was held in Rio de Janiero, Brazil. A very important document called Agenda 21 came out of that conference. Agenda 21 is a plan for sustainable development. A special chapter of this document deals with Freshwater Resources. Conservation and development of water resources is an important aspect of this chapter.

The sustainable management and protection of water supply is particularly important for the small island countries of the Pacific. Important issues in Pacific nations include:

- The establishment of water supply and wastewater treatment infrastructure. Pacific nations need systems that use appropriate technology and are staffed by people with the right expertise and skills to operate and maintain the systems. These systems cost a lot of money to set up, operate and maintain. Water supply systems suppliers also need to consult and work closely with the communities that they serve so that the system can work successfully.
- Access to water supply and sanitation is a basic need and human right. In some Pacific nations, large-scale water and wastewater projects are concentrated in urban areas, and the rural areas are neglected. This is unfair.
- Not all the people of a nation have the same access to basic necessities and opportunities. Poverty can affect access to water supply and sanitation – and these are very important factors for the health of a community. In healthy communities all children can participate fully in school and people can be effective in their employment.
- All over the world there is a need for proper legislation and regulatory controls over water resources. These controls are called governance. Governance is important to protect water resources from being over-exploited. Waterways (e.g. rivers and streams and water catchment areas) need to be carefully looked after and protected in order to maintain both water supplies and water quality. That is why governments need to make rules and give responsible groups of people the authority to enforce these rules.
- The other benefit of governance is that it reduces the risk of one group (for example, manufacturers) taking control of the resource and access to it. Legislation can sometimes give governments rights over and above traditional rights. This may be necessary for such a resource as water, in order to make sure that everyone has equal access to the resource.

Source: Environment, *International Edition. Written by Raren, Berg, Johnson. Sunders College Publishing 1993.*

Did You Know?

Table 4.5.1 Pacific water supply and sanitation coverage

Pacific Nation	Total Population (000)	% Total Water Supply Coverage	% Total Sanitation Coverage
American Sāmoa	68	100	?
Cook Islands	20	100	100
Fiji	817	47	43
Guam	168	?	?
Kiribati	84	47	48
Marshall Islands	64	?	?
Federated States of Micronesia	119	?	?
Nauru	12	?	?
Niue	2	100	100
Palau	19	79	100
Papua New Guinea	4807	42	82
Sāmoa	180	99	99
Solomon Islands	443	71	34
Tonga	98	100	?
Tuvalu	12	100	100
Vanuatu	190	88	100

Activity 1

1 Write paragraph answers for the following questions.

a What is the hydrological cycle?

b How and why is the hydrological cycle important to water supply systems in Sāmoa?

2 Divide up into groups of three to four students, and choose ONE of the following topics to carry out a geographic inquiry. When you have finished your inquiry, prepare a 10 minute seminar for the rest of the class about what you learned.

What is the relationship between the hydrological cycle and ONE of the following:

- ❑ Hydro Electric Power Supply in Sāmoa
- ❑ Waste Disposal Systems in Sāmoa
- ❑ Water Supply Systems in Sāmoa.

Unit 6

Water And Systems Of Production

Water Supply And Renewal

Surface water is fresh water found on the Earth's surface in streams, rivers, lakes, ponds, reservoirs and wetlands. A **wetland** is an area of land that is covered by water for most or all of the year. Surface waters get **replenished** – that is, more water is poured or channelled back into these sources. Surface water is often replenished by the run-off of water from precipitation off the land (or directly by precipitation itself).

Different parts of the world have underground formations that collect and store water in the ground. This is called **ground water**. The water for these sources often originates as rain or melting snow that has seeped or passed slowly through the soil into the underground reservoir. When water seeps or percolates through the soil until it has overflowed the reservoir, ground water is formed or collected up over time. Most ground water is considered to be a non-renewable resource because it has taken many years to build up the water supply in that ground water source.

Collecting and storing **rainwater** (in water tanks) is the main source of water for areas that have very limited access to surface water or ground water supplies.

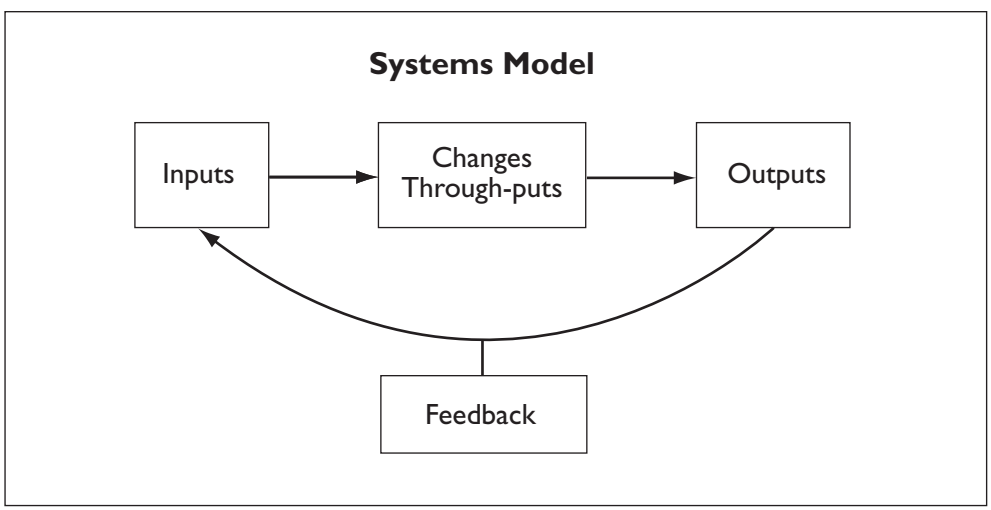


Figure 4.6.1 Simple systems model

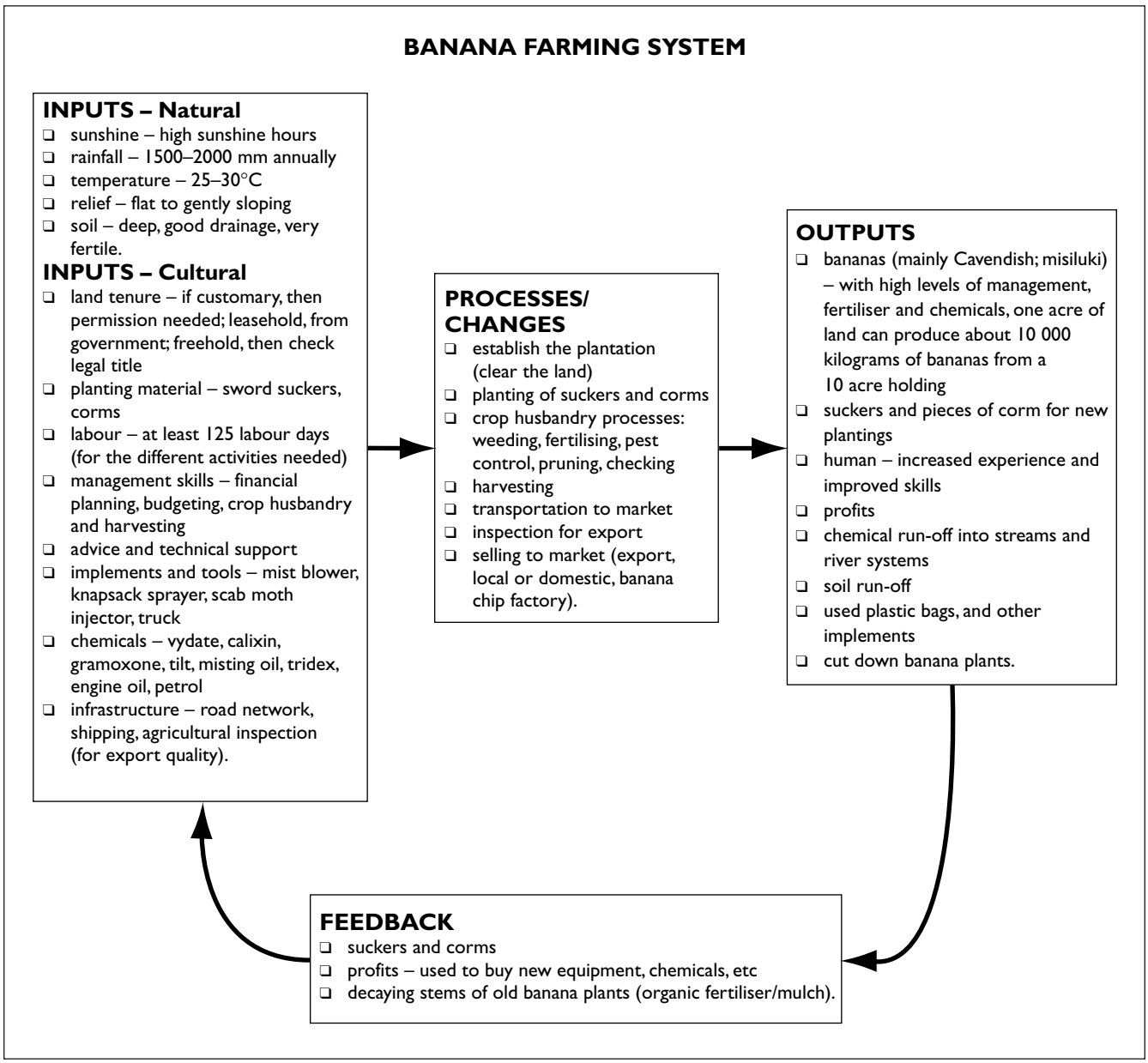


Figure 4.6.2 Banana farming

Activity 1

Do you remember what a system of production is?

Study the systems diagram above.

1 Design a systems diagram for water supply (make it similar to the one for banana farming).
   - ❑ What are the inputs for a water supply system?
   - ❑ What are the processes or changes that occur in the system?
   - ❑ What are the outputs of this system?
   - ❑ Are there any feedbacks? If so, what are they? Are they positive or negative? (e.g. storage filtering, treatment, distribution)

2 If you have the opportunity, do research or hear a seminar (or even invite a guest speaker) on hydro-electric power supply in Sāmoa, then design a systems diagram for the production of HEP (hydro-electric power).

- ❑ What are the inputs for a water supply system?
- ❑ What are the processes or changes that take place in the system?
- ❑ What are the outputs of this system?
- ❑ Are there any feedbacks? If so what are they? Are they positive or negative?

Unit 7

Water Management And Perspectives

Water is a natural resource that people often think of as public property – in other words, people do not believe that water is something that can be privately owned, particularly the sources of water. In countries such as Sāmoa, the state, has taken on the responsibility of looking after the water resources of certain areas of the country. In doing so, the government tries to make sure that:

- ❑ access to water is fair and equitable for all
- ❑ the quality of the water, especially for drinking, is good
- ❑ the quantity or amount of water that is available is sufficient for the present and for changing needs in the future.

As the number of people who need and use water increases, the government has to make decisions on how the water is to be distributed and managed, both for the present and the future. Often, the systems of water management mean pricing systems. In other words, users of water are expected to pay, at least in part, for the water that they want to use and for the services that:

- ❑ deliver water to where it is used (homes, agriculture, industries and other commercial activities)
- ❑ look after both the quality and the quantity of water.

The price of water can vary depending on how it is used. Domestic users often pay more for water than farmers who use it for agriculture. Prices may also be different for industries.

The main purpose of water management, however, is not to make a profit or to cover the costs of producing and looking after a water supply system, but to provide a sustainable supply of high quality water. The price of water is often seen as a way to make sure the supply of water is good. When the price of water rises, it often encourages users to be more careful in how they use it. Water rationing is a more extreme method of managing water supply. Water is often rationed when there are shortages of water, or an increased risk of shortages (for example, when there is a very dry season and the water level in the reservoirs runs low).

Did You Know?

France is often seen as a very good example of water management because it has an effective, comprehensive regional water plan. France is divided into eight regions – these are managed by government agencies that include representatives of the government and other public organisations as well as consumers. Water taxes provide additional funds for special water projects – e.g. water treatment plants. Industries pay a different tax – one that includes a pollution tax. If an industry is able to clean up the water they use *before* they get rid of it (discharge it) into the wider system, then they do not have to pay as much pollution tax. This acts as an incentive (encouragement) to be more responsible for the outputs of their activities.

Dams And Reservoirs

Dams are big constructions that hold back water. They are often like large walls built across rivers. This causes the flow of the river to slow down, even stop, and then water collects and builds up behind the dam. This forms an artificial lake, often called a reservoir. Water is allowed to flow through a dam, but the amount of water is controlled. Only a small amount is allowed to flow out – at times, no water is allowed to flow out. Besides being a storage for water, dams can also be used to generate electricity (hydro-electricity). Controlled water flow passes through giant turbines. Moving water drives or turns the turbines, which make electricity.

Some of Sāmoa's rivers flow all year round and this makes some of them ideal as possible sites for hydro-electricity generation. HEP (hydro-electric power) is cleaner to produce than electricity generated by burning expensive imported fuels such as diesel. HEP production is also better in many ways for the atmosphere, because it gives off no waste gases.

Some people believe building hydro-electric power plants is NOT good for other parts of the natural environment because of the construction work involved. The river channel is changed, natural vegetation is cleared away, and after the dam is built, even more change to the environment happens when the reservoir forms behind the dam. Water will flood areas behind the reservoir and permanently changes the type of natural environment that is there.

However, dams and reservoirs can have other benefits for human activity besides hydro-electricity – they can provide flood control for areas down the river because a reservoir can hold a large amount of extra water during times of heavy rainfall. This extra water can be stored and then released slowly and carefully. The stored extra water can also be released during drier periods of little or no rainfall. Reservoirs can act as 'water storage' systems, in addition to flood control systems.

In some parts of the world, reservoirs have become recreational places – artificial lakes where people come to reservoirs to swim, sail boats, play other water sports and have picnics on the shoreline. However, if reservoir water is for water supply rather than just for electricity generation and flood control, recreational use of the reservoir is often banned.

Water Management In Sāmoa

The Water Authority – who we are

Water in Sāmoa was the responsibility of the Department of Public Works until 1994. The Water Authority was established in 1994 by an Act of Parliament and is now a government corporation responsible to a Board of Directors and Parliament.

The Board of Directors is made up of the:

- Minister for Public Works/Chairperson
- Director of Public Works/Deputy Chairperson
- Secretary for Finance
- Director of Agriculture, Forestry and Fisheries
- Director of Lands, Surveys and Environment
- Director of Health
- Public Representatives.

The General Manager of the Water Authority, together with a senior management team, has responsibility for the divisions that provide various services to customers (see the organisational chart below). The Water Authority relies heavily on Government subsidy but as it moves towards independence it is aiming to produce an operating profit.

The role of the Water Authority

The Sāmoa Water Authority manages the water supply for the majority of people in Sāmoa. The mission statement of the Water Authority is, **in partnership with stakeholders, to efficiently deliver quality water and sewerage services**.

By stakeholders, the Sāmoa Water Authority means all people who have an interest in the development of the organisation, e.g. customers, government, staff, donor agencies, etc.

Over the coming years the vision of the Water Authority is to:

- provide quality water and sewerage services
- be a commercially focused organisation
- be open and accountable.

While the Authority is responsible for the supply of water for virtually the whole population, 84%, is under the control of the local district schemes. The total amount of water produced is 100 000 kilolitres per day.

(cont.)

Why we need the Water Authority

In Sāmoa, we tend to take water supply for granted. The water that falls from the skies, however, does not fall when and where we want it. Someone has to catch it or drill it from under the ground, store it, clean it up, make sure it is safe to drink, and transport it to where it is needed. Someone also has to collect and dispose of it in a way that is hygienic and environmentally friendly. The responsibility for all of these services lies with the Sāmoa Water Authority.

To manage and maintain a water supply system requires expert management and professional skill. There are 167 qualified and committed staff employed by the Water Authority, who work in such diverse areas as customer services, leak detection, plumbing and metering, distribution, water quality, accounting, finance and administration. Providing the service also requires massive investment. In 1997, 7.31 million tala was spent on running the water supply for Sāmoa.

The Water Authority liaises closely with a number of Government departments to employ and protect the nation's water resources.

Better service for customers

The Water Authority is committed to improving the quality of service we offer to our customers. Since 1994, considerable progress has been made. For example:

- 38 new boreholes have been opened giving the public a hugely increased supply of quality water.
- Almost 1000 new households have been connected to the water supply network.
- Over 500 kms of pipelines have been monitored for repair.
- 2000 leaks have been detected and fixed.
- 1800 meters have been installed.

The Water Authority is committed to:

- Reducing the total number of customer complaints by effective maintenance programmes.
- Repairing immediately interruptions for special customers such as hospitals, fire brigade, schools, etc.
- Monitoring regularly the quality of the water in the system.

The finances of the Water Authority

Investment in the Sāmoa Water Authority since 1994 has been largely used to finance capital works programmes needed to achieve higher quality of water and environmental standards.

1.7 million tala was invested in 1997 alone and over the next five years the capital works programme is estimated at 11.62 million tala. The total aid from overseas and international organisations will be in excess of 54 million tala, coming mainly from the European Union, with Australia, New Zealand and Japan also contributing.

(cont.)

In order to help fund the programme of investment by the Authority, water bills have been increased since 1994. However, as the Authority pursues a nation-wide metering policy, it is expected that it will reduce household bills dramatically. In fact the average metered bill could be half of the current flat rate if we learn to use water wisely. Investment, on the other hand, will be more than double and has increased by 100% since 1994. Investment is crucial to achieve high quality standards in the water supply and distribution system.

Paying for water

Sāmoa has one of the *lowest water charges* in the Pacific while having *the highest consumption*. The Water Authority is unable to meet its costs and relies on Government subsidies equivalent to 300 tala per household. At present, water charges are unrelated to consumption, with the result that per capita water use in **Sāmoa is among the highest in the world.** The high demand and usage of water in Sāmoa means that the system cannot cope and the end result for the consumer is poor supply and inconsistent quality. In an effort to better the situation of water supply and quality on the islands the Water Authority decided to implement metering for all customers.

Installation of domestic water meters began in late 1997 and this 'user pays' system ensures that customers are only charged for what they use. When people have to pay for water, they are more likely to conserve it.

Where the water comes from

The Water Authority manages 26 river intakes, 51 boreholes and several springs throughout Sāmoa.

Catch
In the town area, the water mainly comes from three river intakes, in Fulu'asou, Alao'a and Malololelei.

Drill
In rural areas, the water comes mainly from boreholes.

Clean
At the water treatment plant, the water enters a roughing filter, which removes heaviest particles. A sand filter then takes out the bacteria in the water.

Store
The reservoir, the last stage in the process, is where the water is stored to provide water to customers at peak times. In Sāmoa, we have 14 reservoirs/storage tanks.

Transport
The water finally reaches your tap having made a journey through some of the 700 kilometres of pipes.

Figure 4.7.1 Where water comes from

(cont.)

Water resources of a small volcanic island nation

Water resources are limited and vulnerable, especially on a small volcanic island.

Why?

Small islands, especially those situated far from continents, like Sāmoa, are physically, demographically and economically different. Their limited size, their shortage of natural resources, their isolation and their exposure to natural disasters can make the hydrological and water resource problems of these islands very serious. Both the surface water and groundwater resources of small islands can be polluted from urbanisation, agricultural activities and the clearing of forests. The increasing use of pesticides, herbicides and fertilisers is an additional hazard.

In Sāmoa:

- ❑ because the volcanic soil is porous (allows water to pass through), most of the water passes through the ground to the rock below
- ❑ we have very few permanent streams or lakes
- ❑ groundwater is scarce and needs to be managed carefully.

How to use water wisely

Water is one of our most important natural resources, so it's important to use it wisely. We can no longer view fresh water as an unlimited resource. We can't make water. We can only work to conserve and protect it. Wise water use will help protect the environment and it can also save your money. Through awareness campaigns, the Water Authority is trying to get people involved in conserving and protecting the water. This task is the responsibility of all users.

Here are some simple ways to be water wise:

- ❑ Repair all taps and pipes leaking on your property: a small leak can lose up to 1000 litres of water per day, which will cost you money.
- ❑ Quickly inform the Water Authority of all leaks in the distribution system.
- ❑ Don't leave taps running when doing the washing up or while brushing your teeth.
- ❑ Check for leaky cisterns: a leaking toilet can waste up to 16 000 litres a year and cost you money.
- ❑ Avoid watering your garden during the heat of the day because much of the water evaporates before it reaches the roots.
- ❑ Take proper care of toilets and septic tanks. Sāmoa has very porous soil so whatever happens up on the ground will go down to the water below.
- ❑ Be careful of the amount of fertilisers and pesticides used.
- ❑ Do not dump rubbish near rivers or freshwater holes.
- ❑ Help by planting trees near watershed areas, rivers and streams.

Plans for the future

The Water Authority underwent a fundamental restructure in June 1997 with significant strengthening of the management team.

(cont.)

Several aid programmes will help the Water Authority. The European Union is funding a rural water supply programme for the north-north-west of Upolu and the east-south-east of Savai'i, and a public awareness programme.

An AusAid institutional strengthening programme will further augment the management team by providing general, financial, accounting, personnel and asset management assistance. A German bilateral aid project will fund an urban metering programme and the Japanese Government is funding the upgrade of a water supply system in the village of Tafatafa, Southern Upolu.

Source: publication by Sāmoa Water Authority.

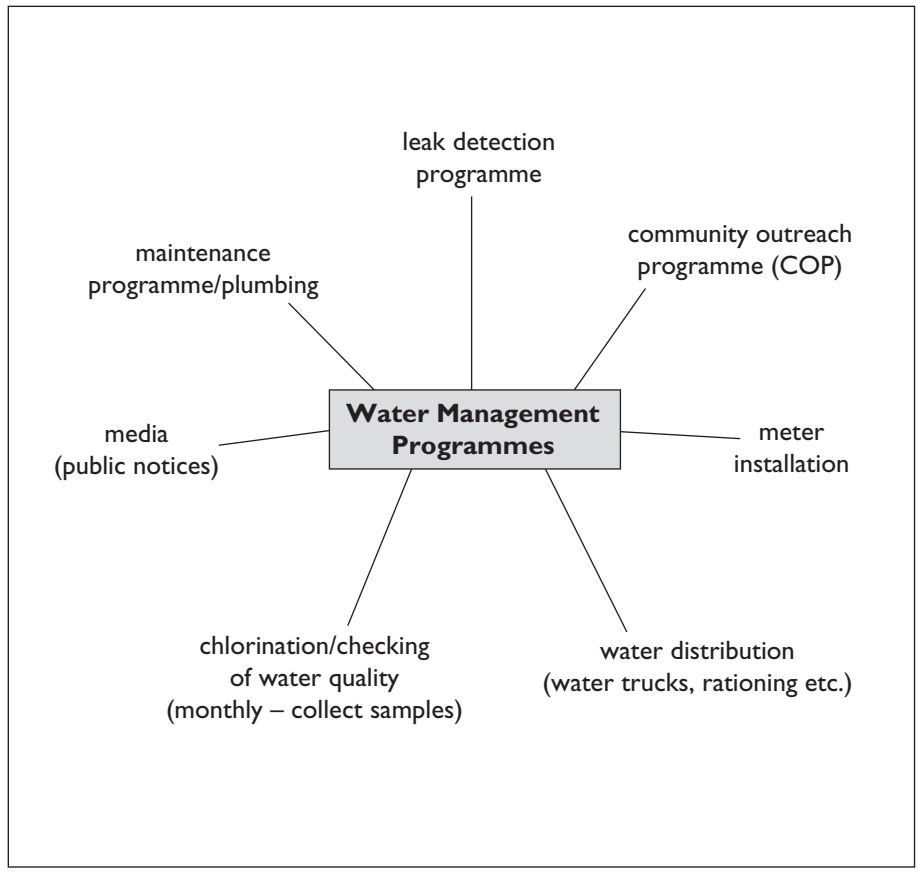


Figure 4.7.2 Water management star diagram

Part 5

Environmental Issues

Overview

This section of the textbook covers the Environmental Issues strand for Year 13. At the end of this section, you will be able to show your knowledge and understanding of the following achievement objectives:

Achievement Objectives

1 Climate change as a consequence of interaction between cultural environments and the atmospheric system

2 Different perspectives and responses to climate change

The focusing questions that this section covers are:

1 What is climate change? What are some specific examples of its effects?

2 What are the processes that cause climate change? How do they interact to cause climate change?

3 What are the consequences of climate change for people, places and environments? How have these been analysed?

4 What are the different perspectives on climate change? How and why do they differ?

5 What are some of the main ways people in different parts of the world, and at different scales, are responding to climate change? How effective are these responses?

Introduction

Climate change is a global environmental issue because human actions and activities in different parts of the world collectively affect the atmospheric system. The general effects have been on the climate and weather patterns in different parts of the world – and growing scientific evidence also shows changes in other systems of the physical environments where human beings live. Natural ecosystems are changing (e.g. certain animal and plant species are at risk of becoming extinct because of changes in their natural habitats). Soil systems are changing (e.g. becoming less fertile due to erosion or decreases in rainfall over time) because of changes in the climate.

You know such terms as 'climate change' and 'global warming' and 'the greenhouse effect'. These terms all relate to the same phenomena. You will have learned about climate change through your science studies, and through the media (television, radio and newspapers). Each year in Sāmoa, there is a public awareness and education campaign about climate change. The Ministry of Natural Resources and the Environment has a special section or division that focuses on climate change. The climate change division organises the campaign.

Because climate change is a familiar topic, some of the information in this part of the Year 13 Geography textbook will seem like revision for you. Remember that this study of climate change will be specifically from a geography perspective.

The first chapter in this part of the textbook will help you to understand the atmosphere as a system of inputs and outputs, and how it interacts with other systems of the physical environment.

The second chapter will explore climate change itself.

The third chapter will explore the causes and consequences for human beings and their activities, as well as different perspectives on climate change.

