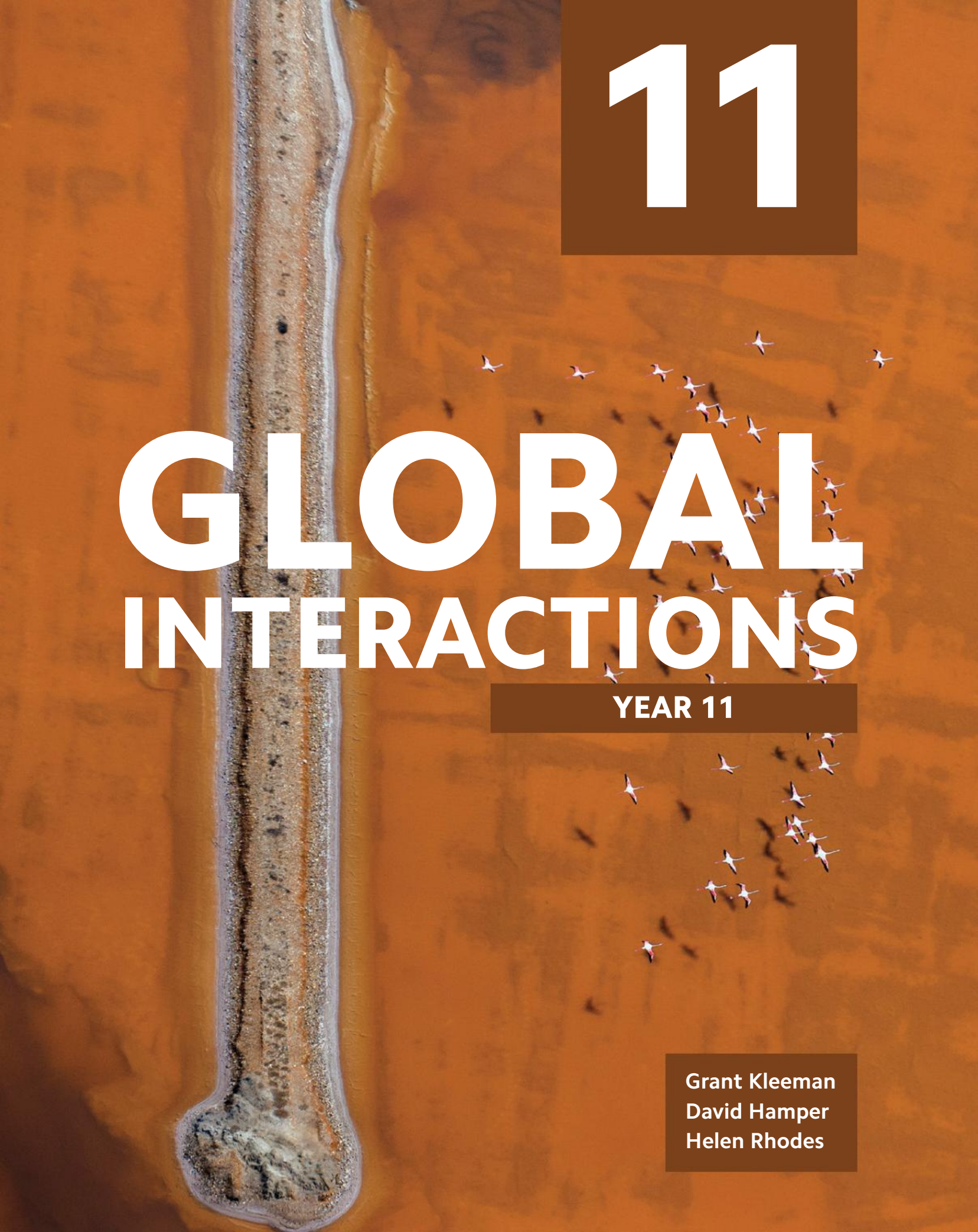

11

GLOBAL INTERACTIONS

YEAR 11

Grant Kleeman
David Hamper
Helen Rhodes

11

GLOBAL INTERACTIONS

YEAR 11

Grant Kleeman
David Hamper
Helen Rhodes

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Global Interactions

The *Global Interactions Third Edition* series is written for the NSW Stage 6 Geography syllabus. The text aims to help develop students' knowledge, understanding, skills, attitudes and values in relation to the biophysical and human environments. Students using *Global Interactions* will be well placed to realise their full academic potential in Year 12 Geography.

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- Chapter titles and units reflect the NSW Stage 6 Geography syllabus
- Full-colour text