The Atmosphere As A System

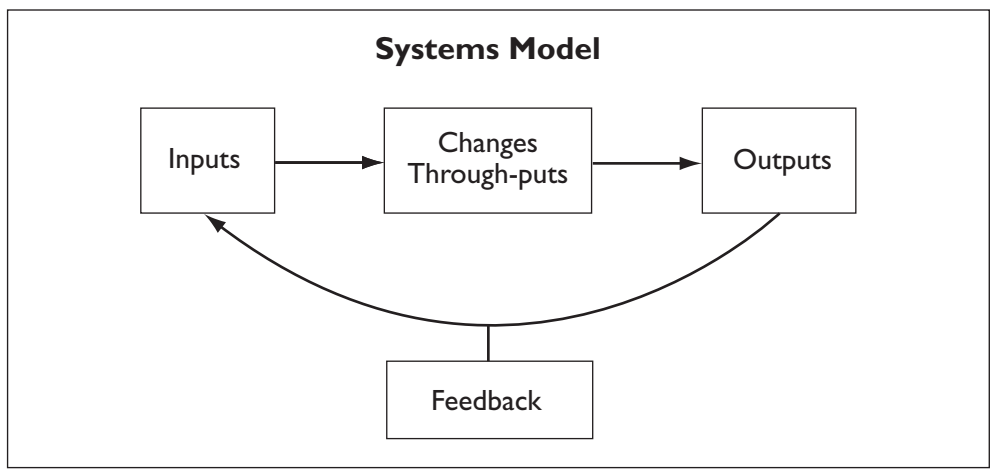


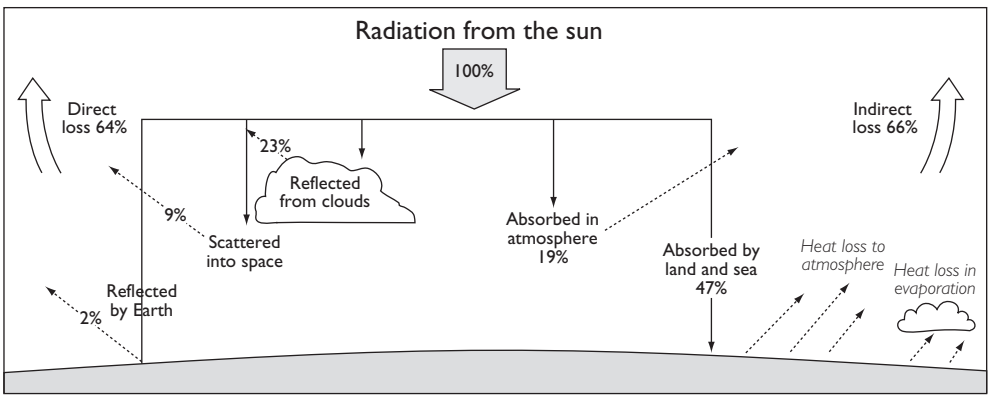
Figure 5.0.1 Simple systems diagram

The atmospheric system is sometimes referred to as the climatic system. It is made up of sub-systems such as the:

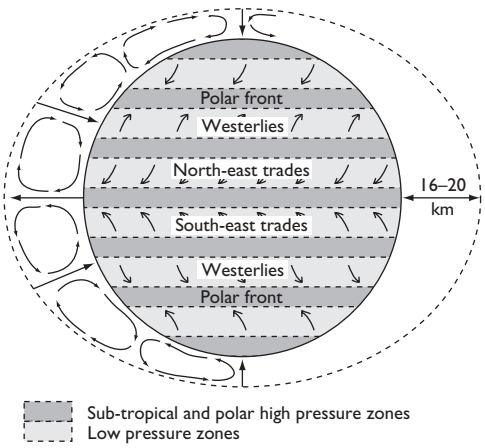
- heating system
- wind and pressure system
- moisture system.

Each of these sub-systems, as well as the overall atmospheric system, is made up of inputs which undergo change within that system. Changes are caused by certain processes. The outputs of these processes are the results of specific sequences of events. Some of the inputs into the atmospheric system (e.g. water, dust particles, gases) are outputs from other physical systems. For example, water vapour goes into the atmospheric system from the leaves of a rainforest. The process that results (water vapour going into the atmosphere) is *transpiration*. Some of the outputs of the atmospheric system (e.g. rainfall) are the result of a process such as *condensation* – rainfall is an input into the rainforest ecosystem.

The Heating System



Wind and Pressure System



Moisture (or Hydrological) System

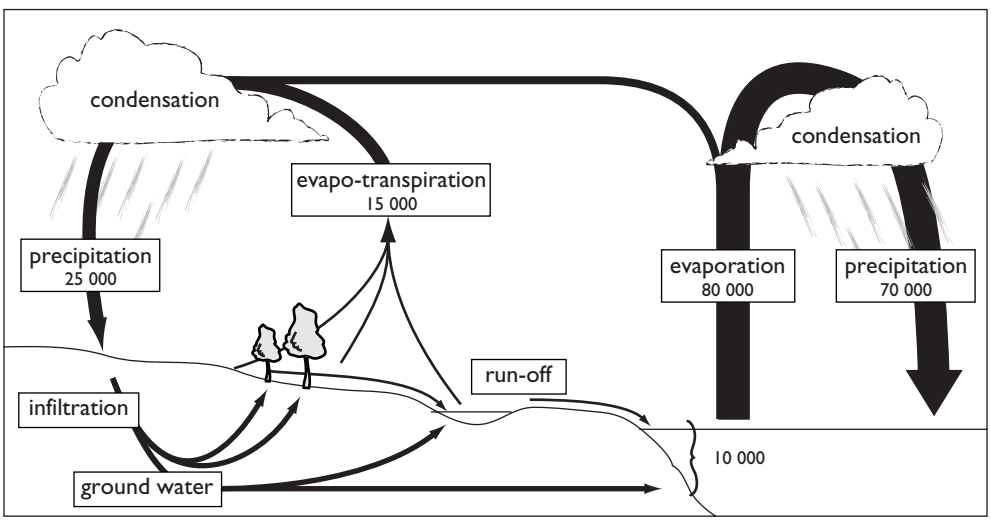


Figure 5.0.2 Atmospheric system

Climatic Elements And Climatic Factors

Regardless of where a person is in the world, that place has a climate. Different places have different climates. *Climate* is the *overall pattern of weather over a long period of time. Weather* is the *day-to-day state or condition of the atmosphere over a specific place (throughout a year and over several years).* But wherever a place is, and whatever the climate or even the weather of that place is, these are the climatic elements that can be measured and described for that particular place:

- air temperature
- atmospheric or air pressure
- wind speed
- sunshine
- humidity
- precipitation.

As geography students you need to know and understand what these elements are and how we measure them.

Air temperature

Air temperature is a *measurement of the amount of heat energy in the atmosphere*. A thermometer is usually used to measure this heat energy – and the unit of measurement is degrees Celsius for most parts of the worlds (the United States measures temperature in degrees Fahrenheit). We will learn more about temperature, and especially heat energy in the atmosphere, in the next chapter.

Air pressure

Imagine the Earth – at least the solid part of the Earth! As you know from your studies of plate tectonics, the solid Earth is round and is made up of layers. However, around the solid Earth is a thick band of gases that is often called 'air'. Gravity keeps this mixture of gases close to the Earth. This band of air is not of equal thickness or width right around the Earth – at some points (for example, at the North and South poles and from the tops of mountains), this band of air is much thinner. This band of air around the Earth is what we call the atmosphere.

The gases that make up the atmosphere are oxygen, carbon dioxide, water vapour as well as relatively far smaller amounts of ammonia, sulphur dioxide, ozone, and traces (very small amounts) of helium, krypton, neon and xenon. Gases are matter – just like solids and liquids, and so they too are made up of molecules.

So what is air pressure? Imagine you are standing outside and can see the atmosphere (or 'sky') above you. Imagine a column of that air is right above your head. That column of air is made up of molecules which are pressing down on the Earth's surface at that point or place where you stand. Air pressure is a measurement of the force of that pressure against the Earth's surface. It is a measurement of air pressing down on the Earth.

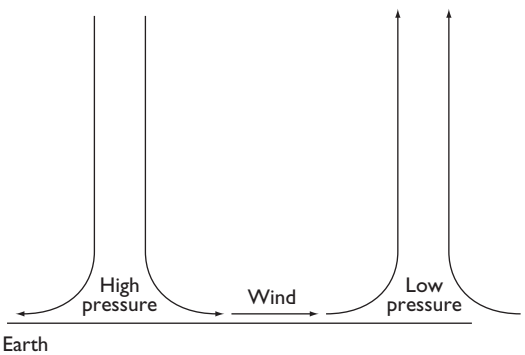
A barometer is the instrument that measures air pressure – and the readings are made in millibars.

Air pressure is very important in understanding weather because of these characteristics:

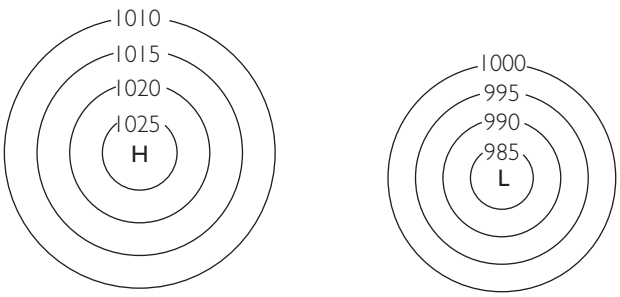
- ❑ Air pressure is NOT equal all around the Earth's surface.
- ❑ Because of its nature, air (gas molecules) moves around very easily.
- ❑ Air moves away from the Earth's surface when it is heated – if it moves away from the Earth's surface, then the air at that place is NOT pressing down.
- ❑ Air that moves upwards creates a vacuum – so air from other parts of the planet moves in along the Earth's surface to fill in that empty space.
- ❑ Air that rises cools as it moves higher up in the atmosphere. It becomes heavier – and then sinks down towards the Earth's surface.
- ❑ Wherever air sinks or moves towards the Earth's surface it presses down on the Earth – so air pressure becomes higher.

Study the following diagrams about rising and falling air (and air pressure) to understand how weather is affected by changes in air pressure.

1. Movement Of Air – Wind

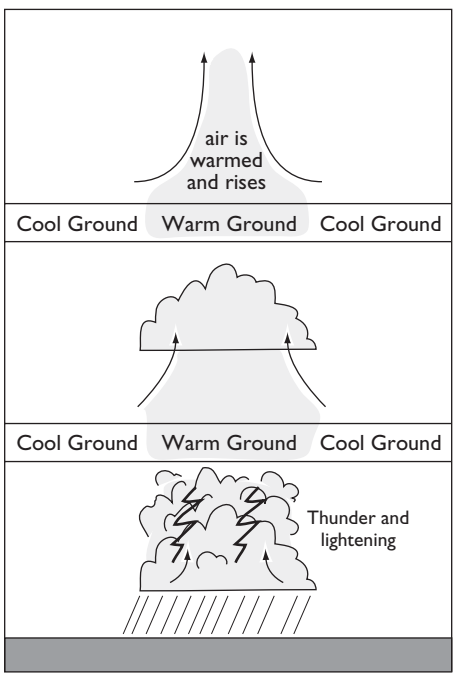


3. Air Pressure Systems



Air moves from high pressure areas towards low pressure areas. This movement of air is called wind.

2. Thunder Storm



4. Air Movement In Anticyclones And Depressions

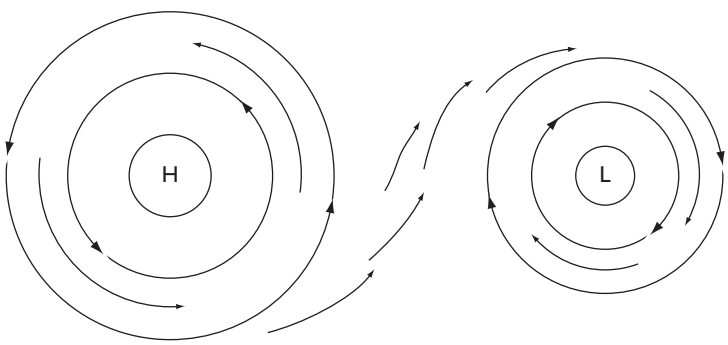


Figure 5.0.3 Wind and pressure system

Wind speed

Wind is air that *moves from one place to another*. Air movement that results in wind is caused by air moving in from a place where air is descending (high air pressure), to a place where air is ascending (low pressure). *Wind speed* measures *how fast that wind or moving air is going*. Wind speeds are high (strong winds) when air pressure is very low. Winds move into areas of low pressure. So when a barometer drops (the bar or needle on the barometer goes low on the scale) we know that strong winds and perhaps a storm are on the way.

Sunshine

Sunshine is the amount of solar radiation that reaches the Earth's surface. It is sometimes called *insolation*. Sunshine is measured in terms of how many hours of solar radiation was experienced at a place in one day.

Remember that not all the solar radiation that enters the uppermost layers of the atmosphere reaches the Earth's surface at any point or place. Different places receive different amounts of sunshine on the Earth's surface because of things like cloud cover and the type of Earth's surface (e.g. grasslands reflect some solar radiation back into the atmosphere – snow-covered areas will reflect back even more).

Some of the solar radiation is absorbed within the atmosphere itself. Dust particles in the atmosphere will reflect some of that solar energy back out into space.

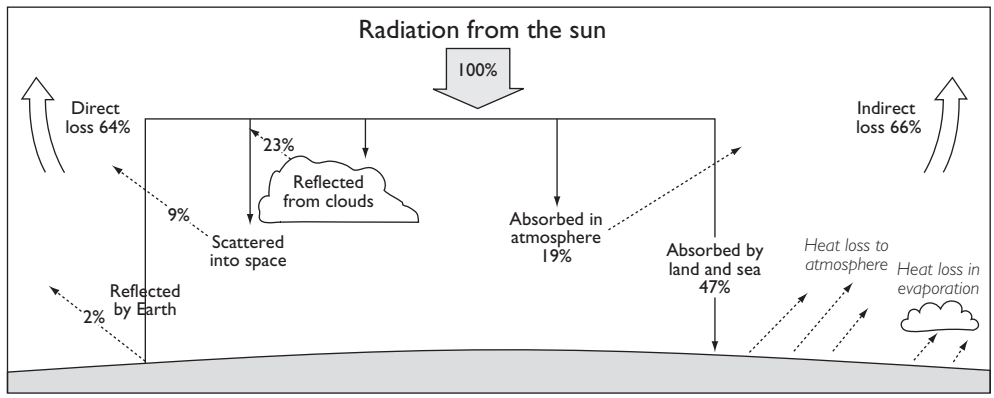


Figure 5.0.4 The heating system

Sunshine hours are important to our understanding of climate and weather patterns because sunshine or solar radiation determines how much heat energy the atmosphere will eventually receive. Think about this VERY IMPORTANT scientific point:

> Solar radiation that reaches the Earth's surface is absorbed there and changed into heat energy. Heat energy radiates out from the Earth's surface – this is what heats up the atmosphere close to the Earth's surface. This is the direct source of heat energy. Therefore the more solar radiation that is absorbed at the Earth's surface, the more heat energy the lower atmosphere will receive. If that heat energy is retained, temperatures will rise.

Humidity

Humidity measures the amount of water vapour in the air around us. Water vapour is created when water is evaporated. This happens when there is enough heat energy (ground heat) to evaporate liquid sources of water – i.e. water from lakes, puddles on the ground, and so on. Humidity is measured as a percentage of the air, e.g. if the air around us is 30% water vapour then that is the humidity level. In places that have high temperatures and a great deal of surface water, humidity can be expected to be high. In some parts of the world, humidity is constantly high, e.g. the highlands and some coastal areas of Papua New Guinea because of the high temperatures near the ocean. In the Sahara desert where there are very few water sources there is no humidity.

Precipitation

This is the word given to the condensation of water in the atmosphere followed by its return to the Earth's surface. In other words, precipitation takes place when water vapour in the air condenses (turns back into a liquid), then falls back to Earth as rain, snow, dew or mist. *Precipitation* occurs *when there is a change in temperature* – when the temperature in the atmosphere falls, water vapour cools and then condenses back into a liquid; or in the case of snow, it very quickly goes from liquid into a solid form. Rainfall is the most common form of precipitation. The amount of rainfall is measured by tools called rain gauges. Precipitation is measured in either millimetres or centimetres. In the United States, it is measured in inches.

The climatic elements described above are different in different places or parts of the world. They are influenced by climatic controls. Climatic controls determine the patterns of temperature, precipitation, humidity, air pressure and so on that make up the climate of a place. You will learn more about climatic controls in the next chapter.

Activity 1

1 Briefly identify and describe each climatic element discussed above in the form of a learning guide. (Your teacher will show you how to do one.)

2 Write out each of the climatic elements above. Write a paragraph which describes the weather outside your classroom. Explain what you see and feel in terms of each climatic element.

Unit 8

Understanding The Atmosphere

This section discusses ocean temperature, global temperature patterns and the seasons.

Temperature

Seasons

The Earth rotates on its **axis** once every 24 hours. The axis is an imaginary line which passes through the North and South poles. It is tilted about 23 degrees from upright. The direction of the axis remains fixed in relation to space and the stars. The Earth takes one year to complete an **orbit** of the sun. The illustration shows that at particular times of the year different places on the Earth's surface are directly under the sun. This causes the seasons as the Earth orbits the sun.

When the sun is overhead in its furthest southern position, on the tropic of Capricorn, it is midsummer in the southern hemisphere. This is about 21 December. During this time the summer days are longer than the nights. In the northern hemisphere summer, the sun is at its furthest position north, on the tropic of Cancer, about 21 June. This is six months after the southern summer. About 21 March and 21 September the sun is overhead on the equator. At these times the day and night are of equal length for all positions on the Earth. These positions are referred to as the **equinoxes**.

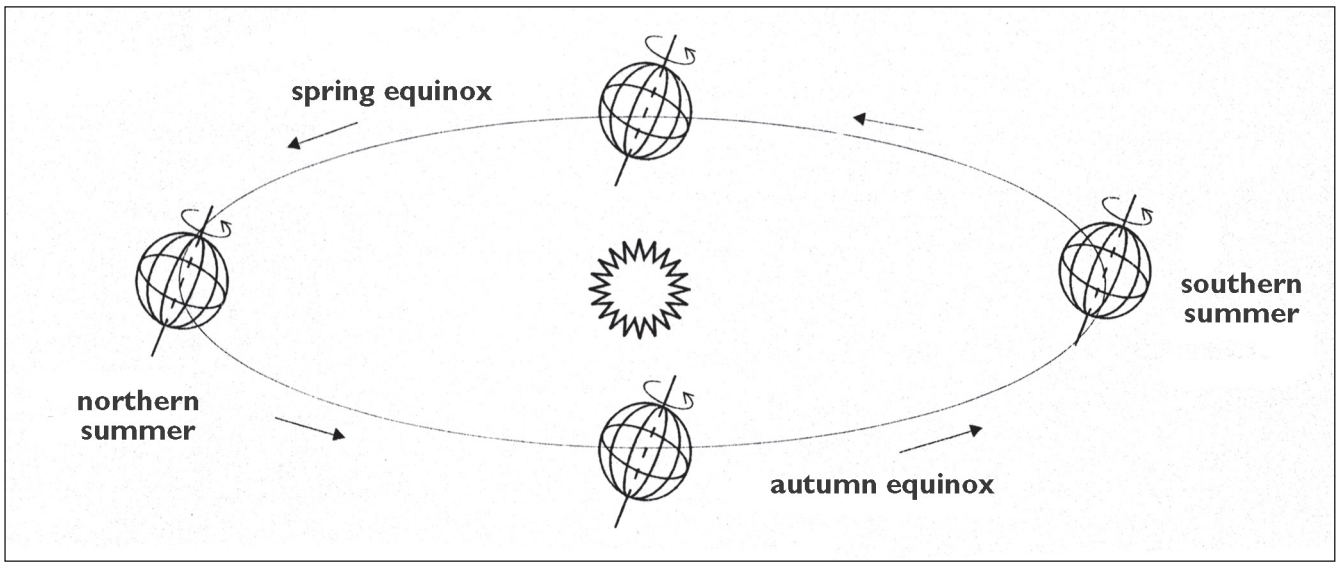


Figure 5.8.1 This is a diagram of the Earth's seasons. The axis is inclined at 23° to the plane of the orbit. This tilts the southern hemisphere towards the sun in their summer, and the northern hemisphere towards the sun in the northern summer. At the equinoxes the tilt is to one side only. This favours neither hemisphere and the days and nights are of equal length. Where is the Earth in its orbit now?

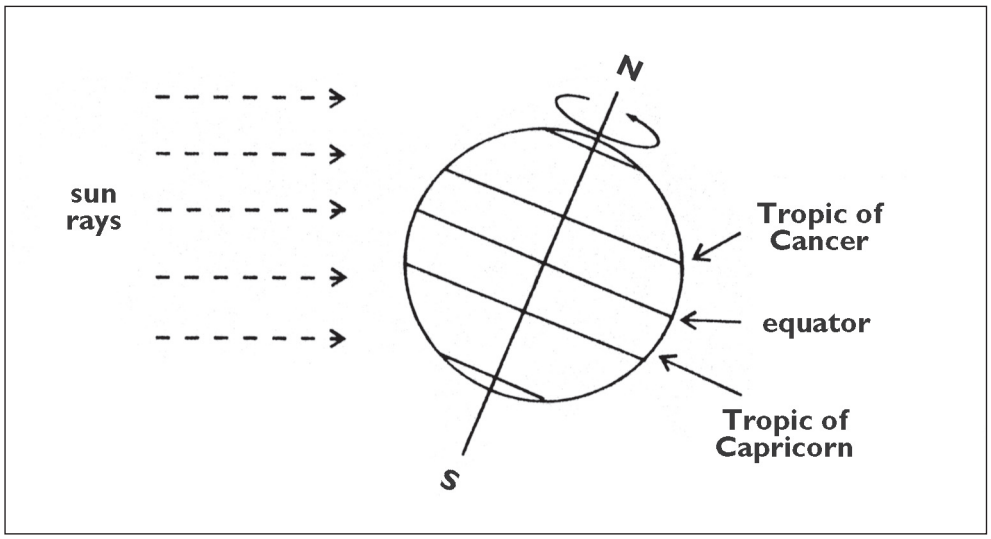


Figure 5.8.2 The position of the Earth when the sun is overhead in the middle of the southern summer (December 21). What would be the maximum height of the sun at this time on the equator?

The combination of day-length variations and the changing position of the overhead sun causes uneven heating of the Earth's surface, and thus the seasons. This would not occur without the tilt of the Earth's axis.

The day-length changes are most extreme at the poles. At mid-summer the sun never sets, while at mid-winter it never rises.

The heating effect of the sun depends on the angle of its rays to the surface. When the sun is overhead, the heating effects are greatest. As the angle decreases, the same amount of sunlight is spread over a greater area of the surface. Also the sunlight passes through more atmosphere. This means that the polar regions do not receive very much sunlight. So snow and ice are there all the year.

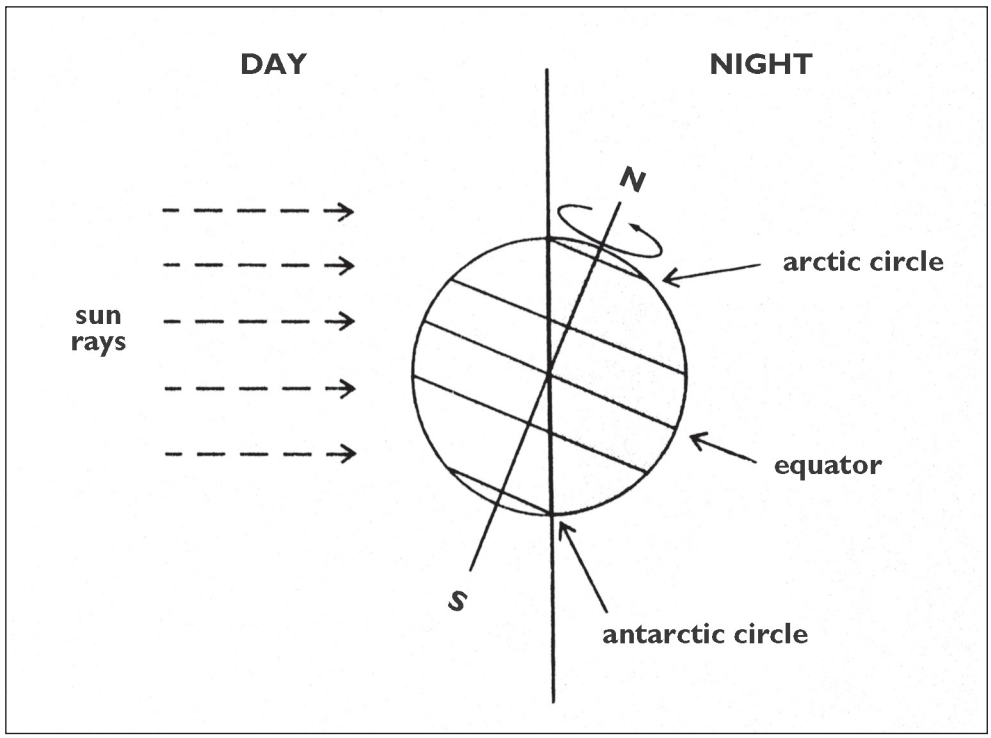


Figure 5.8.3 This diagram shows the length of day and night during the southern summer. From the equator south, the day length increases until at the antarctic circle there is no night. Day length shortens to the north, until there is no sunrise north of the arctic circle

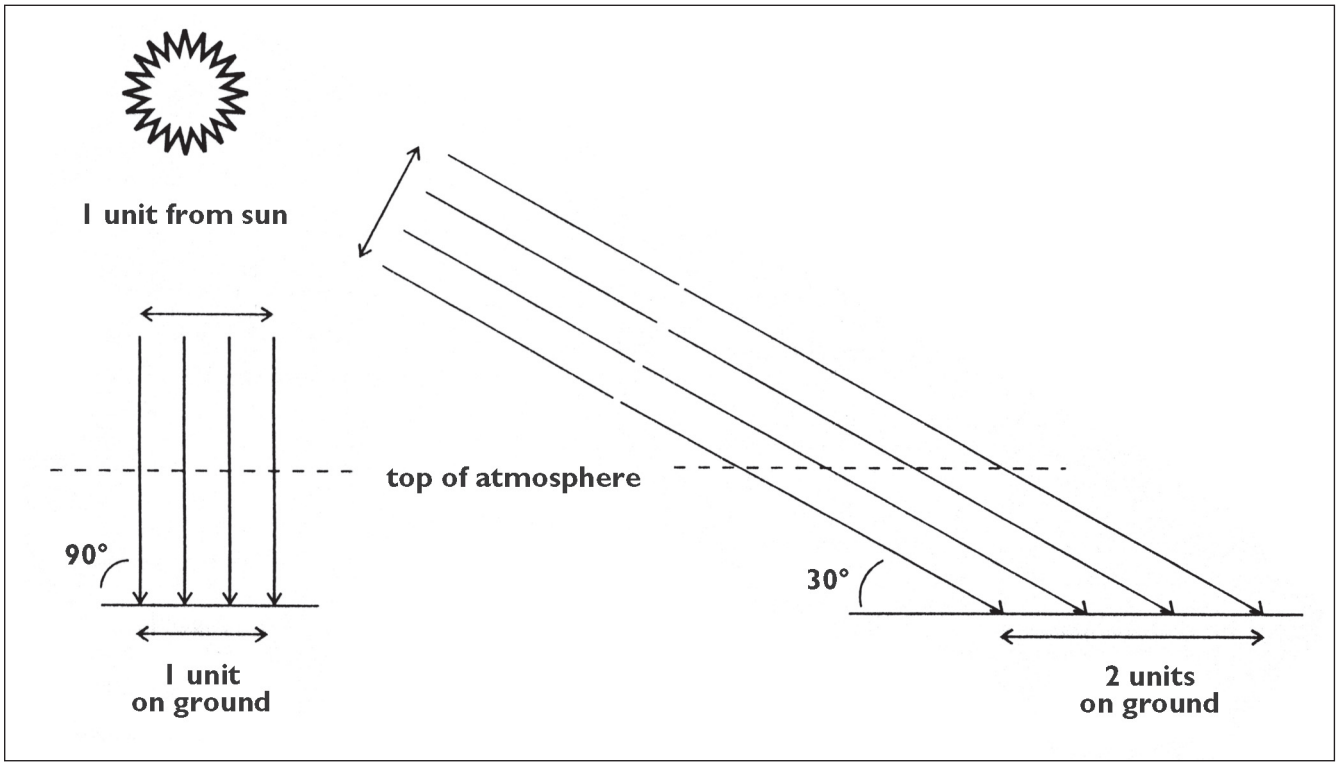


Figure 5.8.4 The effect sun angle has on the energy at the Earth's surface. As the angle of elevation of the sun decreases, the same amount of sunlight is spread over a greater area. It also has to pass through a greater length of atmosphere

Activity 1

The seasons

For this activity you will need a ball or globe to represent the Earth, and a torch to be the sun. If you do not have a globe, then you will need a map of the Pacific region.

1 In a darkened room, shine the torch on the globe. Move the torch so that it is overhead for people living at
   - ❑ Tropic of Capricorn
   - ❑ Tropic of Cancer and
   - ❑ Equator.

2 Explain why places on the Equator like Nauru do not experience as much seasonal change as Tonga.

3 How does the day-length vary between the northern and southern hemispheres in winter and summer?

Ocean Temperature

The surface temperature of the oceans varies with season and global position. The water is warmest in the summer, when the sun's heat is greatest. Figure 5.9.4 on page 195 shows the global pattern of surface water temperatures for January and June. These times cover the summer and winter seasons of both the northern and southern hemispheres. The lines on these maps are lines that join places of the same temperature. They are called **isotherms**.

The equatorial and polar regions are either hot or cold all year. In the mid-latitudes there are variations of five degrees or more. Near to the coastline the seawater temperature changes more than in the open ocean. The main seasonal temperature changes are caused by the changes in altitude of the sun. If the sun's energy has to pass through a great thickness of atmosphere, more energy is absorbed. So less reaches the ocean. Also, at low sun altitudes, the energy is spread over more ocean, so it heats less.

Thermoclines

The temperature pattern also changes with depth in the oceans. Figure 5.8.5 shows a typical temperature profile. On the surface the temperature is variable and depends upon latitude and season. This layer warms and cools as the amount of heating which enters the sea surface changes. Below this upper layer there is a cooler layer. There is a rapid drop in temperature where the upper layer meets the lower layer. This region of change is referred to as a **thermocline**. In the tropical Pacific this thermocline starts between 150 and 350 m depth. It extends down to about 1000 m. Below this depth the water temperature slowly drops with increasing depth. The bottom ocean temperature is 2–3°C. The Pacific Ocean floor is about 5600 m deep.

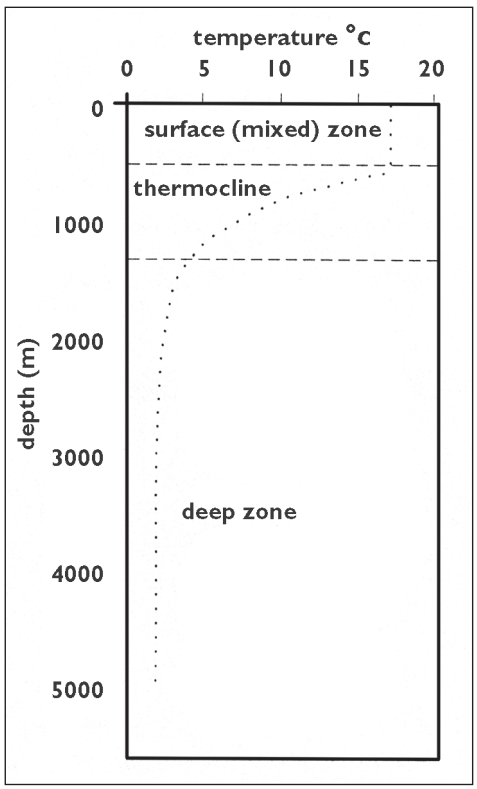


Figure 5.8.5 Typical depth profile of an ocean in mid-latitude summer. The three-layered structure can be clearly seen. What is the temperature range of each zone?

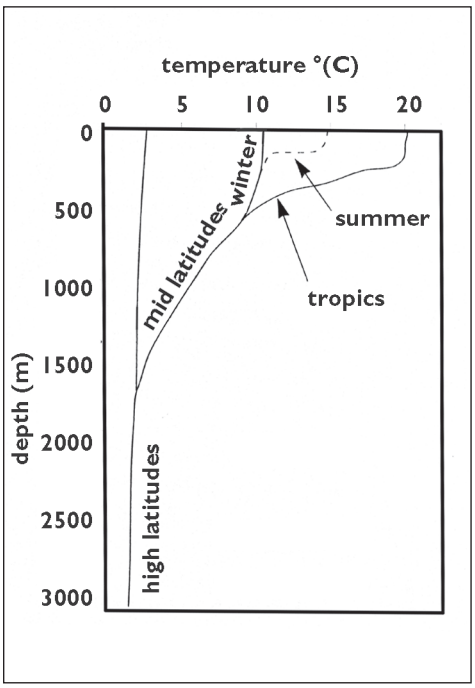


Figure 5.8.6 Depth profile of the oceans. The tropics have a permanent shallow thermocline. The shallow thermocline is seasonal in temperate regions. No thermocline is found in the high latitude polar region

Temperature changes the density of the seawater. This causes the three-layered structure shown in Figures 5.8.5 and 5.8.6. As the temperature drops, the density of seawater increases. The coldest surface water is found beneath sea ice in the Antarctic. Since it has a higher density than surrounding water, it sinks. It forms a slow deep sea current of cold water that spreads away from Antarctica.

This cold water is replaced by warmer surface water which flows in from equatorial latitudes. In this way heat is 'pumped' away from the tropics and taken to the poles. The currents are complex and changed by continental land masses. Eventually deep cold water mixes with shallower and warmer water. It may take 200–500 years for deep cold water to come back to the surface.

Complex air movements in the atmosphere also transfer heat from the equator to the poles. The circulation of both the atmosphere and water cool the equatorial regions and heat the polar regions.

The movements of the atmosphere and the oceans are linked in a complex way. An example of this is the El Niño, which is explained later

Activity 2

1 Why do only the upper shallow layers of the ocean change temperature with the season and latitude?

2 Why is there a thermocline as a middle layer?

3 Where does the extensive deep cold layer come from?

Wind

Wind and waves

Wind blowing over the ocean causes waves to form. In light winds, only small ripples are made. In strong winds, large waves, mixed with a variety of smaller waves, are formed. Large ocean waves last long after the wind that formed them has stopped blowing. The larger waves will form the ocean swells. They crash onto reefs thousands of kilometres from where they were formed. These large waves are very efficient energy carriers.

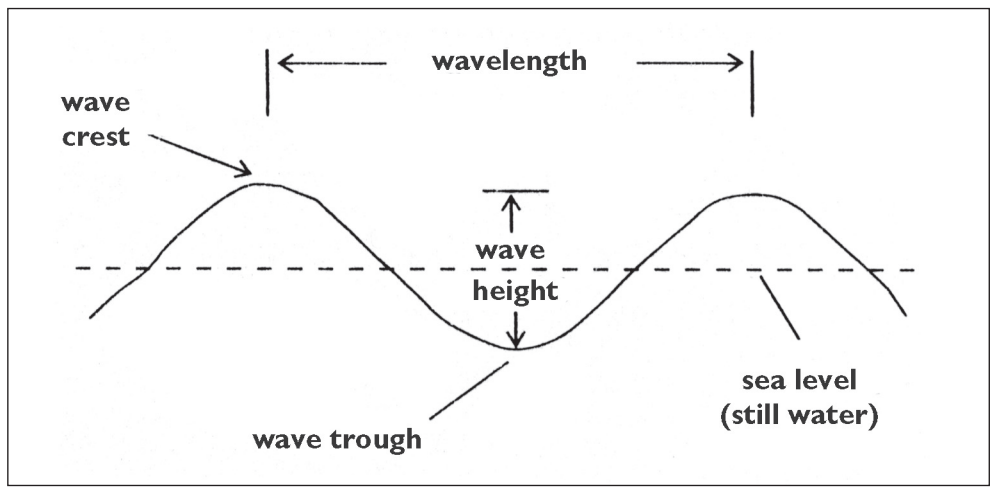


Figure 5.8.7 Some of the names used to describe parts of a wave

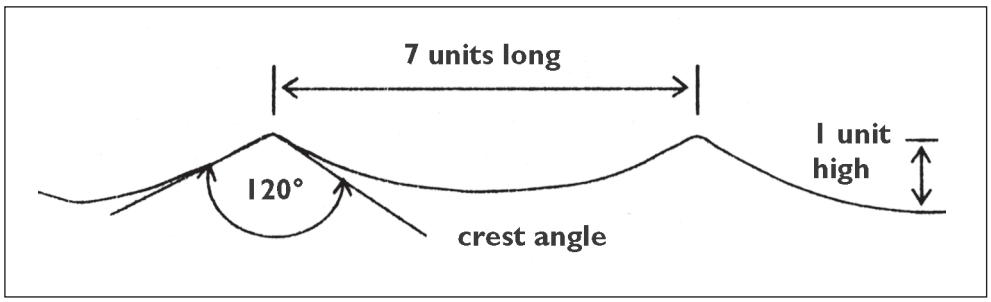


Figure 5.8.8 Waves do not have a height to length ratio less than 1:7. At this ratio, the angle at the top of the wave is about 120°

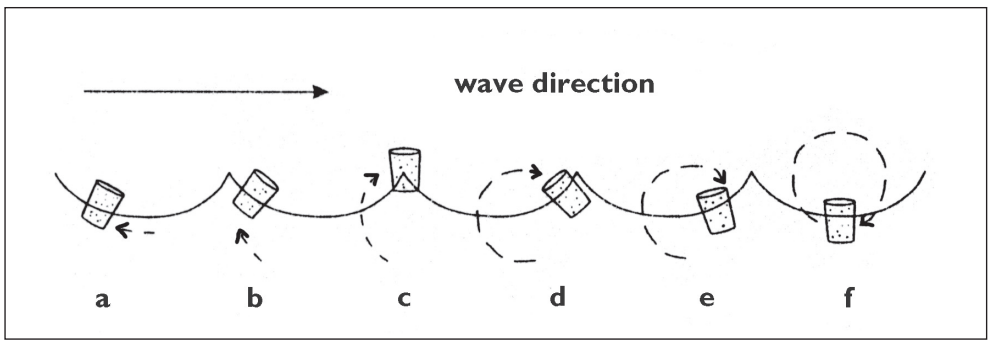


Figure 5.8.9 The movement of the water surface as waves pass can be illustrated by putting a cork in the water. As the wave passes the cork, shown in the diagram a-f, it will move in a circular path

The water particles move in circular **orbits** as the wave passes. A wave only disturbs the water immediately below. Sailors in submarines report that at 300 m the water is still beneath a raging storm at the surface.

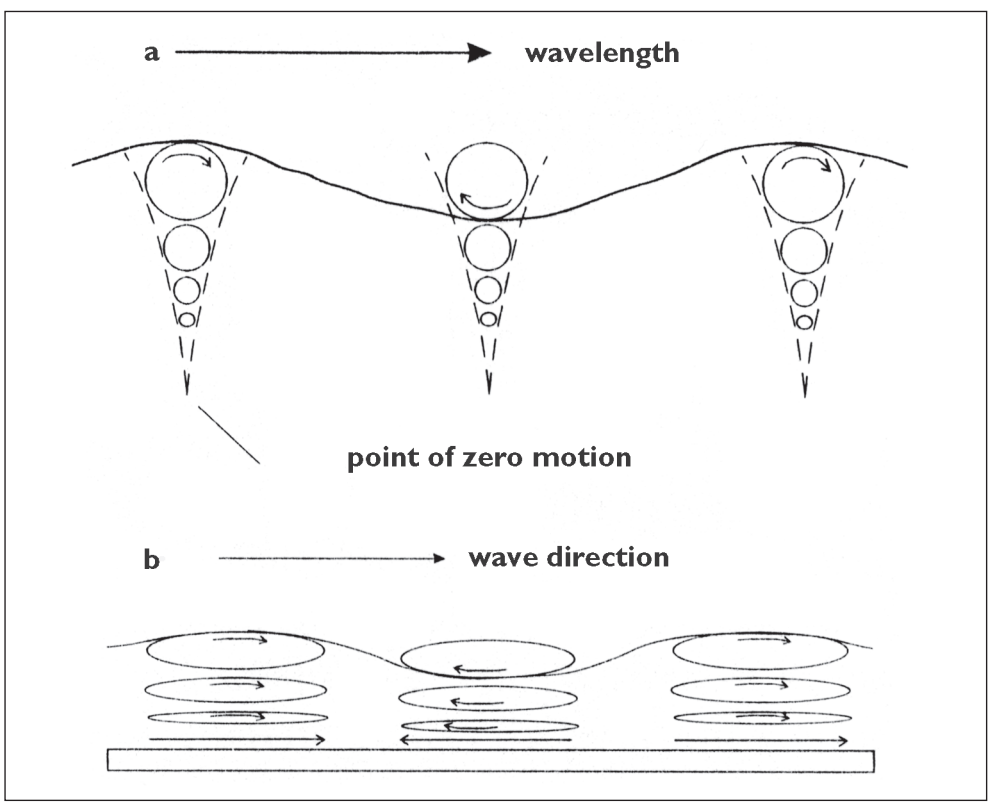


Figure 5.8.10 Water movement under waves: a) in water deeper than half the wavelength, the circular motion of the water decreases with depth: b) in shallow water less than one-twentieth the wavelength, the circular orbits become very elliptical. At the sea floor the water moves back and forth as the wave passes. How would this motion affect the surface of a sandy floor?

As waves approach a shoreline, the shallowing water causes the circular orbits to become **elliptical**. When the water depth is about equal to the wave height, the wave becomes unstable. The top breaks, to form a surf wave. The wave continues to break and lose energy right up to the beach.

When the wave moves into shallow water it slows down. This causes the wave to bend towards the shallower water. This bending of waves by changing wave speed is called **refraction**.

Groups of islands interfere with waves, causing them to change direction and form patterns. Early Micronesian, Melanesian and Polynesian navigators learned how to use these patterns to find islands out of sight over the horizon.

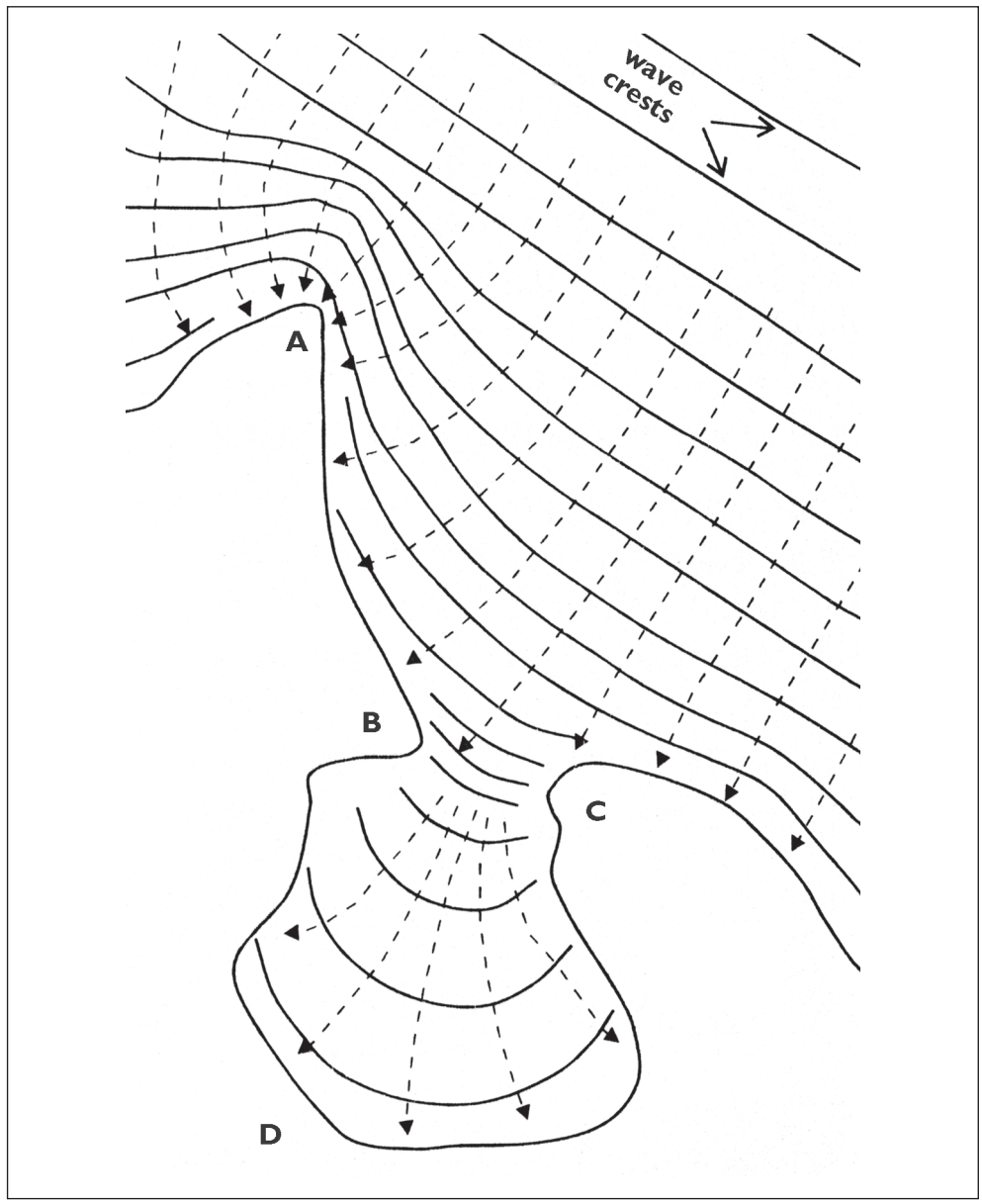


Figure 5.8.11 As the waves travel into shallow water they refract (bend) towards the shore. This will focus wave energy onto the headland A. The energy of the wave passing between B and C is spread out around the bay D. The waves in the bay will be much smaller and have less energy when they reach the shore

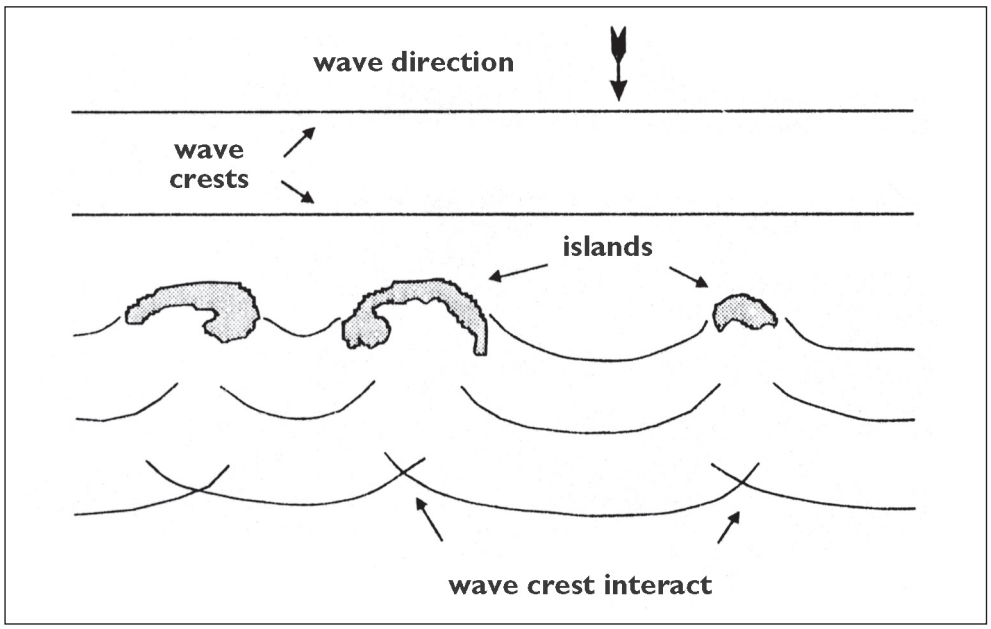


Figure 5.8.12 Island chains will cause the waves to diffract and form characteristic patterns. Polynesian navigators used these wave patterns to locate islands that were windward and out of sight over the horizon

Activity 3

1. One way to observe some of the properties of waves is to find a quiet pool of water. Throw in a large stone. Notice how a group of ripples (small waves) moves away from the point of impact. If you observe carefully you will see that a new ripple forms at the back of the group of radiating ripples. It then moves forward and quickly disappears at the front of the group. In this way the ripples move out in ever increasing circles.
2. Find a way to measure the speed of waves.
3. How does the surface of the water move with the ripples?

Wind-Driven Circulation

If the wind blows steadily, the water moves downwind at about 2–3% of the wind speed. This water movement causes the huge slow water circulations of the ocean basins, known as **gyres**. The wind-driven circulation affects the surface layers of the oceans. Deeper water, below the **thermocline**, is undisturbed. The patterns of the surface currents reflect the prevailing wind patterns. This shows how closely the oceans and the weather are linked together.

Both the winds and the ocean currents move across the ocean in huge curving paths. The paths they take are affected by the rotation of the Earth. As the Earth rotates on its axis, wind flow is deflected away from the equator. This force, which causes the curved paths, is called the **Coriolis effect**. It was named after the mathematician who first investigated it.

The Coriolis effect is strongest at the poles and weakest at the equator. The force causes winds and currents to turn to the left in the southern hemisphere and to the right in the north. The turning forces are very weak near the equator, so that winds and currents are not turned there.

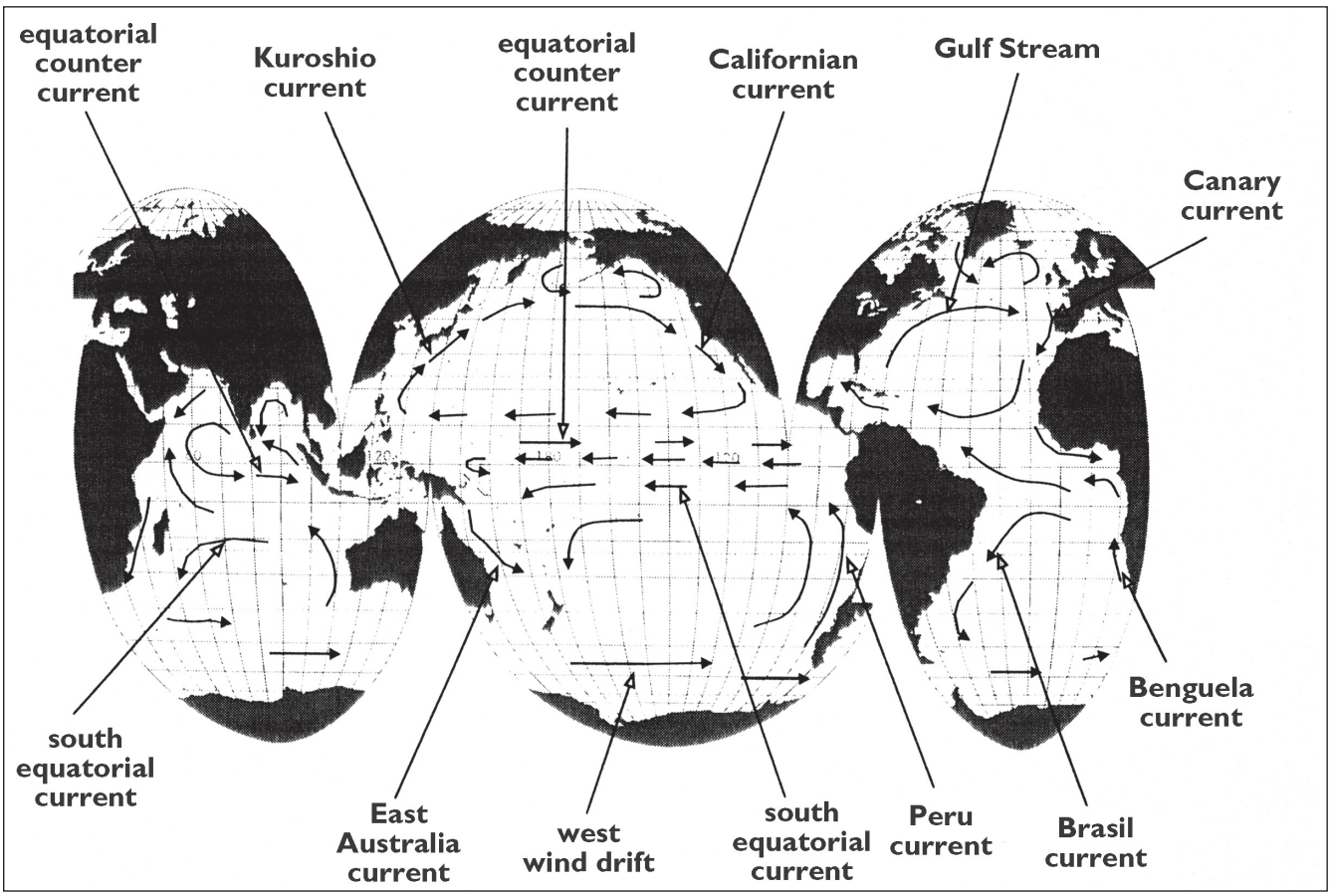


Figure 5.8.13 Surface currents of the oceans. The larger circular patterns are called gyres. They are driven by the global wind patterns

At about 5–10° south or north of the equator, the turning forces become stronger. It is only away from the equator that the big rotating tropical storms and ocean gyres form. The Coriolis force only acts on air or water that has also been moved by other forces. It only modifies the direction of the movement.

Along some coasts the wind brings deep, nutrient-rich, cool water to the surface. In the diagram the wind is shown blowing along a shoreline. Coriolis force moves the water to the left, which moves the water offshore. Deeper water rises to the surface to replace this water. This movement is called **upwelling**. It is very important to many fisheries of the world. The nutrient-rich water fertilises the sea, and starts the fisheries food chain.

What would happen if the wind blew south in Figure 5.8.14? This would move oceanic water toward the shore. So the oceanic water would sink next to the coast. This is called **downwelling**. On such a coast the nutrient-poor oceanic water does not support a food chain, so there is very little marine life.

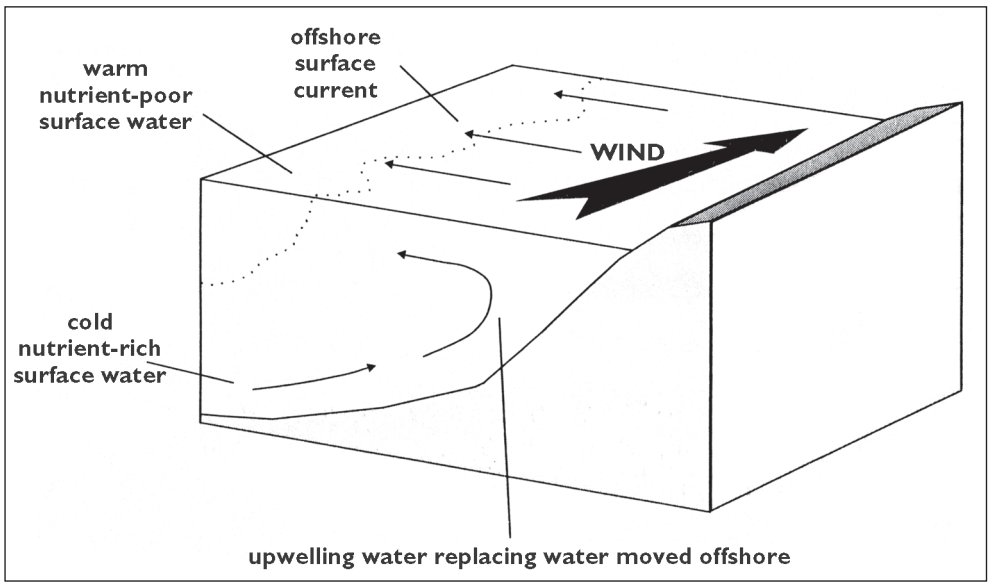


Figure 5.8.14 A southern hemisphere coastline where upwelling is caused by the wind. The surface water moves offshore under the influence of the wind and the Coriolis effect. The deep water that wells up and replaces it is rich in nutrients. Such shores are very productive, and usually support big fisheries, e.g. along the Chile-Peru coast. What would the water movements be if this diagram was of a northern hemisphere coastline?

Ocean-Atmosphere Interaction

In this section, two examples of ocean-atmosphere interactions are discussed. Tropical storms are immediate and violent examples of air-sea interaction. The El Niño – Southern Oscillation (ENSO) example is a slow, long-term interaction that takes over a year to happen.

Tropical storms

Large tropical rotating storms take place in the tropical regions of all oceans. In the *northern hemisphere* they are called *hurricanes* or *typhoons*. In the *southern hemisphere* they are called *cyclones*. Exactly how these storms start is uncertain. But soon after they form, they are recognised by a swirling cloud pattern. The winds blow in a spiral towards the centre.

The seawater over which they form must be at 26°C or above.

The rotating of the winds about the centre of the storm is caused by the **Coriolis effect**. Thus, rotating storms are not found within 10° of the equator. In the southern hemisphere they rotate to the right when viewed from above. In the northern hemisphere they rotate to the left.

Within a few days of forming, a cyclone will usually intensify. The winds near the centre can be 200 kph or higher. The driving force of these rotating tropical storms is the warm seawater. As soon as a cyclone moves over cool water or a large landmass, it breaks up. The centre of a cyclone has a rotating, rising moist air mass. As the air rises it expands (because the air pressure is lower) and it cools. The water vapour condenses as rain. As the rain condenses, it gives up heat. This heat warms the air so it rises even more quickly.

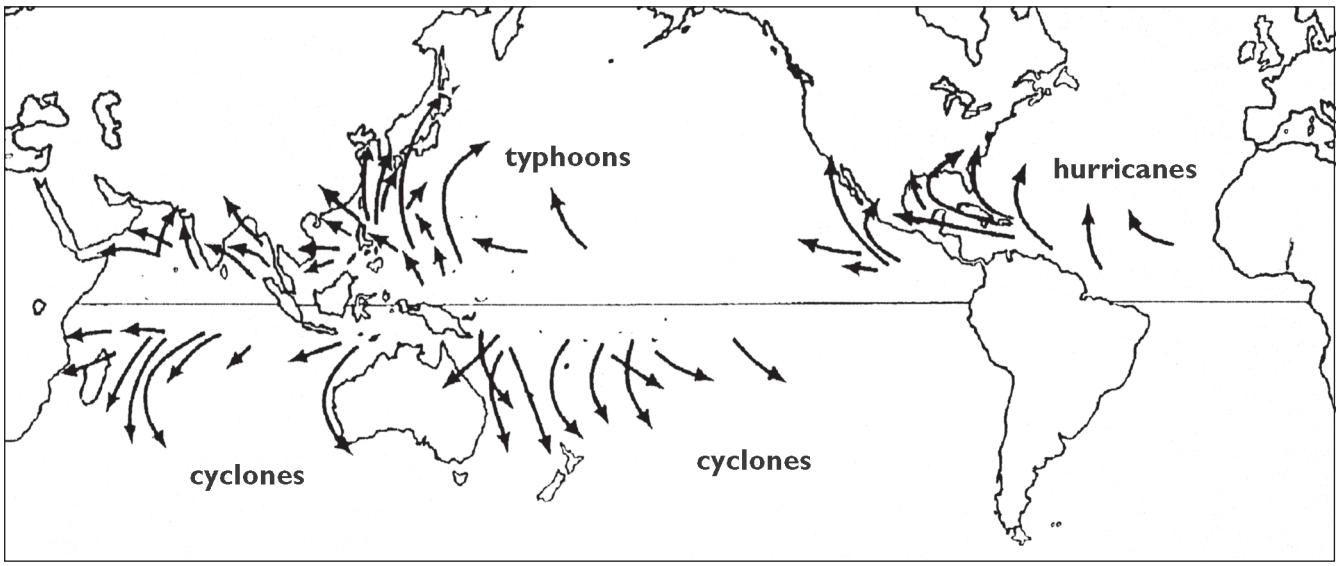


Figure 5.8.15 Typical track of common storms. Note the absence of storms near the equator. These tracks are the average paths for storms. Any one storm can go in almost any direction. When they cross over land they degenerate to rain depressions

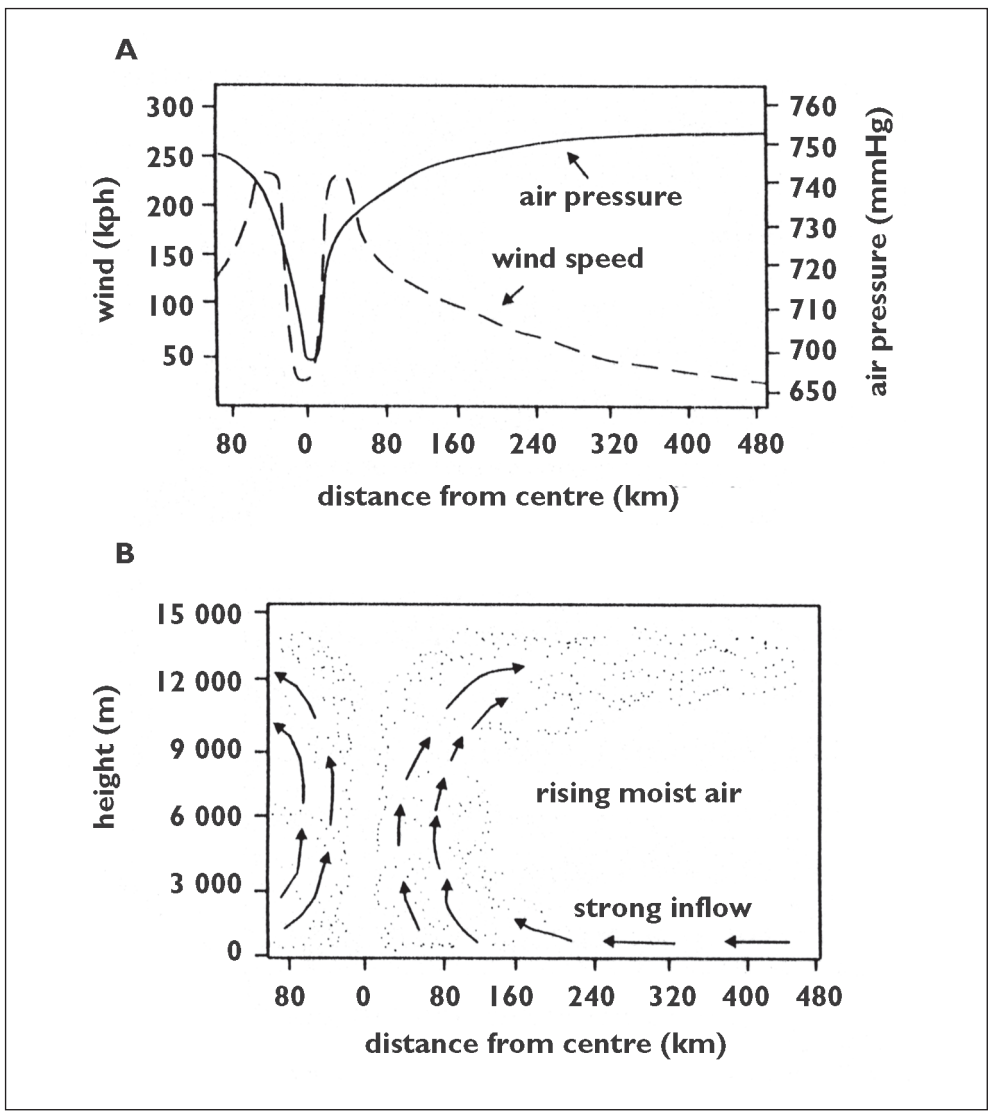


Figure 5.8.16 Anatomy of a tropical storm: a) a graph of air pressure and wind speed about the centre or eye of the storm. When the pressure decreases, the wind increases; b) the air currents in the storm. As the warm moist air rises, the water vapour condenses and produces very heavy rain. As well as rising vertically, the air is also twisting. In what direction do tropical storms rotate in your area?

The warm air rising up the centre of the cyclone is replaced by moist warm air from the sea surface. It is this air rushing in to the centre that causes the strong winds. The strength of winds in a cyclone depends upon the size and air pressure of the centre. The lower the pressure, the stronger the winds.

Cyclones are very dangerous. The wind is the main danger. It can blow over houses and trees. A second danger is the very high rainfall, which can cause flooding. A third danger comes from the sea.

The very low pressure in the centre of the cyclone 'sucks up' the sea surface. This forms a large wave similar to those formed by tides. Combined with the strong winds this causes a storm surge (very big wave). Such waves can destroy coastal villages and wreck small boats.

Activity 4

Cyclone Project

1 Find out how to prepare for an approaching cyclone.

2 How effective is the cyclone warning system?

3 How much warning do you get?

4 What local areas will be subject to storm surges?

5 Which areas might be affected by flood rains?

6 Suggest improvements that could lessen the impact of a cyclone.

El Niño – Southern Oscillation (ENSO)

ENSO is an example of the way in which the atmosphere and the oceans interact together. It is not clearly understood and meteorologists are still actively researching it.

The *southern oscillation* refers to air pressure and weather changes over the Indo-Pacific region. The **El Niño** is when an unusually large amount of warm water appears in the eastern equatorial Pacific. This water stays there for a few months, usually about Christmas time.

The warm water stops cool nutrient-rich water from upwelling near the coast of Peru. This cool water is the start of a food chain for fish off the coast of Peru. When the warm water stops the upwelling, fish starve and the Peruvian fishery collapses.

The El Niño is irregular; these same conditions returning any time between 2 and 11 years. In normal years the eastern Pacific usually has strong easterly winds. These blow across the Pacific and set up a very slight slope on the surface of the ocean. Cool water is slowly moved from the east to the west.

During an El Niño year the easterly winds slow. This allows warm water from the western Pacific to flow to the east, to form the warm water pool. At the same time wetter weather also moves eastward. Islands in the east have much higher rainfall, while those in the west have lower rainfall. This produces droughts in the Australasian region.

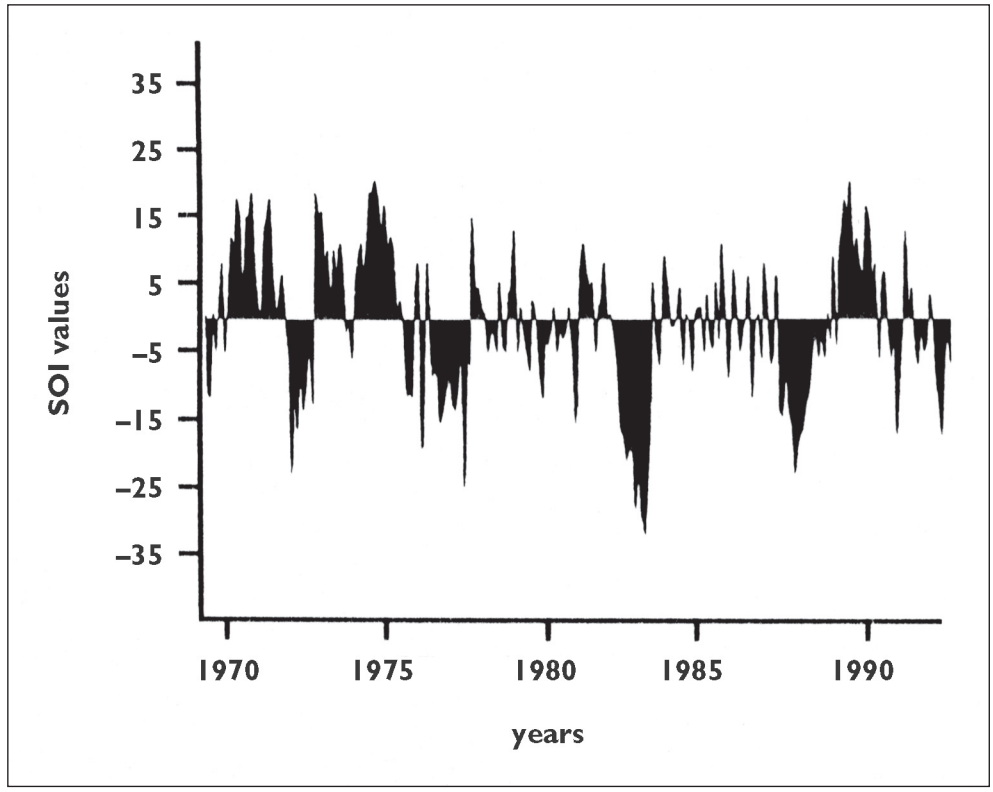


Figure 5.8.17 A graph of the Southern Oscillation Index (SOI) since 1970. Strong negative periods are El Niño years. What happens to your weather pattern in an El Niño period?

If the air pressures of Tahiti and Darwin are compared, they appear to oscillate. Sometimes Darwin has a higher pressure and at other times Tahiti has a higher pressure. These pressure differences are used as a measure, or index, of the southern oscillation in weather patterns. Figure 5.8.17 is a graph of the **Southern Oscillation Index** (SOI) for the years 1980 to 1992.

In an El Niño year the SOI is strongly negative. This means that the Darwin air pressure is much higher than Tahiti's. The relationship between the southern oscillation and the El Niño is not perfect. So the weather patterns are not entirely predictable. For example the SOI index for 1982–1983 was the strongest for over a hundred years. It did not result in as much rain in the South-West Pacific as the weaker 1986–87 index.

When the SOI is positive, tropical cyclones form in the Coral Sea. During a strong ENSO year they form much further to the east than normal. ENSO rainfall patterns cause the islands of Tuvalu, Tokelau and the Northern Cooks to have increased rainfall. At the same time the islands of the Southern Cooks, Fiji, Tonga, Western Sāmoa and Niue will have less rainfall.

The southern oscillation is part of a larger weather pattern that extends around the tropics. There are regions of warm moist air rising to form clouds and rain areas. These are low pressure regions.

Rising warm air regions are called **convection cells**. These are linked to areas where cooler air descends. This cool air is dry, and where it descends there is little rainfall.

The cool dry air that descends to the surface of the Pacific spreads westward and forms the South East trade winds. As these winds pass over the water they become warm and pick up moisture from the sea.

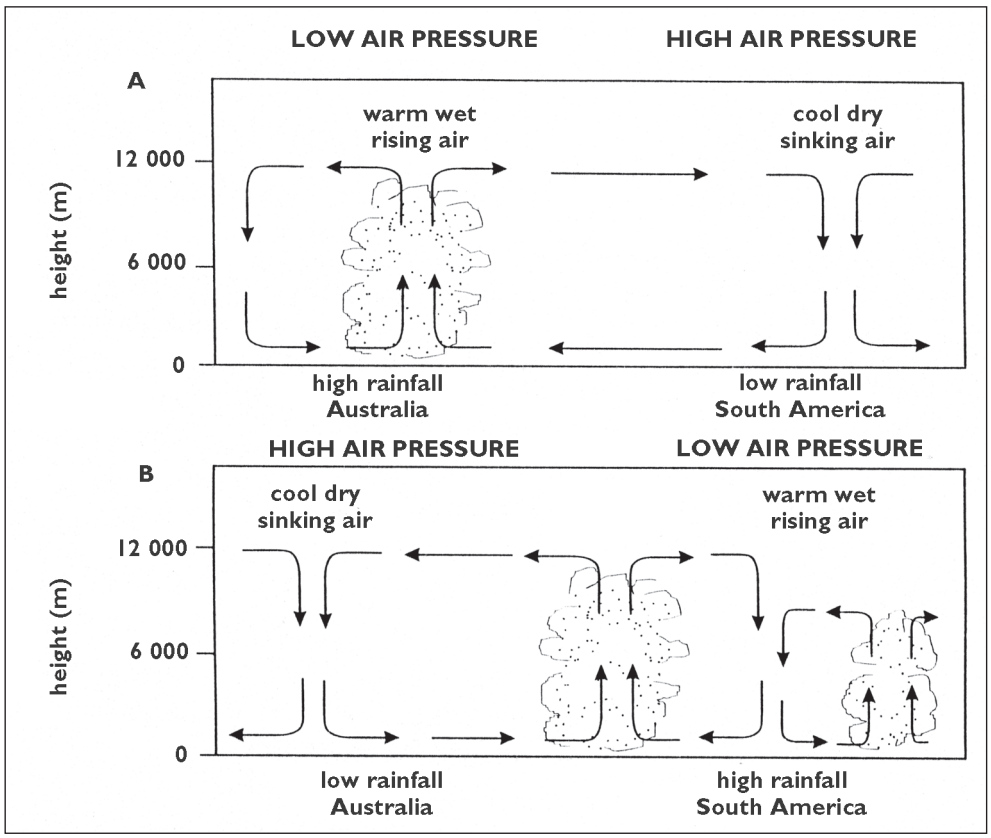


Figure 5.8.18 The equatorial air flow a) when the Southern Oscillation Index is positive and b) when it is negative in an El Niño period

The ENSO causes the rising warm air of the West Pacific to move eastward. This forms the weather patterns that are associated with El Niño. All tropical weather patterns are interconnected. This global linking of climates makes the ENSO hard to predict. So it appears as a short-term almost random event.

Activity 5

ENSO Project

Find out where you can get information on the ENSO cycle. This may require you to contact the local observatory. What resources are there in your library that cover the ENSO problem? Is there any traditional knowledge that explains cycles of dry and wet years?

Unit 9

Climate Change And The Processes Of Climate Change

Heat Budget

The *heat budget* describes *the way the heat from the sun is distributed around the world*. Not all the sunlight reaches the Earth's surface. Some is reflected back into space. As the angle becomes flatter, more sunlight is reflected back into space.

Clouds and snow also reflect sunlight back into space. At night the Earth **radiates** heat back into space. Think about why the polar regions of the Earth are poorly heated.

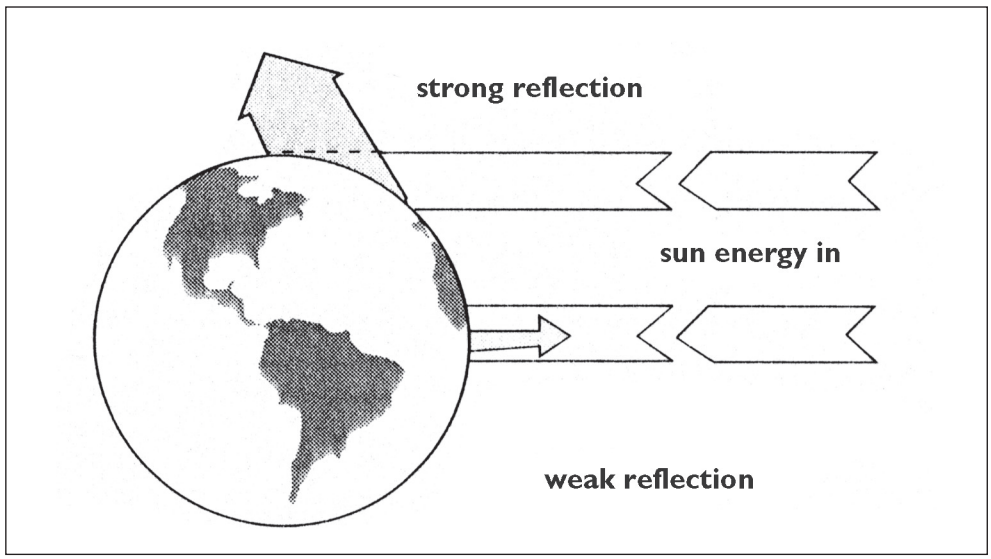


Figure 5.9.1 More energy reflects back into space from the Earth when the sun is at a lower angle. In polar regions the high reflection from snow will further decrease the amount of energy absorbed

Consider your ideas about sunlight in the polar regions, against the following factors:

- Sunlight arrives at a very shallow angle.
- Snow and ice reflect energy back into space.
- For part of the year the sun does not even rise above the horizon during the very short days.

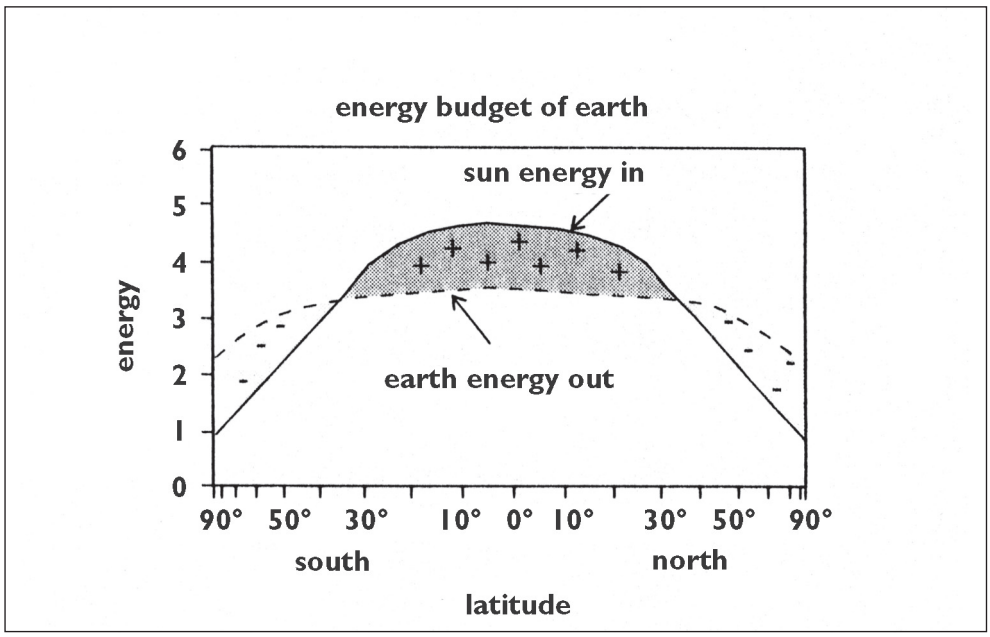


Figure 5.9.2 Graph of the heat budget of the Earth. In the tropics heat is gained. Temperate and polar regions lose heat. The budget is balanced by the movement of warm air and water from the tropics to the poles. What would happen to the temperature if the air and water did not transport heat?

On average, more heat is lost than gained in polar regions. This contrasts with the tropical regions where the sun is overhead for much of the time and little energy is reflected back into space. Here there is an excess of heat. On average, more heat is gained than lost in the tropics.

The excess heat of the tropics travels towards the poles. It is carried in the atmosphere (as warm air) and in the oceans (as warm sea water). Cool air and water return to the tropics to become heated again. In this way the tropics are kept cooler, and the polar regions kept warmer.

Greenhouse Effect

To understand the greenhouse effect, you need to understand about energy radiation. The heat radiated from a body depends on the temperature of that body. Consider a piece of iron that has been heated until it is white hot. At this very high temperature it is radiating energy mainly in the yellow/blue part of the light **spectrum** (at a wavelength of about 0.5 microns). As it cools, the colour changes to orange and then red (at a wavelength of about 0.7 microns). This follows the rule that a lower temperature body radiates longer wavelengths. As the iron cools further, it will stop glowing. At this temperature, the radiated wavelengths are not visible to our eyes, as they are down in the **infra-red** region of the spectrum. However the iron is still hot enough to burn your hand. At room temperature the iron will radiate energy with a wavelength of about 10 microns.

The name 'greenhouse effect' comes from the glasshouses (greenhouses) where people grow plants in cooler parts of the world. These houses let in sunlight, heat up and help the plants grow. At night greenhouses cool down slowly. This is because the glass lets in the short wavelengths of energy that come from the sun, but does not let out the longer wavelengths of energy that are radiated from the warm soil and plants at night.

The sun has a very hot surface, about 5500°C. A body at this temperature radiates most of its energy at a wavelength about 0.54 microns (a micron is 1 millionth of a metre). This appears to us as yellow light. The surface of the Earth is much cooler than the sun. At a temperature of 20°C a body will radiate energy at infra-red wavelengths of about 12 microns. The glass of the greenhouse keeps the longer wavelengths in. This causes the temperature to rise, producing shorter wavelength radiation. This can get through the glass. So the temperature stabilises.

The Earth's atmosphere is like a greenhouse. The gases and vapours in the atmosphere are transparent to certain wavelengths only. The dangerous **ultraviolet** light from the sun is blocked by the **ozone** and oxygen molecules. The infra-red end of the energy from the sun is blocked by water vapour and carbon dioxide gas.

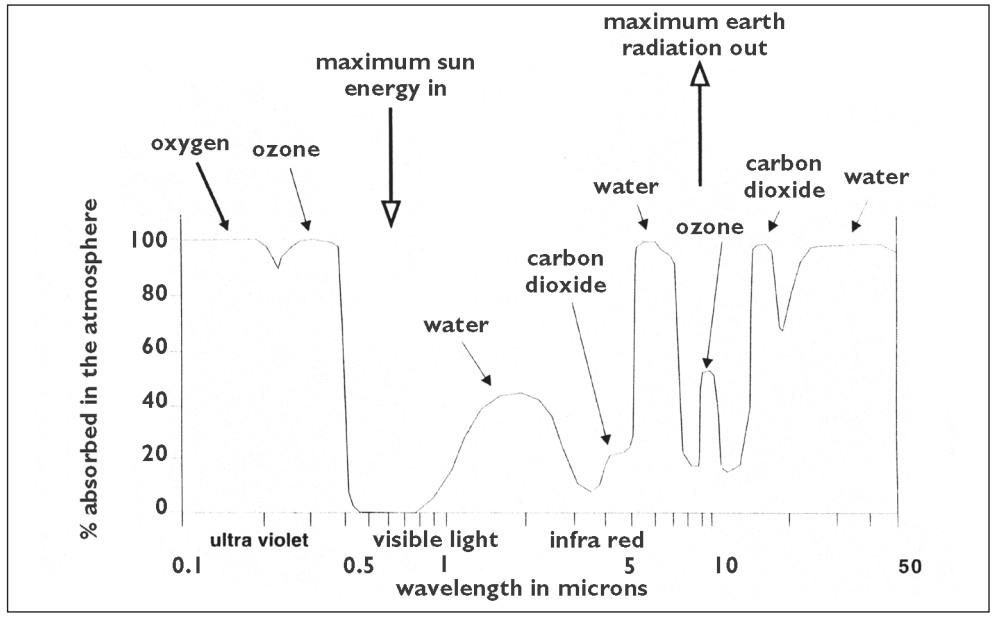


Figure 5.9.3 Absorption of energy by water vapour, carbon dioxide and other gases in the atmosphere. Most of the energy from the sun is in the visible region of the spectrum. The Earth's radiation back into space is mainly in the longer wavelength infra-red part of the spectrum. What would happen if there was less ozone and more carbon dioxide?

The atmosphere lets in nearly all the energy between these limits (0.4 to 0.8 microns). As in the greenhouse, this energy warms up the Earth.

Industrial pollution has increased the amount of carbon dioxide in the atmosphere. This stops some of the longer wavelength radiation getting back into space. So the world's temperature rises. This may be just a few degrees above normal. So what? A few degrees will not matter much . . . or will it?

At present there is a lot of water in polar snow and ice. If this melts, it runs into the sea. If it all melted, the sea level would rise by tens of metres.

If greenhouse gases, like carbon dioxide, continue to increase, the sea level will rise 1 to 2 m over the next 100 years. A few degrees rise in temperature will cause this. Many low-lying islands in the Pacific will come under increasing threat. (See page 198.)

People who live on an island or close to the sea will be able to appreciate that a rise in sea level of 2 m could cause big problems. Many countries of the world are now trying to reduce emission of greenhouse gases.

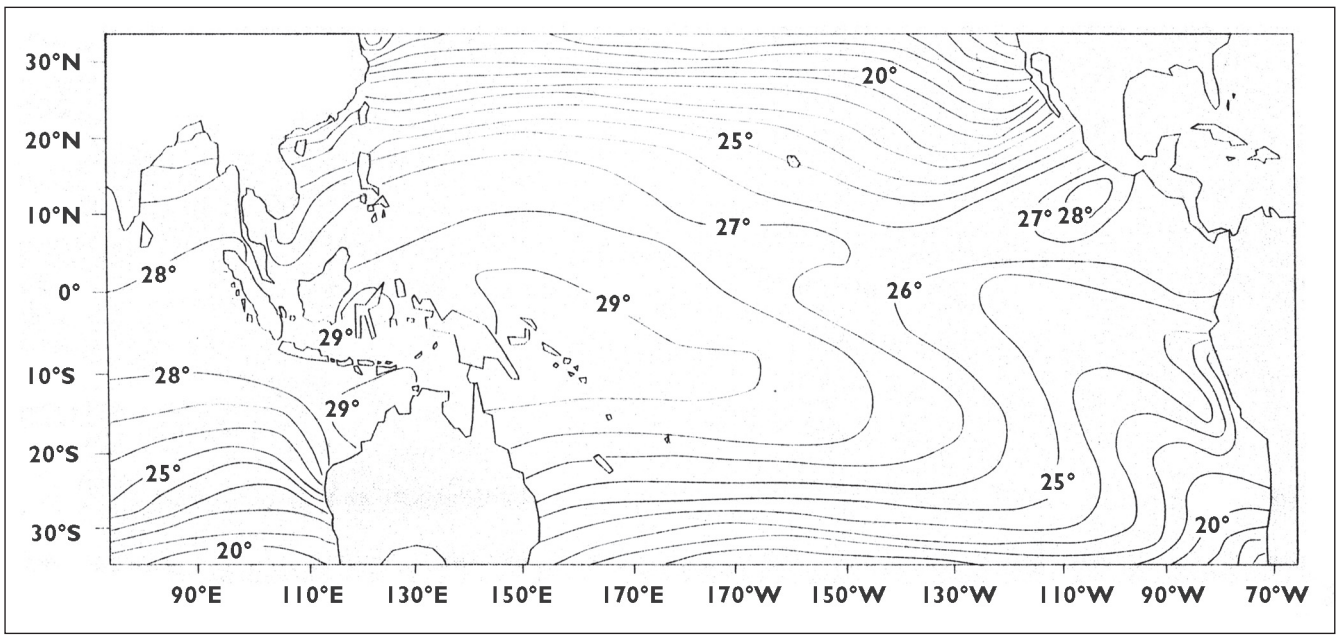
The greenhouse problem is one example of atmosphere-ocean interaction. Two other examples are the **El Niño-southern oscillation (ENSO),** and tropical storms. As far as we know, the only problem influenced by humans is the greenhouse effect.

Activity

Greenhouse Gases

Find out how some countries are trying to reduce their greenhouse gas emissions. Why might some countries be less concerned about reducing their emissions? What could you do to reduce greenhouse gas emission associated with your lifestyle?

A



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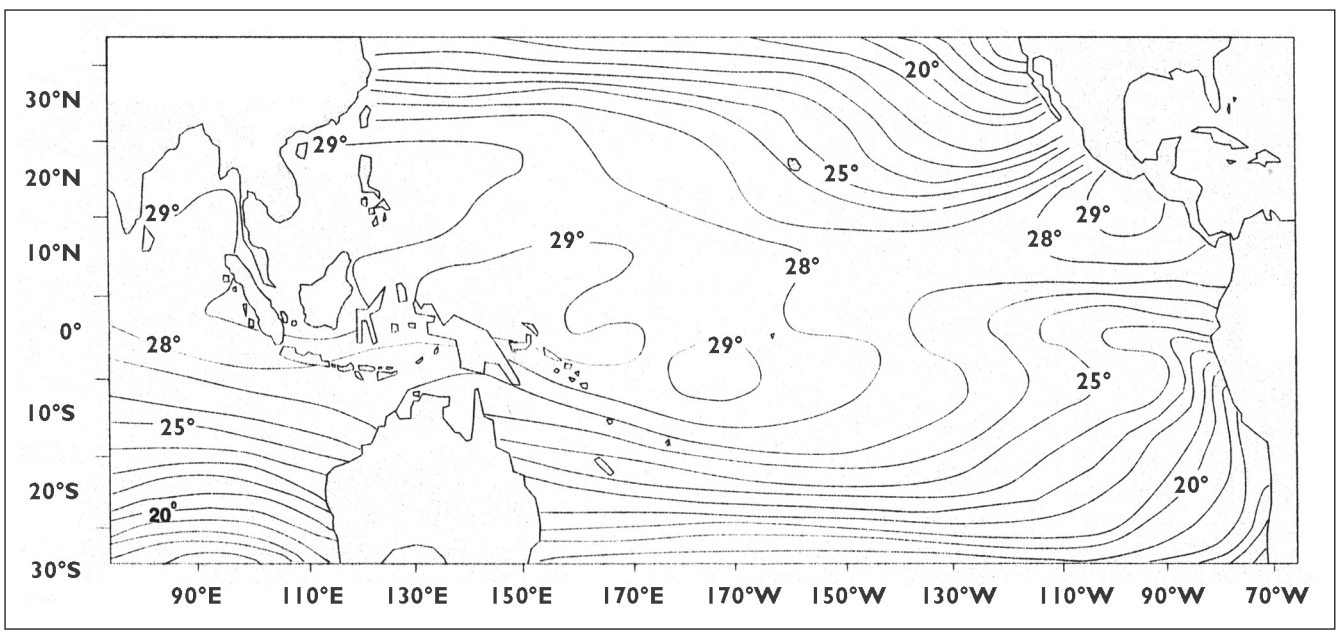


Figure 5.9.4 Pacific Ocean surface temperature in: A) January and B) June. At what latitude is the sun overhead in these months? Where is the warmest Pacific water in January and June?

Unit 10

Consequences Of And Perspectives On Climate Change

Examples of the effects of climate change from throughout the world are reported on regularly in newspapers.

For example:

1

Breadfruit trees vanishing from Pacific

01.11.2003 by Kathy Marks

SYDNEY – Experts warn that the Pacific breadfruit tree, which contributed to the mutiny on the Bounty and was once hailed as the solution to world hunger, is in serious decline.

The tree – part of the iconography of the South Pacific – is vanishing at an alarming rate, mainly because of global warming and a switch to Western-style diets. Some varieties have already been lost.

2

Climate change killing 150,000 a year, says WHO

12.12.2003

MILAN – Global warming killed 150,000 people in 2000 and the death toll could double again in the next 30 years if current trends are not reversed, the World Health Organisation said today.

One heatwave killed 20,000 people in Europe alone this year, the WHO said, launching a book on health-weather links at a UN environment conference.

Climate change, linked by scientists to human emissions of gases such as carbon dioxide from cars and factories, is causing more frequent floods and droughts and melting ice caps.

'An estimated 150,000 deaths... were caused in the year 2000 due to climate change,' the study said. A further 5.5 million healthy years of life were lost worldwide due to debilitating diseases caused by climate change, it said.

'The 1990s were the hottest decade on record and the upward trend in the world's temperature does not look like it is abating,' it said. 'In Europe this past summer, for example, an estimated 20,000 people died due to extremely hot temperatures.'

The situation will worsen if climate trends continue, WHO experts said at a news conference to launch the book.

3

The frozen continent: hot and cold penguins

07.01.2004 by Simon Collins

It's getting too hot for the penguins in some parts of Antarctica. Scientists blame global warming for the disappearance of child-sized Adelie penguins from the northern tip of the Antarctic Peninsula, which stretches up towards South America, and for signs that the Adelie penguins are migrating southwards to the Ross Sea south of New Zealand.

But the evidence of warming is patchy. Some parts of both the Antarctic and the Arctic are warming dramatically, sending an apparent warning to the rest of us. But other parts are getting colder.

4

Global warming threatens mass extinctions

08.01.2004

OSLO – Global warming could wipe out a quarter of all species of plants and animals on earth by 2050 in one of the biggest mass extinctions since the dinosaurs, according to an international study.

The United Nations said the report, highlighting threats to creatures ranging from Australian butterflies to Spanish eagles, showed a need for the world to back the Kyoto protocol, meant to brake rising temperatures linked to human pollution.

'A quarter of all species of plants and land animals, or more than a million in all, could be driven to extinction,' said Chris Thomas, professor of Conservation Biology at England's University of Leeds.

Thomas, lead author of the study published in the science journal Nature, said that emissions from cars and factories could push temperatures up to levels not seen for one million to 30 million years by the end of the century, threatening many habitats.

The survey, the largest of its kind to date, studied global warming links to 1,103 species of plants, mammals, birds, reptiles, frogs and insects in South Africa, Brazil, Europe, Australia, Mexico and Costa Rica and extrapolated findings as far as 2050. It did not examine the oceans.

5

The fight against the rising tide

11.01.2004 by Charles Arthur

It is possible that Kiribati has failed to make much of an impression on many people. The most easterly island in the world, it reached its apotheosis in popular recognition at the start of this millennium, when wealthy travellers flocked there to see the first sun rise on a new century.

The chances are the island will fail to make any impression by 2100. For Kiribati is one of a group of islands at risk of disappearing beneath the waves as a result of dramatic climate change - and the local people are facing a hard battle to have their concerns heard on a world stage.

Kiribati is not alone in fearing the effects of rising sea levels.

Tuvalu consists of nine coral island atolls, the highest of which is only 4 m above sea level at its peak. It's not the sort of nation that can generate much of its own greenhouse gases, but its 10,500 inhabitants expect to be among the first to feel the effects of global warming. The coastline is gradually being eroded by the sea, and the island has been hit by high tides that sweep away trees and roads.

But the threat of the advancing sea isn't just about being submerged. More immediately, the salt water is seeping into the soil, making it increasingly difficult for the islanders to grow crops. Farmers have to use tin containers, filled with compost, instead.

In 2002, a record high tide covered much of the island and flooded its airport. The situation is deteriorating rapidly.

For the Tuvalu people, joining forces with similarly threatened people has certainly raised their profile, but their security is far from being resolved. And despite their fears, most of those involved in their campaign are reluctant.

6

Britain aims to cut emissions

21.01.2004

Britain said yesterday that it would cut its carbon dioxide (CO^2) emissions in excess of its international treaty obligations. The UK said it aimed to cut emissions by 20 per cent from 1990 levels by 2010 and at an initial rate consistent with a 16.3 per cent cut in the first phase from 2005 to 2007.

The proposals, part of a European Union-wide scheme, exceed Britain's obligation under the Kyoto Protocol on climate

Activity 1

1 Use an atlas to identify the location of each place for each article.

2 Write a brief description, for each article, of the issue, its causes and its effects.

3 As a class, discuss the consequences of climate change. Compare different points of view, from the articles.

Climate Change And The Special Concerns Of Developing Countries

Climate change as a global environmental issue has different consequences and problems for different countries in the world. Many developing countries feel the way they see climate change issues is different to the way industrialised countries see the issues. Government and environmental representatives from developing nations have met together regularly to discuss their shared issues and concerns about climate change, for example in the:

- Ninth Conference of Heads of State of the Non-Aligned States (1989)
- Twentieth South Pacific Forum (1989)
- Langkawi meeting of the Heads of Government of the Commonwealth (1989)
- Second Ministerial Conference of Developing Countries on Environment and Development (April 1992).

Developing nations that participate in such conferences agree on specific statements and declarations which show their shared point of view.

Generally speaking, such declarations and statements follow these principles:

Principle 1: International co-operation on climate change is essential, but industrialised countries should accept the main responsibility.

In other words, all nations of the world must work together to minimise the effects of climate change and to reduce the rate of change that the atmosphere is experiencing, BUT developing countries argue that this global problem is largely the fault of developed or industrialised countries. As a result, these countries must shoulder most of the financial responsibility for responding to or dealing with the problem on a global scale, not just the impact in their own countries. Besides, developed countries are more likely to have the technological resources (laboratories, industry, specialists) as well as the financial resources to address the problems of climate change.

This principle is therefore also known as **the principle of common but differentiated responsibility of states**.

Principle 2: Industrialised countries should transfer funds and technology to help developing countries respond to climate change.

Because of both geography and poverty, developing countries are more likely to suffer the impacts of climate change. Dry or arid parts of the world (that is water-deficit areas, such as deserts) and **low-lying coastal and island states** are at the greatest risk. Because developed countries have better resources and because of their role in causing climate change, developed countries should help poorer countries. They should pass on environmentally sound technologies to such countries on preferential, non-commercial terms – that is, the developed countries should share these technologies with developing countries without trying to make a profit for themselves. Developed countries should also contribute additional funds, over and beyond development aid, to help developing countries respond more effectively to the negative impacts of climate change.

Principle 3: Sustainable development strategies can alleviate or reduce poverty while minimising environmental damage.

In developing countries, poverty is the main reason for environmental degradation (spoiling or damage). Short-term economic development remains more important for poor countries than long-term environmental protection. Ways of overcoming environmental problems like climate change must include and promote sustainable development. At the same time, international action on climate change must not interfere with the rights of individual countries to develop and use their own natural resources for the benefit of their own people.

Principle 4: Climate change negotiations require the full involvement of developing countries.

Because climate change is a global issue, *all* states of the world must participate in the negotiations. Funds must be made available to make sure that developing countries can participate fully in international climate change negotiations – in other words, for key people from developing countries to prepare for and to attend these important conferences in different parts of the world.

These four principles have strongly influenced the negotiations about climate change between nations of the world. These principles are repeated over and over again in the statements and declarations that developing countries have agreed upon and presented. So these principles represent a set of perspectives about climate change shared by developing countries.

The needs and concerns of developing countries have received special attention during what is called the **Climate Convention negotiations**. Special funds were established to finance the participation of developing country representatives.

This perspective was taken into consideration and incorporated into a very important international document by the United Nations called the **1992 UN Framework Convention on Climate Change**. The Climate Convention established different levels of commitment for developed and developing countries. It recognised the need for sustainable development and required developed countries to provide new and additional funds to developing countries. It also encouraged the transfer of technology – however, there is still no commitment by developed countries regarding preferential and non-commercial terms.

Activity 2

1 Answer the following questions:

- **a** Why did developing countries get together to discuss climate change?
- **b** What are the differences between the effects of climate change on developing countries and developed or industrialised countries?
- **c** What are the four principles that developing countries agreed on?

2 Imagine a government representative from a developed or industrialised country is having a talk with a government representative from a developing country.

Think about the opinions and points of view each person might have on the four principles.

3 Design and sketch a cartoon strip, where the two government representatives share their points of view with one another.

4 Share your ideas with the rest of the class in a class discussion.

Some Facts About Key International Agreements

The Framework Convention

The United Nations Framework Convention on Climate Change (UNFCCC) was negotiated by the United Nations to deal with the impacts of human activities on the global climate system. This agreement came into force on 21 March 1994.

The main objective of the Convention is:

> *. . . stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous* ***anthropogenic interference*** *with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.*

[***anthropogenic***: from human activity; ***interference***: to become involved, to disrupt without the right to do so. Interference is usually negative]

Developed countries, which have been involved in and signed this convention, agree to limit carbon dioxide and other human created greenhouse gas emissions, and to protect and enhance greenhouse gas sinks and reservoirs. Members also agree to promote and co-operate in research, systematic observation and development of data related to the climate system, to share information, and to co-operate in education and training related to climate change. Members are required to report regularly on what they are doing in their countries to meet the objective of the convention, and also report on their projected emissions and sinks of greenhouse gases. The convention also made developed countries pledge to help developing countries which are particularly vulnerable to adverse effects of climate change, by helping:

- ❑ with the costs of adapting to the negative effects of climate change
- ❑ such countries to get environmentally sound technologies.

The UNFCCC itself contained no legally binding targets or timetables, but the general interpretation was that developed countries should reduce their emissions to 1990 levels by the year 2000.

The Kyoto Protocol

The first Conference of the Parties to the Convention was held in April 1995. At this meeting, it was decided that the UNFCCC was not strong enough to avoid dangerous human-induced interference with the climate system. Further negotiations followed – and this led to a new document called the Kyoto Protocol. This protocol was agreed to in December 1997.

The protocol was to become 'active' and binding *'on the ninetieth day after the date on which not less than 55 Parties to the Convention . . . which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 from that group, have deposited their instruments of ratification, acceptance, approval or accession'.*

(cont.)

Unlike the UNFCCC's Framework, the Kyoto Protocol is a legally binding protocol. The developed or industrialised countries which have signed the Kyoto Protocol have committed themselves to reduce their collective emissions of greenhouse gases by 5.2%. The 5.2% reduction in total developed country emissions will be realised through national reductions of:

- 8% by Switzerland
- 8% by many Central and East European states
- European Union (the EU will achieve its target by distributing differing reduction rates to its member states)
- 7% by the US
- 6% by Canada
- Hungary, Japan, and Poland, Russia, New Zealand, and Ukraine are to stabilise their emissions
- Norway may increase emissions by up to 1%,
- Australia by up to 8%
- Iceland 10%.

The Kyoto Protocol is an agreement – which grants countries flexibility in how they make and measure their emissions reductions. Developed or industrialised countries that finance emissions-reduction projects in developing countries can receive credit for doing so. An international 'emissions trading' regime will be established allowing industrialised countries to buy and sell excess emissions credits amongst themselves. The operational details for these schemes must still be fully developed.

The agreement aims to lower overall emissions from a group of six greenhouse gases between 2008 and 2012, calculated as an average over these five years. Cuts in the three most important gases – carbon dioxide (CO^2), methane (CH^4), and nitrous oxide (N^20) – will be measured against a base year of 1990. Cuts in three long-lived industrial gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF^6) – can be measured against either a 1990 or 1995 baseline.

Putin refuses to say if Russia will ratify Kyoto protocol

30.09.2003 by Michael McCarthy

Vladimir Putin, the Russian President, fuelled concern about the future of the world climate change treaty yesterday when he refused to say whether Russia would ratify it.

Disregarding pleas from the UN and several European leaders, the President spurned the opportunity to announce his support for the Kyoto protocol at the opening of a climate change conference in Moscow.

Since the US dropped out of Kyoto in 2001, the treaty, which commits industrialised countries to cut back on emissions of greenhouse gases such as carbon dioxide, needs Russia's support for it to enter into force. If Russia declines, a 15-year international effort to counter climate change will collapse.

Mr Putin said yesterday: 'The government is thoroughly considering and studying this issue, studying the entire complex of difficult problems linked with it. The decision will be made after this work has been completed, and of course it will take into account the national interests of the Russian Federation.'

Pressed by conference delegates for a ratification commitment, Mr Putin responded ambiguously and pointed to domestic critics of the Kyoto pact who have said that global warming would have benefits for Russia.

'They often say, half-jokingly and half-seriously, that Russia is a northern country and if temperatures get warmer by two or three degrees, it's not that bad - we could spend less on warm coats and agricultural experts say that grain harvests would increase further,' he said.

'That may be so, but we must also think about the consequences of global climate change.' He added: 'We must think what consequences of these changes we will face in certain regions where there will be droughts and where there will be floods.'

Russian officials must consider 'what consequences there will be for people living in these regions; social, economic and environmental consequences'.

The treaty calls for industrialised countries to reduce greenhouse gas emissions to 1990 levels by 2010. If a country exceeds the emissions level, it could be forced to cut back industrial production. Russia's emissions are substantially lower than in 1990 because of the collapse of post-Soviet industry.

Mr Putin said Russia's emissions have decreased by 32 per cent since 1990, a fall he asserted was due not only to economic decline but also to structural reforms.

Russian officials have suggested the country will eventually ratify Kyoto, and supporters of the pact had hoped it would do so this week.

Other Perspectives

Other groups of people have important yet different perspectives on climate change, its causes and effects.

Example One

Within the scientific community, for example, there are different points of view about how serious the problem is, and programmes to address the problem.

Hot air on global warming

24.01.2004 by Michele Hewitson, *New Zealand Herald*

Dr Chris de Freitas is a very annoying fellow. I know this because he told me so, and he knows this because his wife tells him so.

He has certainly managed to irritate the hell out of a fair few of his scientific peers with his unpopular and controversial views on global warming. De Freitas has annoyed his way into what has been described as a political storm in the United States.

He has been attacked in a Senate committee for publishing – in the rivetingly entitled Journal of Climate Research – a study that challenged the widely-held idea that human beings are significantly altering global climate.

He has been named by radical campaigning magazine the New Internationalist as one of the Top Six 'Toxic Sceptics', the 'climate-change deniers who have shot to fame for their views – and for their talent for attracting publicity'.

He is our own Bjorn Lomberg, the Greenie turned eco-Judas. This is the sort of sweeping statement guaranteed to irritate De Freitas.

Lomberg 'is a much more competent and accomplished person than me. He's an international figure. I'm not.'

De Freitas seems to be well on his way.

He writes for the 'popular press', an activity which, he says, causes 'a lot of people to look down their noses at you'.

His motivation is his belief that it is the role of the scientist to act as the 'conscience of society'. Scientists are the people who have 'time to assess things critically'.

To that end he has published research challenging the accepted scientific wisdom that the temperature changes of the 20th century were unprecedented. Research based, says de Freitas, on nothing more than a mathematical construct.

His minority view is that 'although the future of global climate is uncertain, there is no reason to believe that catastrophic change is under way'.

Example Two

Different interest groups have perspectives that reflect their vested interests – for example, dairy farmers in New Zealand were very concerned about a proposal by the government that would tax them for the gas emissions from their herds of cows. Taxes would add to their costs of production, which they would have passed on to the consumers. Consumers would ended up paying higher prices for milk, a basic food item in most households in New Zealand. The New Zealand government's point of view is that the increased revenue from the taxes on diary farmers would help cover the costs of research to find methods the farmers could use to reduce the amount of gas their herds gave off.

Hodgson backs down on fart tax

17.10.2003 by Liam Dann, primary industries editor, *New Zealand Herald*

The Government looks set to back down over its controversial flatulence tax.

In a joint statement yesterday [The New Zealand] Environment Minister, Pete Hodgson, and Agriculture Minister Jim Sutton said a new research plan put forward by an agricultural industry group should be sufficient to avoid the need for a statutory levy on farmers. Opposition MPs seized on the comments, calling the decision an 'embarrassing u-turn' and a victory for farmers.

National MP, Shane Ardern – who drove a tractor up the steps of Parliament to protest against the proposed levy – congratulated Federated Farmers for its campaign of opposition. 'The Government has finally admitted their mistake,' he said, 'but this backdown came at a cost to our farmers both financially and in time.'

A spokesman for Mr Hodgson's office said the decision was not a backdown because the [New Zealand] Government's bottom-line requirement – that industry funded enough research to meet Kyoto Protocol requirements – would be met. The statutory levy was always going to be a last resort, he said.

Though the Government has finally found a compromise it can live with, it has had to endure a winter of bitter relations with farmers, who rallied throughout the country against the levy. An opinion poll in August found 80 per cent of those surveyed opposed the tax. Even among Labour voters the levy was hugely unpopular, with seven out of 10 siding with farmers.

Federated Farmers vice-president, Charlie Pedersen, said the Government showed an arrogance about the issue from the start.

'They sullied our reputation by suggesting there was something less than wholesome about farming sheep and cattle in New Zealand. We're the most environmentally friendly, sustainable farmers in the world.'

The solution to the standoff has been brokered by the Pastoral Greenhouse Gas Research Consortium, which has already been researching methane reduction methods for more than a year with backing from Fonterra, Dairy Insight, DEEResearch, Meat New Zealand, Wrightsons and the state-owned AgResearch institute.

Since the prospect of an emissions levy was raised in June, the group has argued it was already doing a significant proportion of the research the Government required to meet its commitment to the Kyoto agreement. 'What we've been saying is there is potential here for a win-win,' said consortium chairman, Mark Leslie.

Once the research that had already been done had been identified, it was just a case of finding the gaps.

The result is that the consortium's budget will be beefed up to $3.2 million next year, he said.

That figure is still well short of the $8.4 million the Government originally demanded from farmers, although last month it said it was not wedded to that figure as long as the research was done.

Mr Leslie said that by building new trials into existing research frameworks, the total costs were significantly lower than they would have been to set up from scratch.

The new research will be funded by agricultural companies and farmer industry groups without the need for new levies.

The flatulence tax: a summary

- the Government wanted to raise $8.4 million a year from farmers for research into agricultural greenhouse gas emissions.
- it proposed a levy on livestock that would cost each farmer about $300 a year on average.
- livestock were targeted because animals produce methane gas, which is linked to global warming.
- industry groups will pick up the research tab.

Activity 3

1. Design a PMI chart ('positive', 'minus' and 'interesting') for each example above. Read each article carefully, and list the things that you think are 'positive'. Then make a list of the things that are 'negative'. Finally, list the things that you think are 'interesting'.
2. Write sentences to give reasons for the lists that you have made.

Part 6

Field Studies

Overview

This section of the textbook covers the Field Studies strand for Year 13. At the end of this section, you will be able to show your knowledge and understanding of the following achievement objectives:

Achievement Objectives

1 Why field work is important in the investigation of geographic concepts at a national level.

2 Techniques that can be used in the geographic inquiry process.

The focusing questions that this section covers are:

1 What are the key concepts within a specific field study and how are they applied in that study?

2 How can the evidence from a field study explain in depth and detail the geographic ideas that relate to that field study?

3 How does field data from a specific study compare to available secondary sources of information?

4 How should we classify different field study or data gathering techniques for suitability in different physical or cultural environments?

5 How and why should we select the best field techniques to gather and process information for field work?

Introduction

This part of the textbook builds on what you learned and experienced with field studies in Year 12. You may need to spend some time revising the geographic inquiry process that was introduced at Year 12, and discussing it with your class. You may also need to revise the key concepts and geographic ideas, and their role in field work and the activities at the end of this overview that can help with your class revision.

In the Year 12 level of school geography programmes, you are very likely to do field work on issues related to your Environmental Studies topic. This could be mangrove forests, tropical rainforests or inshore marine environments. Field studies at Year 12 level are intended to be at a local scale.

At Year 13 level, field work is intended to support our learning of processes and patterns that have national significance. It is up to individual schools and their geography teachers to develop field studies that are relevant not only to the geography curriculum, but also relevant to:

i your interests and needs and

ii available resources and

iii the abilities of both teachers and students to carry out the necessary field work.

Schools therefore develop their own specific field studies for Year 13 level. The first chapter of this part will help you to think more deeply abut the importance of geographic concepts and ideas, and their purpose in learning through geography.

The second chapter provides guidelines for students and teachers to evaluate and reflect on their field work experience.

The third chapter in this part of the textbook gives information about some different field work techniques that may be of interest, and of use to the field studies that schools develop for themselves.

Answering the focusing questions

The ability to address or answer the focusing questions for this strand depends on your taking the opportunity to step back from the field work before, during and especially after it, and to study the process itself. Again, guidelines or approaches for your class to do this are outlined in the chapters of this part. At the end of the field work (which is more than likely going to be integrated into a topic from one of the other strands), you can use the following template to evaluate your work in relation to the focusing questions for this strand.

Focusing Question	Brief Explanation and Discussion	Specific Example to Illustrate
1 What are the key concepts within a specific field study and how are they applied in that study?		
2 How can the evidence from a field study be used to explain in depth and detail the geographic ideas that relate to that field study?		
3 How does field data from a specific study compare to available secondary sources of information?		
4 How should different field study or data gathering techniques be classified for suitability in physical or cultural environments?		
5 How and why should the best field techniques be selected to gather and process information for field work?		

Revision And Review

1 Key Concepts

a What is a geographic concept?

b Name the ten geographic concepts that are identified and discussed in the Sāmoa Geography Curriculum Statement.

c Draw symbolic sketches for each of the concepts. The sketches should be simple and symbolic of the meaning of each concept.

2 Geographic Ideas

a What is a geographic idea?

b Name three geographic concepts, and describe ONE geographic idea for each.

3 Field Work

a What is field work? What is the purpose of field work?

b Describe, in 3–4 sentences, the steps for the geographic enquiry approach (sometimes known as geographic investigations).

c Name at least two field work methods or techniques used in geography.

d Think about field work that you did in Year 12 Geography.

- ❑ Name one of the key concepts that was being studied.
- ❑ Name one geographic idea that you learned more about.

e Which of the following statements is TRUE and which is FALSE ?

- ❑ A geographic field study must take place outside of the classroom.
- ❑ Field work is a non-essential method of geography education.
- ❑ A geographic field study must include a survey as one of its techniques.
- ❑ Field work helps students to develop a range of practical, organisational and intellectual skills.

Unit

11

Learning Through Geographic Concepts And Ideas

Concepts help us to learn. These special words do this *by helping our minds to organise and to structure what we experience in the world around us*. Geographic concepts enable us to make sense of and to order our experiences with a specific perspective. Some geography educators say that geography concepts can be classified into general groups. Possible categories or groupings could be:

- ❑ spatial location (e.g. place, location)
- ❑ spatial distribution (e.g. patterns, scale)
- ❑ spatial relations (process, systems, interactions)
- ❑ geographic realities and time (change, sustainability, perspective).

Concepts need to be expressed in a simplified manner to help learners to concentrate or focus on the most important features or attributes of certain experiences.

Our studies of geography need to encourage us to think. We need to think about and talk about geographic concepts because this will help to develop deeper understandings and knowledge. In-depth knowledge and understanding is transferable – that is to say, it can be applied in other situations and contexts.

Another important characteristic of the development of conceptual understanding is that it happens over time. The more opportunity you have to think about and talk about geographic concepts in your school geography programmes, the greater your chances of developing these essential understandings. The work that you do through the topics of each strand, as well as field studies and research assignments, are all opportunities to elaborate (work out carefully and in detail) on the meanings of geographic concepts and the ideas that support them.

Activity 1

Copy and complete this table into your workbooks. Follow each of the following steps.

1. Identify and list each of the ten key concepts from the Geography Curriculum Statement in the first column.
2. Develop a second geographic idea or generalisation (to accompany the one provided).
3. Add to the meaning of the concept by writing an explanation using your own words.
4. Provide 1–2 examples from your own observations, your own studies or from field work that you have done, to illustrate that concept.

Concept	Generalisation/ Geographic Idea	Explanation	Example to Illustrate

Unit

12

Reflections On Field Work

A Framework For Field Work

Here is a framework for developing an in-depth and meaningful learning experience that is based on field work. Please notice that the field work itself is NOT the only active stage of this framework. Rather, it is a tool for an overall learning experience.

Some of the important characteristics of this framework are:

- it recognises the importance of pre-field work preparation and post-field work follow up for the desired learning outcomes
- the knowledge and skills that you (the learners) will need are identified long before the field work takes place
- that you are given a chance to be as prepared as possible for the field work so that you can get the maximum benefit from it, and you are prepared with the knowledge and skills that you need.

Study the triangle part of the 'Framework for Field Work' diagram. The three parts are:

- people-environment interactions (often captured in the problem or issue that is being investigated or studied)
- ideas and concepts from geography
- procedures and techniques for field enquiry.

These three parts are of equal importance and value to geographic learning and they are meant to support and complement one another. If you do field studies using this framework, then you must think about these three areas and integrate them.

Your field study must not only involve decisions about which are the best techniques to use to gather data and information, but you must also carefully consider the interaction between people and a specific physical or cultural environment (or even both). You need to identify and focus upon specific concepts and geographic ideas.

If you identify relevant geographical ideas, processes and, where appropriate, people-environment interactions, it will help you decide what data you need to collect before you plan the techniques that you will use in your field enquiry. These considerations will in turn influence decisions about learning objectives and enquiry processes.

Although field work provides you with experiences that are educationally valuable, it is very important that you follow up field work and evaluate it in a planned and purposeful way. Planned follow-up will use the findings or results of the field work, as well as your experiences, to enrich, organise and extend learning. This involves more than just writing up and presenting the data that is collected. (see the 'Evaluation' part of the 'Framework for Field Work' diagram.

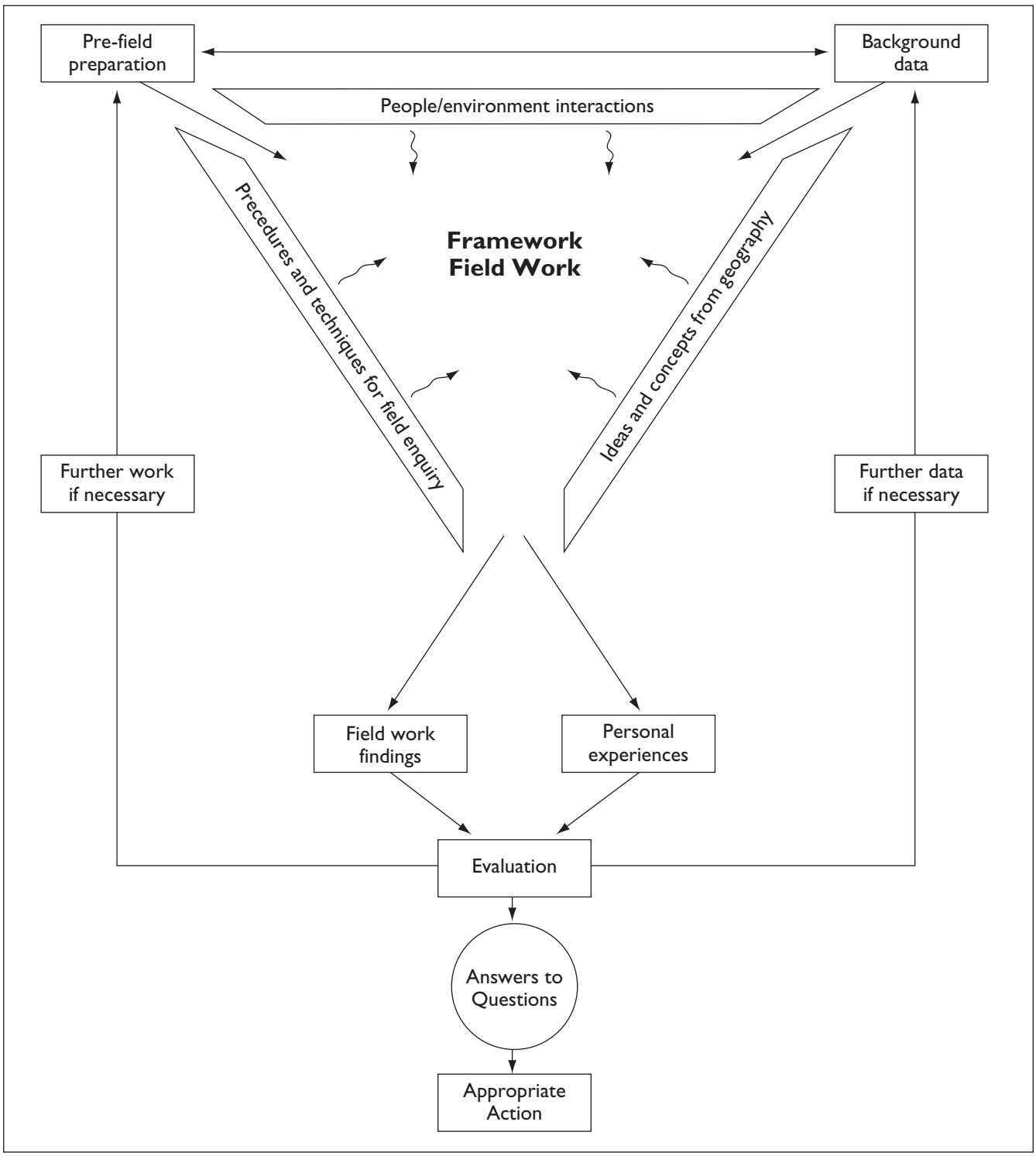


Figure 6.12.1 A framework for field work. Source: D. Lambert and D. Balderstone, Learning to Teach Geography in Secondary School

A specific example of the 'Framework for Field Work' diagram has been included to show how this framework can work. The example is based on a field study for the topic of Urban Settlement. More specifically, the field study helps us to learn more about differences within urban settlements.

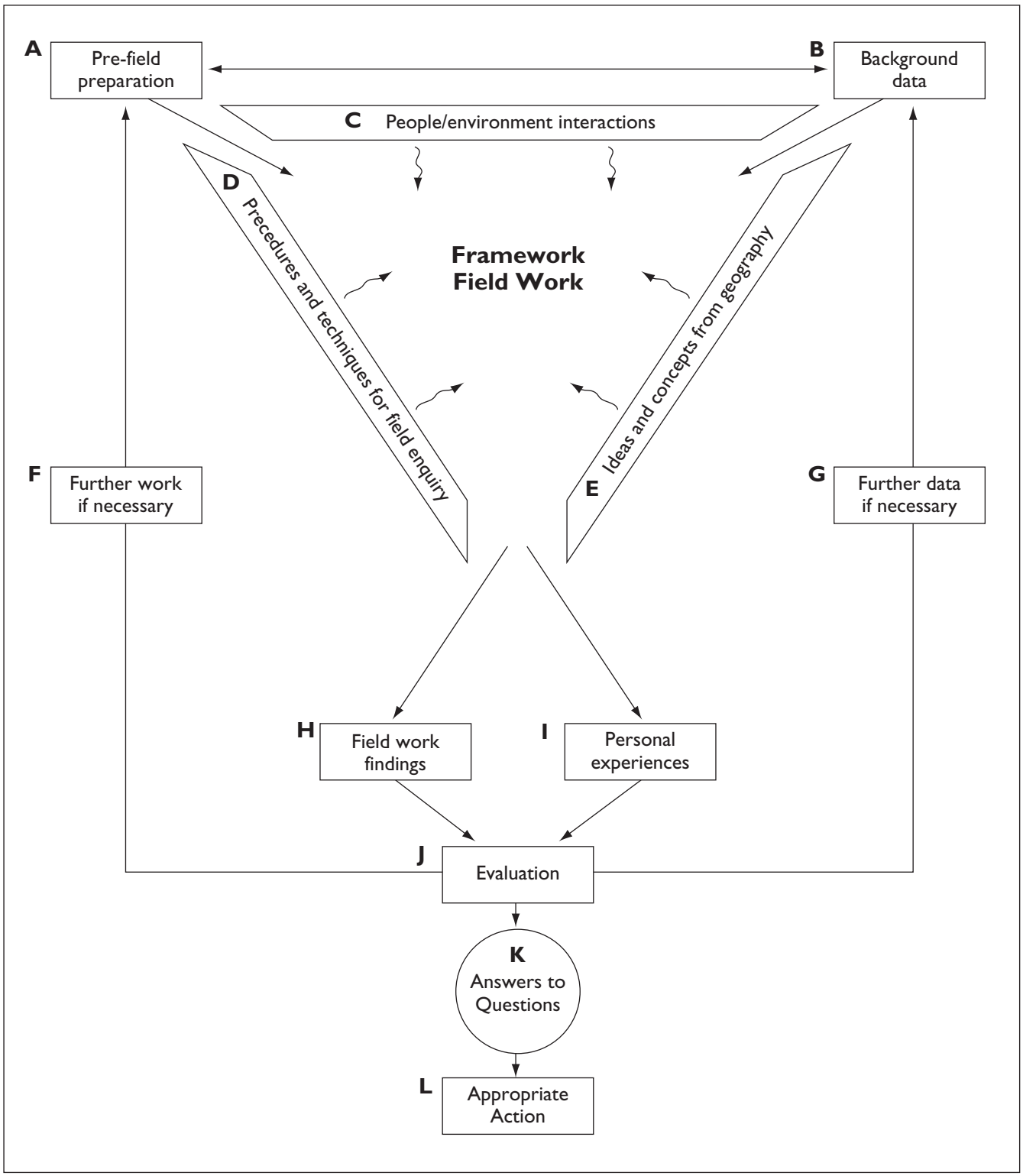


Figure 6.12.2 A framework for field work – differences within urban settlements

Table 6.12.1 Text for 'differences within urban settlements' framework for field work diagram (Figure 6.12.2)	
A	e.g. practical organisation
B	e.g. study of urban models such as Burgess Concentric Zone Model; latest census data for Apia Urban Area
C	Interaction between people and urban environment of Apia e.g. different functions of Apia such as retail and wholesale outlets; services to support tourism
D	Concept: Patterns Geographic idea: patterns are the outcomes of processes
E	e.g. Observation; Transect Lines
F+G	After the field work has been done, check the data. Is it enough information? Return for more if needed
H	Analyse the results from the field work. Spend some time in class, and independent time (homework)
I	Draw on personal experiences of the place that was studied and where data was collected ❑ e.g. observation of people at busy road intersections (and compare this to your own experience of walking in those places) ❑ e.g. draw on own personal experience and observations of the street where the transect line was done
J	Evaluate the field work steps to this point. Evaluate the findings and personal experiences
K	Think about what has been learned. Develop answers to research questions/research problems being investigated
L	Social decision making – is there an issue or a problem related to the field work on differences within Apia urban area? Is there anything that you (students) can do as a group or as individuals to address the issue or problem that was studied?

A Route For Geographic Enquiry

The steps for geographic enquiry are simple and straightforward. However, here is a diagram of an approach that can help elaborate or extend our understanding of the geographic enquiry.

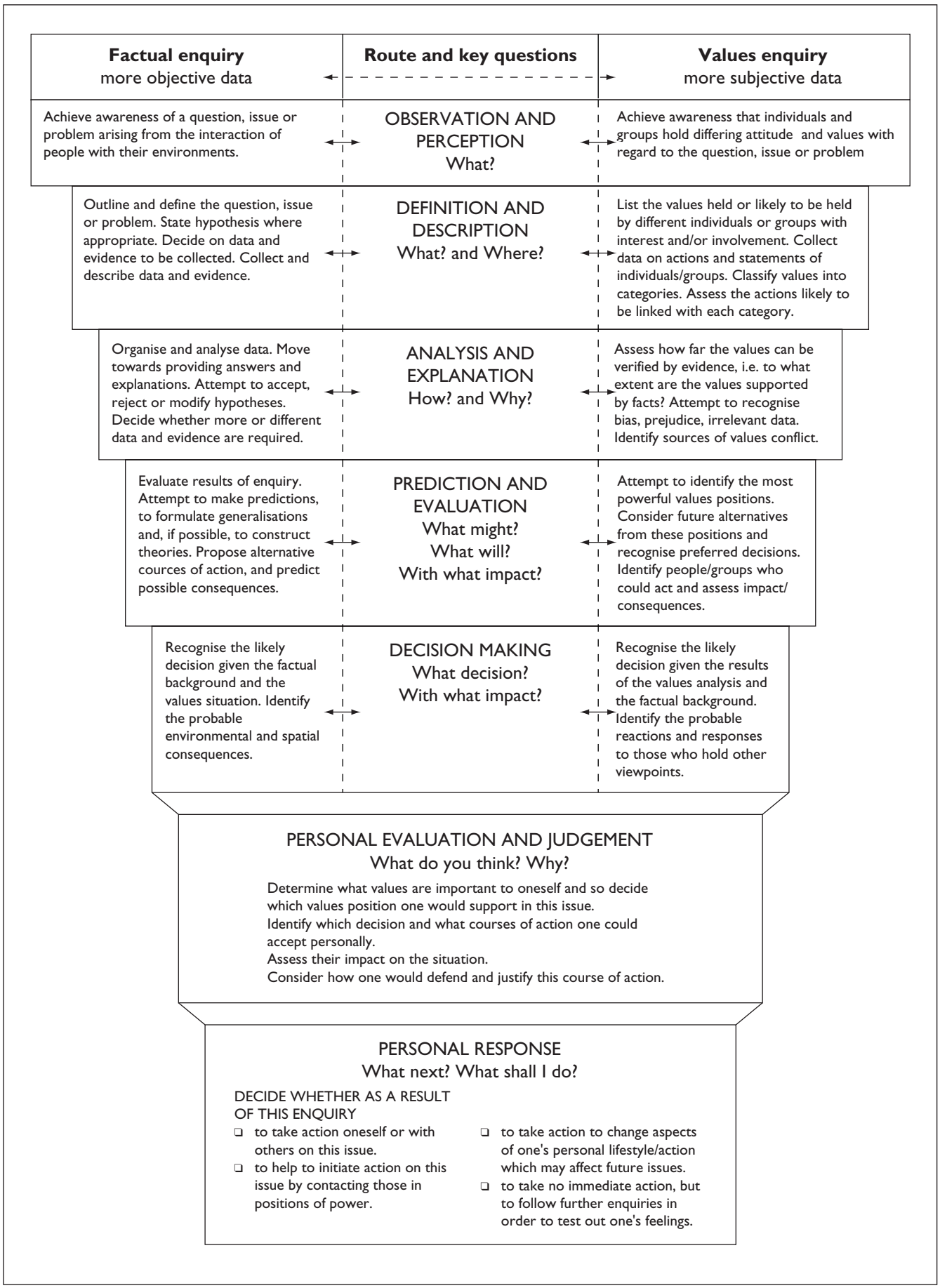


Figure 6.12.3 A route for geographic enquiry. Source: D. Lambert and D. Balderstone, Learning to Teach Geography in Secondary School

With this diagram two types of knowledge are identified and developed – factual or objective knowledge and value-based or subjective knowledge. In this approach to geographic enquiry, both types of knowledge are valued and treated equally.

Another important feature is that, like the 'Framework for Field Work' approach, our field work is followed up and evaluated in a planned and purposeful way. Your own evaluations and reflections (thinking about what you have found) are important. This means that you are expected to include your own informed point of view. Again, '. . . planned follow-up will use the findings or results of the field work as well as students' experiences to enrich, organise and extend learning. This involves more than just writing up and presenting the data that is collected.'

As this is Year 13 level geography, following the 'Route for Geographic Enquiry' approach is more challenging for you at this level than the geographic enquiry model that you were introduced to in Year 12.

Unit

13

Field Work Techniques

Field work can be used extensively in the social sciences. It provides a chance to put into practice, test and understand theories and facts. This creates a vital link between what we learn in the classroom and how it all works in the real world outside the school gate. A key skill in field studies is observation. It is important to concentrate on what is going on around you when making field observations – do not shut off or day dream.

Observation

Steps in procedure

1 Before you go into the field, list all the headings for the features you expect to be able to observe; for example for a visit to a hospital you may list headings like those in Figure 6.13.1A.

2 At the field site write down all you can see under the headings you have made (see Figure 6.13.1B).

3 Now add new headings if necessary, but keep them simple and do not use too many (see Figure 6.13.1C).

Note
Not all observation needs to be written down in detail but it is important you take in as much as you can.

A: Headings:
people
department
jobs
management
equipment

B: Lists:

PEOPLE
employees
patients
family
friends

JOBS
doctor
nurse
orderly
clerical

EQUIPMENT
scanner
x-ray
respirator
microscope etc.

DEPARTMENT
food services
critical care
accident and emergency
children's, etc.

MANAGEMENT
head of department
hospital board
management committee
supervisor, etc.

C: Extras

BUILDINGS
administration
medical
kitchen
morgue

Figure 6.13.1 Hospital observations

Key Points To Remember:

- ❑ Look at everything around you (i.e. What is there?).
- ❑ Ask yourself why features are there, how they got there.
- ❑ Look at the uses and functions of features.
- ❑ Group items into
  - – natural features (created by nature) and
  - – cultural features (made by people).

Activity 1

You can *either* do these activities as a class trip *or* do a small piece of your own fieldwork like a trip to a local:
police station
courtroom
food bank
city mission.

1. List four category headings you think you will see on your field trip. List them before you go.
2. While on the trip, write down as many features as you can observe under these headings.
3. Try to add another two headings for categories which you may not have thought of before the trip.
4. List features under these two headings as well.
5. Was it easy or difficult to guess what categories to write before you went on the trip? Give a reason for your answer.
6. Write a paragraph summarising what you learnt from the observations you made on your field trip.

Sketches

As well as taking notes of field observations it is useful to make sketches. Sketches can be of large areas, or closer, more detailed features. On a visit to a colonial village the following sketches could be made.

EXAMPLES: see Figures 6.13.2 and 6.13.3 for examples of sketches.

Detailed sketches

Detailed sketches are useful to show specific examples of features in field reports and conclusions, for example:

- ❑ a kitchen utensil, i.e. pot, a dish
- ❑ furniture, i.e. chair, bed
- ❑ clothing, shoes, hair, combs
- ❑ a building.

Steps in procedure

1 Draw a frame, rectangular or square in shape. (See Figure 6.13.2.)

2 Mark the halfway points on each side of the frame, by eye, not with a ruler. These are helpful for locating features and drawing them in proportion. Marks at the quarter and three-quarter points can also be made.

3 Lightly sketch the outline of the object or feature.

4 When the outline is correct go over it with a marker and shade it in, adding as much detail as possible. Colour can be used if desired.

5 Give the sketch a title.

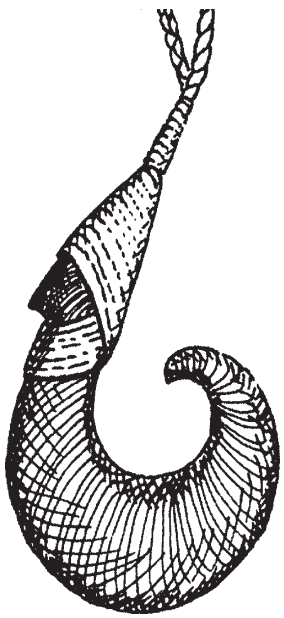


Figure 6.13.2 Detailed sketch – Pounamu

Field sketches

Field sketches are simplified and only show the location of different features on the sketch, not exact details, for example:

- the interior of a building
- a street with several buildings
- the entire village.

Steps in procedure

1. Draw a rectangular or trapezium shaped frame. The trapezium is used for an oblique angle sketch because in reality the background land area is wider and deeper than the foreground area. The trapezium stretches the width and depth of the background to allow for this. (See Figure 6.13.3).
2. Marks can be made around the trapezium or rectangular frame. On the trapezium, because of the stretched shape of this frame, the halfway points on the sides showing depth (length) are stretched also.
3. Lightly sketch the outline of the features or land areas. Do not include any moving objects, people or animals. When the outlines are correct, go over them darker.
4. Remember exact details are not included, instead features and land-uses are indicated by shading in different colours and labels in a key.
5. Give the sketch an accurate title.

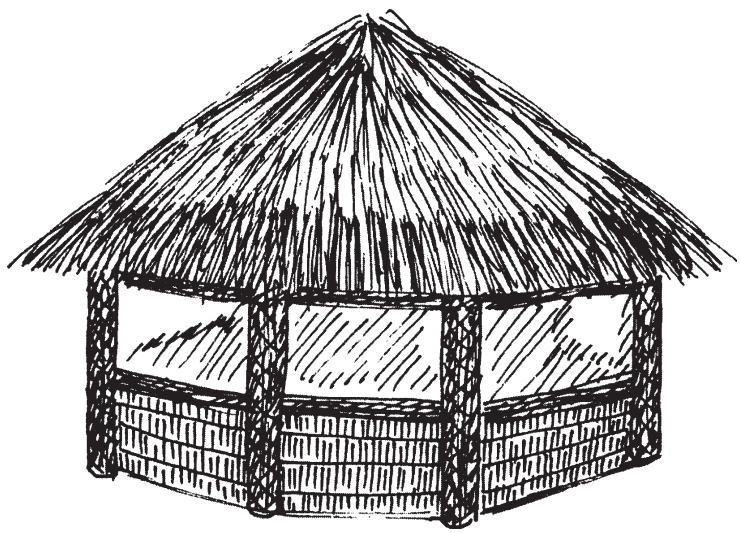


Figure 6.13.3 Field sketch – traditional Pacific Island house

Activity 2

The following activities can be either be done on a field trip or can be used for your own field work at a place like:

an historic building

a museum

a traditional village.

1. Pick four objects to do detailed sketches of. Make sure the objects are very different and are important to the study you are doing.
2. Write a couple of sentences beside each sketch which say why each of the objects are important.
3. Do two field sketches of the areas you are working in.
4. Write a brief paragraph describing the land-use of the area.
5. How did sketching help you to better understand the field study?

Questionnaires And Interviews

Questionnaires and interviews are very similar. They are a set of prepared questions which are to be answered by one or more people.

EXAMPLES: Figures 6.13.4 and 6.13.5 are examples of a questionnaire and interview.

Questionnaire

1. Design the questions to be asked.
2. They should require short and to the point answers. (See Figure 6.13.4).
3. With a questionnaire you probably need to ask a large number of people to complete the questions.
4. You can either give a person the questionnaire to read and fill in themselves or you can read out the questions to them and then write down their answers for them. The second way is usually quicker.
5. It is useful to hold the questions so the person being interviewed can see the questions as well.
6. Give the questionnaire to enough people so you can establish a pattern of results.
7. Put the data together and compare the results. Refer to the general comments opposite.

Interview

1. Design a set of questions to ask one person or a questionnaire that you are likely to use with only a few people.
2. The interviewer (you) asks the interviewee (the person you are questioning) the questions you have written out. (See Figure 6.13.5).
3. The interviewee replies verbally; answers can be written down or tape recorded.
4. Interviews are usually conducted on a one-to-one basis.
5. With interviews it is possible to add questions as you go along to gain additional information. The same questions should be asked of each interviewee.
6. When all the interviews have been conducted, collate the results and compare them. It is a good idea to see what type of people give what type of results (see the comments below).

General comments

- Questions need to be simple and to the point. They must be worded so that people can easily understand them and give very brief answers. The complete interview/questionnaire needs to be short so it does not intrude on people's time, otherwise people will not want to participate.

- ❑ Do not ask direct personal questions such as, *How old are you? How much do you earn?* Always give categories which people can choose from.
- ❑ Use Y/N or tick answers as much as possible.
- ❑ Establish general information about a person first so that interviews/ questionnaires can be sorted into categories (e.g. age, sex, occupation, income, etc.) to compare with each other.
- ❑ Plan questions carefully so data can be statistically analysed.

Note down their sex.

1 What is your age? (Circle one of the following)
0–18 19–30 31–45 46–65 66+

2 What ethnic group are you? (Circle one of the following)
Pacific Island European Asian Other

3 What is your occupation?

4 Are you a Sāmoan?

5 Where in Sāmoa are you from?

6 Have you been to Apia before?

7 Why did you come here?
Employment Friends Family Holiday Other

8 How long are you staying here?

9 Are you going to visit other places as well?

10 Have you been to? (Circle on of the following)
Salelologa Piula Lalomanu Asau Lefaga

11 What other villages and districts have you been to?

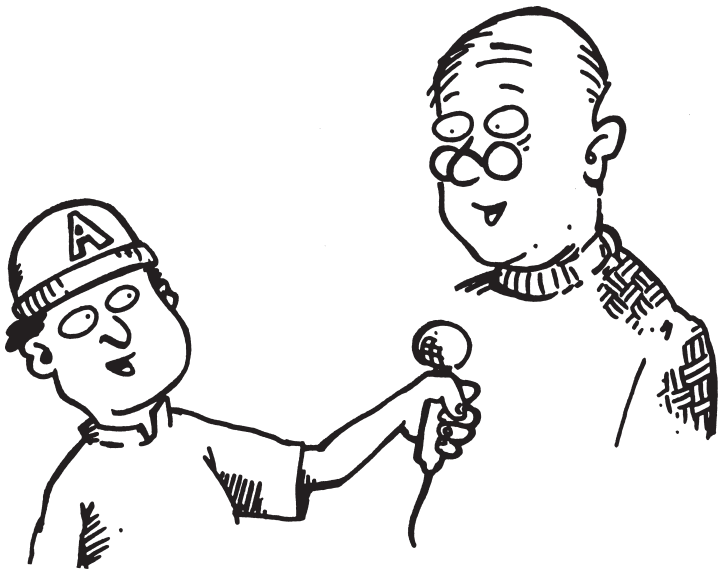
12 Have you been overseas?

13 Where have you been?

14 Why did you choose to go there?

15 How long did you stay there?

Figure 6.13.4 Questionnaire extract



Note down their sex and approximate age.

1. Can I ask what ethnic group you are and what your occupation is?
2. How long have you been living in Sāmoa?
3. Are you satisfied with your decision to leave your homeland?
4. Do you have any regrets about coming here?
5. What was life like back in your homeland?
6. Do you still have family back there?

Figure 6.13.5 Interview extract

Activity 3

Questionnaire

1. Draw up a questionnaire to ask tourists. Find out: where they have been in Sāmoa, how long they stayed in each place, how many times they have been to Sāmoa, and what other countries in the world they have visited.
2. Make 10 copies of the questionnaire. Question 10 different people. You could alter the questions so that Sāmoa domestic tourists to your local region could also be asked.
3. What conclusions can you make about where they had been, for how long, whether they had been here before and what other countries they had visited?
4. Draw up four graphs to summarise your conclusions.

Activity 4

Interview

1. Construct a set of interview questions for someone who has immigrated to Sāmoa from New Zealand. Your aim is to establish the reasons why they came and their impressions of Sāmoa. Word your interview so that you can use the same questions for immigrants from other countries also.
2. Now, interview an immigrant from Australia. Interview two immigrants from other countries also.
3. Write a summary paragraph on their reasons for immigration and their impressions of Sāmoa.

Surveys

Surveys are specific observations made out in the field, which are recorded. Like a questionnaire, surveys are prepared beforehand and outline what information you need to gather. Sheets on which to record data are set up with appropriate headings, columns etc. Surveys are commonly used in urban, residential or traffic studies.

EXAMPLES: Figure 6.13.6 is a traffic survey.

Steps in construction

1. Decide on the topic (e.g. traffic observations). (See Figure 6.13.6).
2. Decide on the data that needs to be collected.
3. Draw up a survey from using different categories for data collection like:

   time *place*
   vehicle type *peak/offpeak*
4. Conduct the survey to collect the data.
5. Analyse the data.

Note
the bi-polar survey is a quick and easy way of recording variations on the same theme, for instance the opinions of different people from the same area. Figure 6.13.7 is an example of a bi-polar survey of two suburbs.

AIM:
To find out which out of the two local roads is the busier and which are the most common vehicles used.

1 Select the two roads to be surveyed.

2 Stand beside the first road for 20 minutes.

3 Record the number of vehicles which pass by on both sides of the road during a 20-minute period.

4 Record the vehicles as follows:

SITE 1:

VEHICLE TYPE	TALLY
Car	𝍸 𝍸 𝍸 𝍸 𝍸 lll
Bus	lll
Van	𝍸 𝍸 ll
Truck	𝍸 l
Motorbike	𝍸 ll

5 Do the same for the second site; make sure it is approximately the same time of the day, the same day of the week and similar weather.

SITE 2:

VEHICLE TYPE	TALLY
Car	𝍸 𝍸 llll
Bus	l
Van	𝍸 l
Truck	lll
Motorbike	llll

6 Give the numbers of each vehicle and rank them. Total all of the vehicles.

SITE 1:

VEHICLE TYPE	TALLY	NUMBER	RANK
Car	𝍸 𝍸 𝍸 𝍸 𝍸 lll	28	1st
Bus	lll	3	5th
Van	𝍸 𝍸 ll	12	2nd
Truck	𝍸 l	6	4th
Motorbike	𝍸 ll	7	3rd
	TOTAL:	56	

SITE 2:

VEHICLE TYPE	TALLY	NUMBER	RANK
Car	𝍸 𝍸 𝍸	14	1st
Bus	l	1	5th
Van	𝍸 l	6	2nd
Truck	lll	3	4th
Motorbike	llll	4	3rd
	TOTAL:	28	

7 Write a conclusion on what the results show.

NOTE: Percentage calculations can also be made and graphs of results drawn.

Figure 6.13.6 Traffic survey

AIM:

To find out which out of two local suburbs is the best off for tourism.

1 Select two local places to be surveyed.

2 Walk through and observe the first place, scoring it on the bi-polar analysis with ticks.

CATEGORY	Very Poor	1	2	3	4	5	Excellent
Shops (groceries)	plenty						none
Broken Pavings	plenty						none
Gardens	untidy						beautiful
Litter/rubbish	plenty						none
Houses	rough						very tidy
Parking	no area						plenty of area
Good roads	plenty						none
Places to stay	plenty						none

3 Score the second suburb on the same sheet using a different coloured pen.

4 Compare the results, draw graphs and write an analysis.

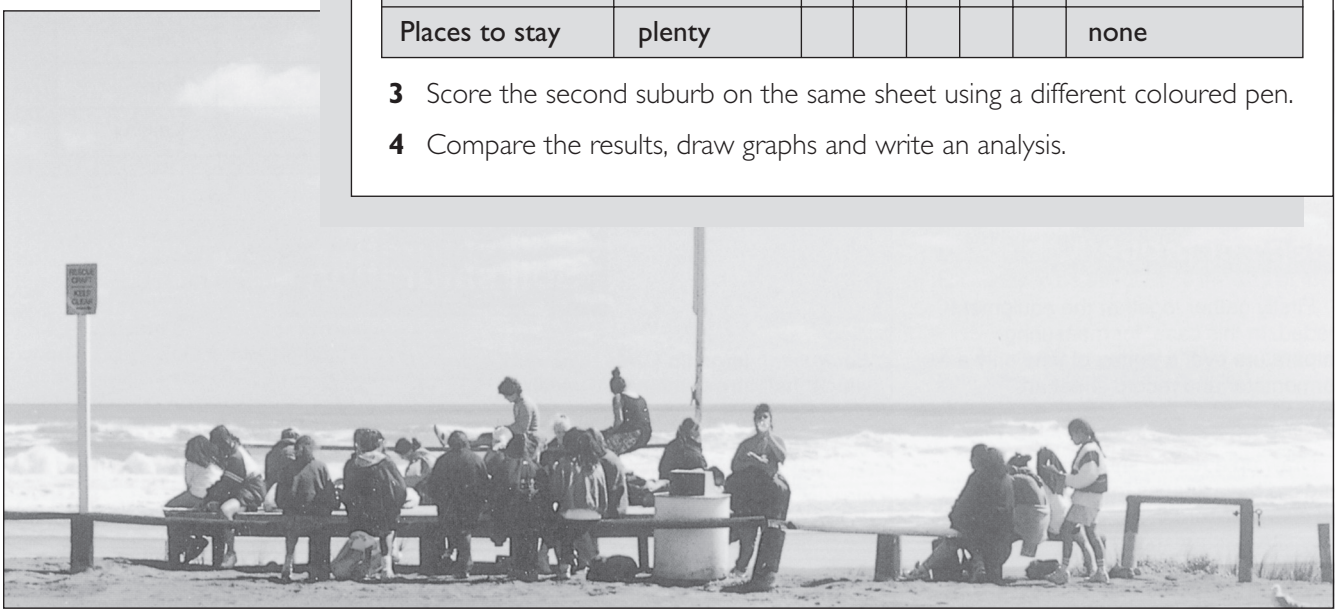


Figure 6.13.7 Residential bi-polar survey

Activity 5

Traffic

1 Use the traffic survey (see Figure 6.13.6) at a local intersection. Make two peak period (7.30 a.m. to 9.00 a.m. and 4.30 p.m. to 5.30 p.m.) observations and two off-peak observations.

2 Draw a bar graph on which to present the data.

3 Write a conclusion about how much more traffic there is at peak compared to non-peak periods. Refer to the sections on graphs and percentages to help you.

Residential

4 Use the survey on tourism places (see Figure 6.13.7). Compare two contrasting areas near you. Tick which category you agree with.

5 Conclude which place looks like it would be better for tourists. Explain what influenced your decision.

Pedestrian

6 Design your own survey for pedestrian traffic. Record the number of pedestrians who enter a shopping mall or large store.

7 Do the survey as a class so that much of the day can be recorded, including out of school times.

8 Write a conclusion on the times of the day when the shop is most commonly used.

Monitoring Patterns Of Change

Extended recordings are surveys over a long period of time. Each individual recording may only be brief, but the recordings may be taken over a month, six months or one year etc., to see what patterns of change occur. This is a suitable method for collecting data on rainfall, temperature and soil saturation, etc.

EXAMPLE: Figure 6.13.8 is a record sheet for recording temperature change.

Steps in procedure

1 First gather together the equipment you need. In this case, for measuring temperature over a period of time, only a thermometer and a record sheet.

2 Draw up a record sheet. The sheet needs to have spaces for the temperature and also to record the time, day, date and study site. (See Figure 6.13.8).

3 It is important that you make the recordings at the same time and place so the data can be accurately compared.

Note
If recordings are only being done for a month or so, then it will be necessary to do them daily. If recordings are to be for a longer period, six months or a year, they could be done every second day or every week.

Activity 6

Equipment

Thermometer

Record sheet

Temperature

1 Use the temperature sheet and a thermometer to record temperatures for a study site at your school for one month.

2 What changes did you notice? Were there obvious fluctuations (changes from high to low)?

3 Were the changes what you would expect for that time of the year? Explain why or why not.

Record Sheet For Temperature				
STUDY SITE:				
DAY	DATE	TIME	TEMPERATURE	WEATHER
Monday	15/4	1.00 p.m.	21	Sunny
Tuesday	16/4	1.00 p.m.	19	Fine
Wednesday	17/4	1.10 p.m.	16	Drizzle
Thursday	18/4	1.05 p.m.	18	Fine
Friday	19/4	1.10 p.m.	15	Raining

Figure 6.13.8 Record sheet – temperature

Equipment

Large tin (ends removed)
Watch
Half litre container of water
Marker
Record sheet
Ruler

Activity 7

Soil saturation

1. Use a large tin with both ends removed, a watch, a half litre container full of water and a ruler. Put a mark on the outside of the tin, halfway up the side. Draw up a sheet to record results on.
2. Put the tin into the soil up to the halfway mark, or as close as possible to it.
3. Pour the half litre of water into the tin (do not let it overflow). Start timing as soon as you begin pouring. Stop timing when all the water has soaked through into the soil.
4. This procedure can be repeated at different times of the month or year to measure changes in soil saturation. Recordings can also be made at different study sites (e.g. near a stream bed and higher up a valley slope).
5. Write a conclusion on the differences noted. What relationship do you think the differences may have had to temperature or rainfall?

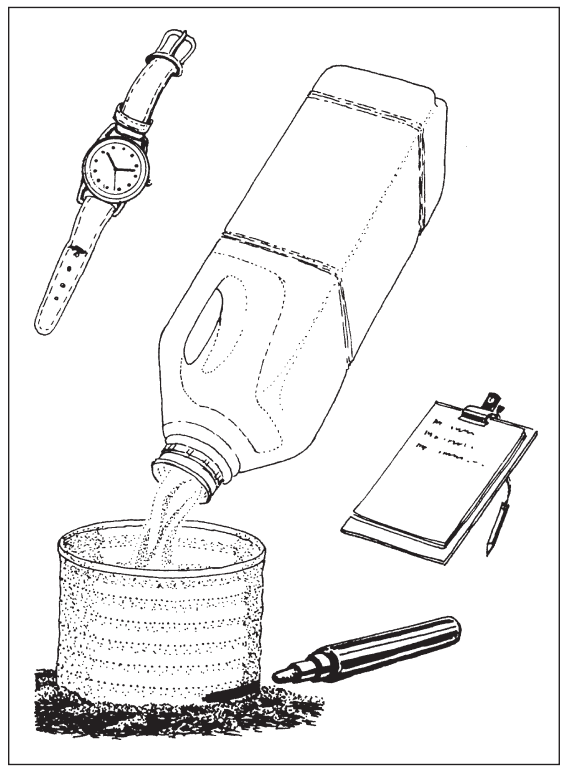


Figure 6.13.9 Soil saturation

Activity 8

Equipment

- Container
- Funnel
- Tall slim beaker (millimetres labelled)
- Tape or similar
- Record sheet

Rainfall

1. To record rainfall, use a funnel and a tall slim beaker, with millimetres marked down its side (see your school's science department).
2. Set up the funnel and beaker in a place where they will not be disturbed, preferably by a pole so they can be placed in a container and attached or taped to the pole.
3. Record how much rainfall occurs daily. Empty the rainfall from the beaker daily.
4. Record the results on a sheet.
5. Compare the recordings to those taken at another study site.
6. Write an explanation for your results.

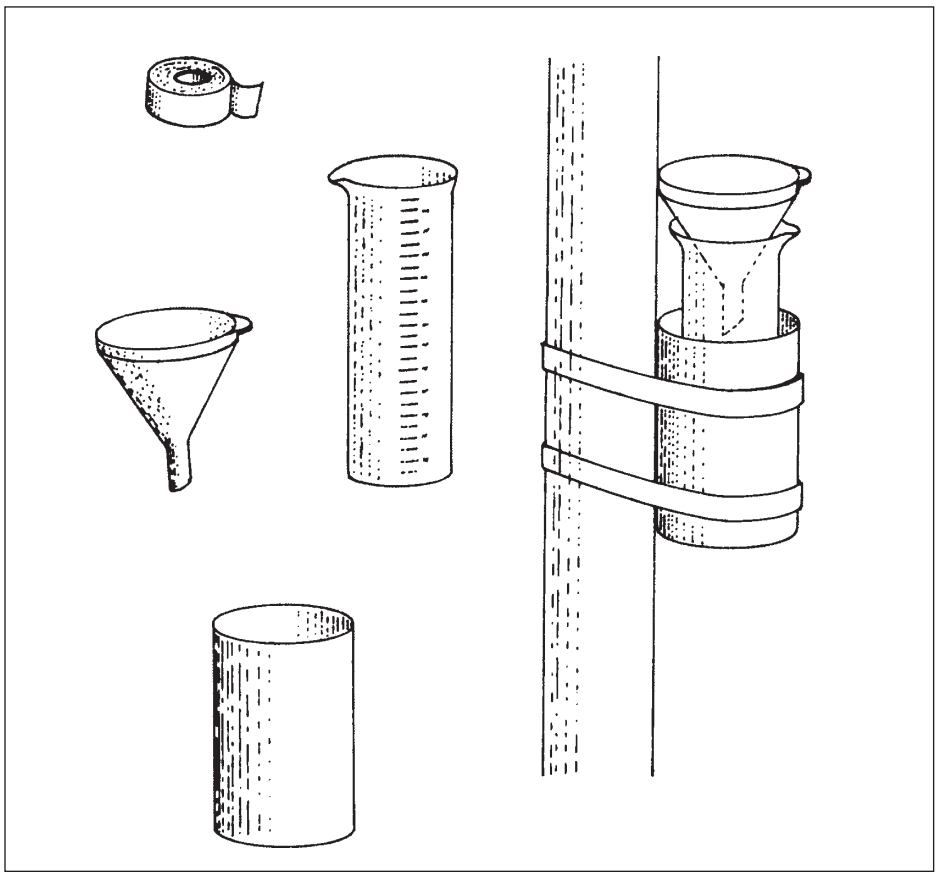


Figure 6.13.10 Rainfall recording

Equipment

- Base-board 30 cm x 50 cm
- Drill
- Metal rod – threaded – 40 cm
- 6 nuts
- Plywood for compass rose
- Ice cream lid
- Tack, staple or nail
- Hammer
- Glue (optional)
- Plywood for arrow
- Wood – 2 cm x 2 cm x 40 cm long
- Record sheet
- Tape, wire or nails to attach to house

Activity 9

Wind

1 To read the wind, construct a wind vane. Use a base of wood, formica or similar. It needs to be flat and approximately 30 to 50 cm square.

2 You will need a metal or plastic threaded rod approximately 40 cm long. Drill a hole in the centre of the base. Push the rod through the hole just enough to attach it. Attach the rod to the base with a nut above and below the base. The bottom end of the rod should be level with the bottom of the base.

3 Get a thin sheet of plywood and cut it into a cross shape. Drill a hole through the centre of it. This will be the compass rose.

4 Using a plastic ice-cream carton or similar, cut out the letters N, S, W and E from the plastic. Tack, staple or nail these to each point of the compass rose.

5 Attach the compass rose to the rod halfway up the rod. Use a nut above and below the compass rose to attach it. Use glue also if desired. It needs to be firm so it will not move.

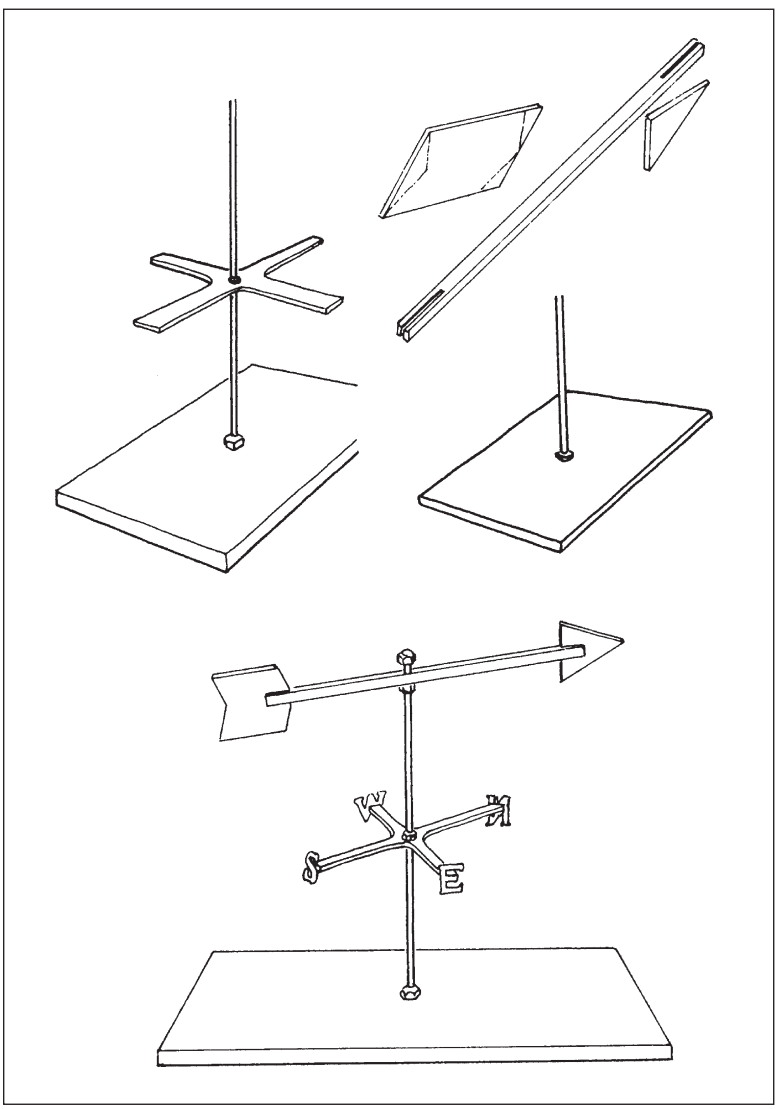


Figure 6.13.11 Wind vane

6 Next cut out a separate head and tail for the arrow from a piece of plywood. The tail needs to be about the same size as the head.

7 Attach the head and the tail to the 2 cm x 2 cm x 4 cm piece of wood.

8 Drill a hole in the arrow so that when it is fixed to the rod the arrow head and tail will be vertical. The arrow needs to be balance evenly before the hole is drilled.

9 Attach the arrow to the top of the rod, with a bolt above and below the arrow. These must *not* be screwed up tight against the arrow. The arrow needs to be able to turn in the wind.

10 Lastly, set the wind vane up in an exposed position such as a veranda or roof. Use a compass to check the compass rose points are facing in the correct directions. Attach the wind vane securely.

11 Now the wind direction can be monitored at any time. Direction changes can be recorded and frequency amounts for the prevailing wind recorded also.

12 Try monitoring direction and frequency over a month and explaining the results.

Scientific Method

To follow scientific method in field work, you have to make a statement that you believe is true and then go out and collect data which enable you to either prove or disprove the statement. The statement you analyse is called a hypothesis.

EXAMPLE: see Figure 6.13.12.

Steps in procedure (for a student in New Zealand)

1 Choose a topic area, e.g. crime. (See Figure 6.13.12).

2 Make a statement or hypothesis related to your topic, e.g.

'that most criminals in New Zealand are under 25 years of age'.

The list below may provide possible sources from which you can gather information to prove or disprove the hypothesis stated above:

Department of Statistics	Justice Department
District Court	High Court
Police	New Zealand Yearbook

3 Now go and research the topic to gather data which will enable you to prove that your statement is either correct or incorrect, i.e. you can either prove or disprove the hypothesis. Use the sources shown in the list above for information.

HYPOTHESIS:

'that most criminals in New Zealand are under 25 years of age'.

STATISTICS:

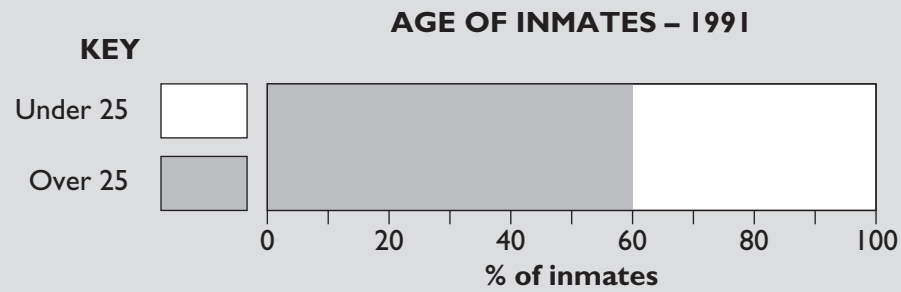
Age distribution of inmates – 1991	
Age	**Percentage**
14–19	11.0
20–24	28.9
25–29	22.2
30–34	15.4
35–39	8.9
40–49	9.2
50+	4.4

TOTALS:

Age	Percentage
Under 25	39.9
25+	60.1

(cont.)

PERCENTAGE BAR GRAPH



CONCLUSION:

Most criminals in New Zealand are not under 25 years of age. However, for conclusive evidence, data from other years could also be examined. It should also be noted that 20–24 year olds had the highest percentage of crime out of the various age divisions. Therefore the hypothesis shows there is a strong relationship, but it does not prove that most criminals in New Zealand are under 25 years of age.

Figure 6.13.12 Disproving a hypothesis – New Zealand criminals

Activity 10

Sports

1 a Support or disprove the following hypothesis:
'that boys participate in school sports more than girls do'.

Survey your class to see if this is correct.

b Give a possible reason for the outcome of the hypothesis.

Other topic

2 a Choose your own topic, e.g. *housing population, traffic, social welfare, jails.*

b Write a hypothesis for the topic.

c Do some research on the topic to support or disprove the hypothesis.

People Skills

The social sciences not only require you to learn about people but also to work with others and to understand differing opinions. Such skills can be gained through groupwork activities, valuing exercises, games and marking exercises.

Groupwork

1 When you work with other students, different members of your group can take on different roles. Some can take on passive roles, waiting to be told what to do by others. Some will take on more active roles, leading, guiding and instructing members in what to do. Still other members will fall somewhere between the two extremes, contributing at times and working on their own at times.

Active/Assertive	Leader/Instructor
In-between	Sometimes leads/sometimes follows instructions
Passive	Waits for instructions
Negative	Disagrees with instructions

Identify where you fit on the social/groupwork skills continuum.

2 Those who are more active or assertive take on leadership roles, initiating (motivating) and facilitating (organising) others.

3 In a groupwork exercise, where everyone takes a turn at different organised roles within the group, you can experience different roles which you otherwise might not experience.

Valuing

Within the community different people hold different viewpoints and values. In the social sciences we learn to identify these different viewpoints and values.

It is usually easy to identify and understand the values and views of other people who have a similar background to our own. However, when people hold very different values and views to ours, we sometimes cannot understand them or we may judge them unfairly. To examine people's views and values, ask yourself what makes others different to you?

- ❑ culture
- ❑ age
- ❑ education
- ❑ interest group
- ❑ religion
- ❑ sex
- ❑ socio-economic group
- ❑ other reasons.

A values continuum is a quick yet effective way of displaying different people's viewpoints on a particular issue (see Figure 6.13.13).

You may feel very strongly about something and want to share it and tell someone else about it. We are free to do this, but we cannot force others to accept our values and opinions. We have to learn to appreciate that others are different to us and understand why, so we can accept them as they are.

Steps in procedure – Case study from New Zealand

1 Use an issue like a plan by the Ports of Auckland Company to develop the Auckland waterfront. This concerns a number of groups in the community.

2 List the groups involved.

3 Find out what each group's opinion is about the issue (see Figure 6.13.13)

4 Draw up a values continuum (see Figure 6.13.13).

5 Plot each group along the continuum according to what you think their opinions about the issue are (see Figure 6.13.13).

Development of Auckland's Waterfront

ISSUE: Proposal by Ports of Auckland Company to develop Auckland waterfront

VIEWPOINTS: (Groups):
Ports of Auckland Co.
Architects
Local residents
Auckland City Council

Values Continuum

Groups Plotted

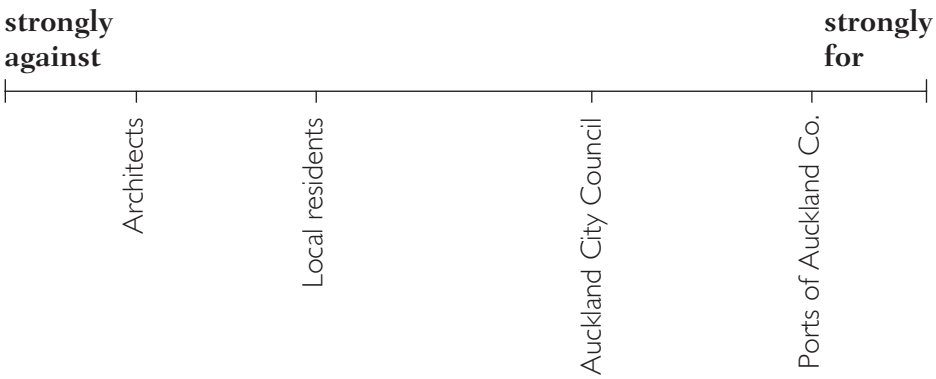


Figure 6.13.13 Values continuum

Activity 11

1 Justify the placement of each group on the values continuum above.

Survey

2 With your class do a quick survey to ask students what they think about:
Greenhouse Emmissions – USA
Immigration Policies – New Zealand and Sāmoa
Do they – Agree/Disagree – Reasons why?

3 Look at the answers each student gave. Why do you consider they gave those answers? Consider, for example, their culture, age, education?

Continuum

4 Plot the answers you have been given onto a values continuum (refer to Figure 6.13.13 for ideas).

Discussion

5 Why can't we push/impose our values or views onto other people? Discuss this in a group.

Paragraph

6 Write a paragraph saying what freedom of speech has to do with values and viewpoints.

Perception

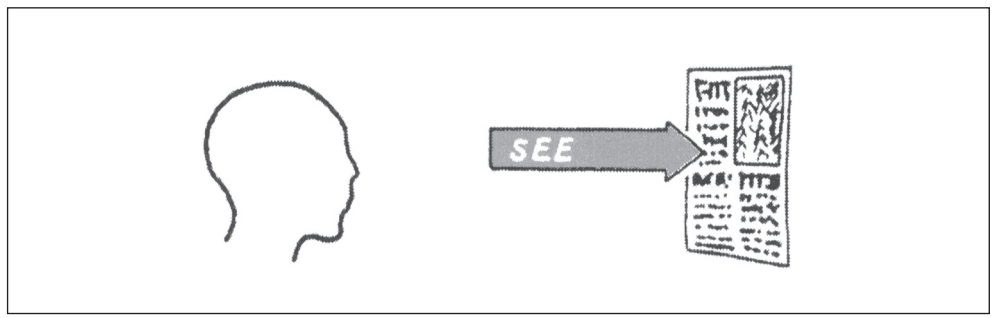
Every individual person sees the world through different eyes (perspectives). We may see the same features but interpret them differently. As a result the decisions we make may be different from the decisions that someone else may make. This process of how we see something is called perceptions.

EXAMPLE: a runner may look at a city park and see a place for recreation. A developer may see a space to build townhouses.

Understanding perception

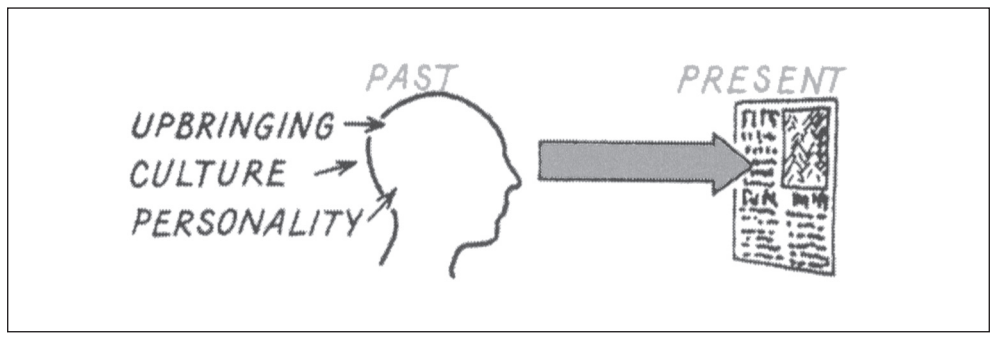
1 We look

When we look at a resource, feature or event we will usually see the same thing as other people.

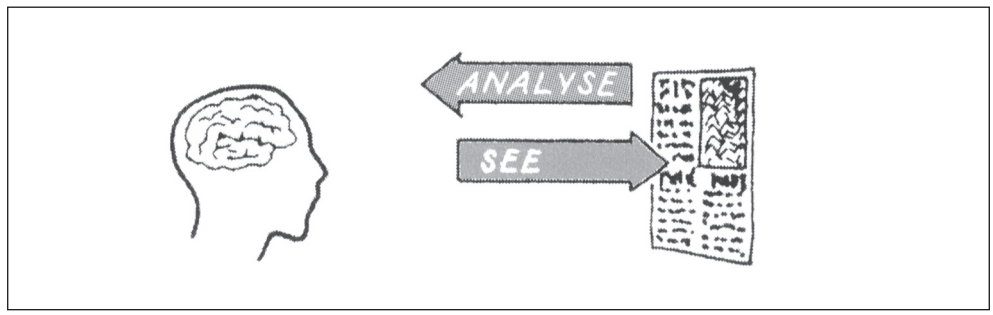


2 We interpret

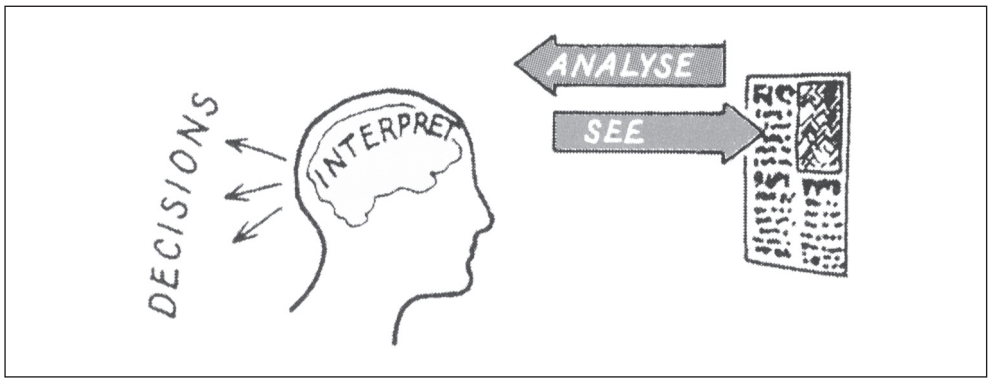
Our past will be a filter to influence how we see the resource, feature or event.



3 We analyse



4 We decide



5 We act

The interpretations we make will influence the decisions we make regarding our response to what we are seeing. We act according to our perceptions.

6 Different perceptions

Each person's filters are different so people come to different conclusions as a result of this process. When people decide to act differently, conflict can arise. For example see the Perception/Conflict Model in Figure 6.13.14.

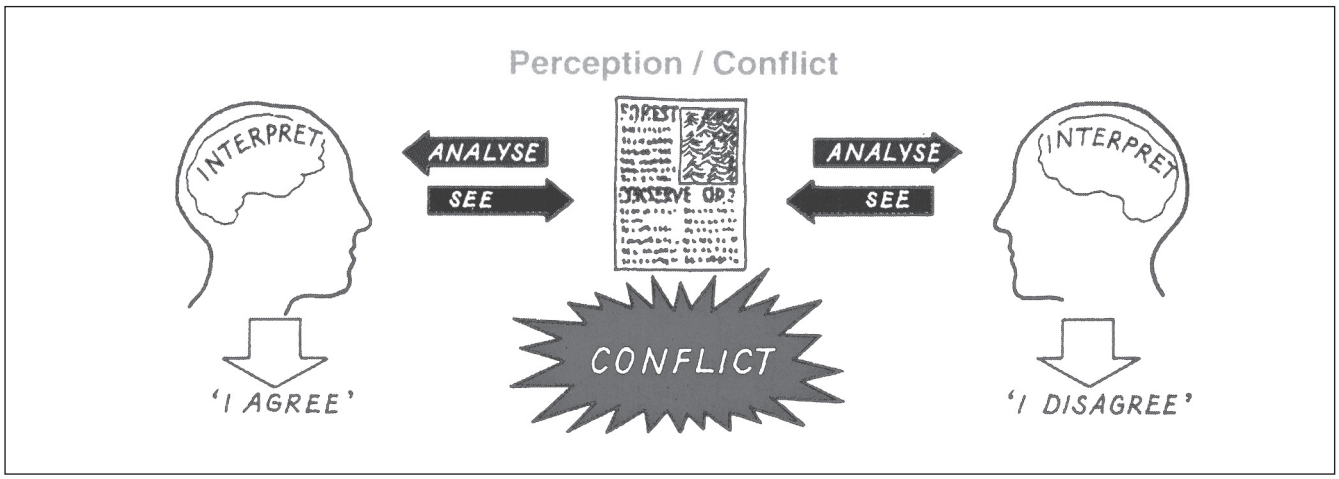


Figure 6.13.14 Perception/conflict model

Activity 12

1. Figure 6.13.15 below shows four different people looking at the same place. Describe the place.
2. Create profiles for two of these people. The profiles should include:
   - ❑ name
   - ❑ gender
   - ❑ age
   - ❑ occupation
   - ❑ family background
   - ❑ cultural background
   - ❑ personality.
3. Construct a perception/conflict model that shows how the two people perceive the future use of the place in different ways.
4. Suggest actions that each person may take based on their perceptions.

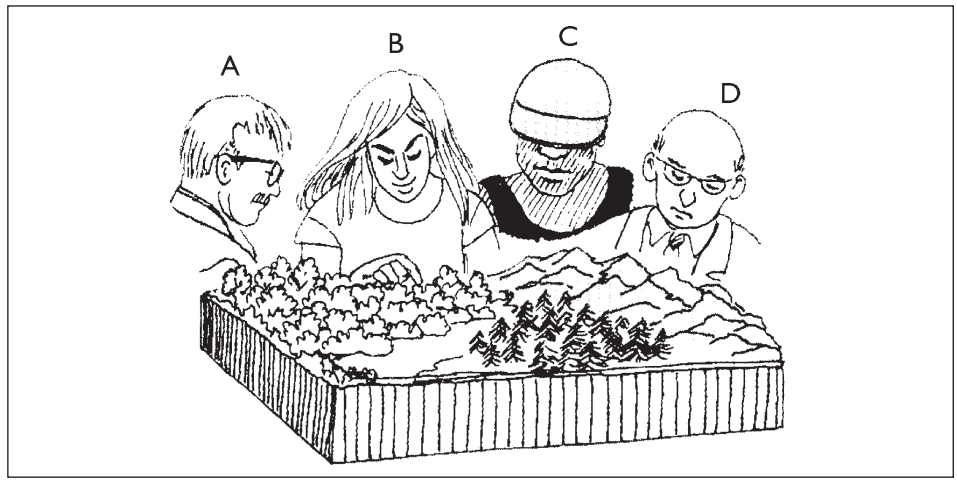


Figure 6.13.15 Different perceptions of the same place

Key Vocabulary

Vocabulary	Derivations	Collocations
access	accessible	accessible locations
administer	administration, administrator	to administer the colony
aspect		the economic aspects of globalisation
assess	assessment	the government assesses the cost
broad		in the broadest sense
colony	colonise, colonial, colonialism	
combine	combined with combination	these combine to determine the water supply
complex	complexity	complex air movements
concentrate	concentration	a concentration of tourism activities wastewater projects are concentrated in . . .
concept	conceptualise	the package tour concept, key concepts
consequence		the consequences of climate change as a consequence
decline		urban growth and decline, the population declined . . .
detect	detection	seismometers detect earth tremors
determine	determination	many factors determine the best location . . .
determined		Niueans are determined to maintain links . . .
disrupt	disruption	cyclones disrupt island economies
distinct		its own distinct characteristics
distribution	distribute, redistribute	the distribution of transport networks
dominate	dominant	these processes dominate the environment
ensure		ensure everybody's needs are met
establish	re-establish, establishment	scientists have established that . . . trading systems were established
extreme	extremely	extreme events, between the two extremes
factor		economic factors factors that influence development
feature		key features, features of the environment
focus	focal	commercially focussed activity, a focal point
frequency		an increase in frequency the frequency decreases as . . .
function		a range of functions
generate	generation	to generate differences to generate employment electricity generation
global	globalisation	on a global scale
impact		reduce the impact of disasters
influence		a dramatic influence on tourism
intense	intensity, intensify, intensification	intensification of land use
interact	interactions	the main patterns and interactions they interact directly
invest	investment, investor	invest money, tourism investment
maintain	maintenance	maintain a water supply system
modify	modification	modify the environment
network		a transport network
operate	operation	the skills to operate the system these processes operate in the environment

Key Vocabulary

Vocabulary	Derivations	Collocations
perception		different perceptions of the same place
potential	potentially	a potential tourist, the potential for growth
predict	predictable, unpredictable, prediction	weather patterns are not entirely predictable
range		a range of natural hazards, the group ranges from steep cones to ephemeral islands
release		magma releases gas as it rises, a sudden release of pressure
rely	reliant	rely on, reliant on imported goods
risk		at risk, a high risk of fire
sequence		a sequence of events, trend sequences
series		a series of related actions, of photographs
significant	significance	a significant role, of national significance
specific		in a specific place
stable	unstable, stabilise, stability	the wave becomes unstable
strategy	strategic	a strategy to reduce risks, strategic importance
tend		facilities tend to be concentrated
threaten	threat	life-threatening injuries, a threat to health
unique		unique environments, foods unique to Samoa

Topic Specific Vocabulary

Part 1

Introduction
setting
high order, low order
variable
scenario
magnitude
hazard

Unit 1 Volcanic Eruptions
magma
zone
mudflow
explosive, explosively
viscous
tremor
swarms of earthquakes
fissure
predictable/recurrent unpredictable/erratic
emergency
evacuate / evacuee
survivor
monitor
trigger

Unit 2 Tropical cyclones
meteorologist
surge
lash

Part 2 Population and Settlement
urban
hinterland
haphazard

Part 3 Development Studies
globalisation

Unit 3 Globalisation
bureaucracy
ideology
infrastructure
nationalism
communication technology
regulatory role
currency exchange
corporate executives
minimise, maximise

Unit 4 Tourism Development
leisure
domestic, domestically
profile
trend
motivate
cumulative
phenomenon (singular), phenomena (plural)
interdependence
agglomerative
[see also key words in boxes in text]

Topic Specific Vocabulary

Part 4 Resources And Their Uses
hygienic

Unit 5 The Hydrological Cycle And Water Distribution

Unit 6 Water And Systems Of Production

Unit 7 Water Management And Perspectives
reservoir
dam
hydro-electricity

Part 5 Environmental Issues

Unit 8 Understanding The Atmosphere
equatorial
isotherm
thermocline
gyre
the coriolis force
prevailing wind
offshore
downwind
windward

Unit 9 Climate Change And The Process Of Climate Change
heat budget
radiate, radiation

Unit 10 Consequences And Perspectives Of Climate Change
emission
overall
convention
protocol
legally binding
ratify
levy

Part 6 Field Studies

Unit 11 Learning Through Geographic Concepts And Ideas

Unit 12 Reflections On Field Work
factual
value-based
objective / subjective
enrich
reflect / reflection
evaluate / evaluation

Unit 13 Field Work Techniques
feature
category
sketch
trapezium
stretch
collate

Useful Structures

Complex sentences with several clauses:

- Natural processes are natural events that occur in a sequence whereby one event causes another event to occur or change.
  - Natural processes are natural events . . .
  - that occur in a sequence . . .
  - whereby one event causes another event to occur or change.
- In urban areas that receive high volumes of tourist traffic accommodation types concentrate in the Central Business District and their frequency decreases as the distances from the Central Business District increase.
  - In urban areas . . .
  - that receive high volumes of tourist traffic . . .
  - accommodation types concentrate in the Central Business District . . .
  - and their frequency decreases . . .
  - as the distances from the Central Business District increase.

Descriptive phrases placed before a pronoun (or noun):

- . . . moderate mixing of subducting crust with magma makes intermediate lava. *Less viscous than rhyolite, it* erupts fairly explosively and cools quite quickly to form andesite.
- The volcanoes of Auckland and Northland have a different cause. *Associated with hot spots under the crust, they* erupt basaltic lava.

Use of the same grammatical form in each item in a list:

- Several techniques are used to detect the early warning signs:
  - *seismometers to detect* earth tremors associated with rising magma
  - *tiltmeters and levelling surveys to detect* ground deformation (bulging)
  - *temperature measurements to detect* heat from rising magma.
- Civil Defence personnel may:
  - *evacuate* buildings and places
  - *restrict* entry into buildings
  - *remove* vehicles which block their work
  - *requisition* (make use of) private property that may assist them during the emergency, e. g. a person's family home or car.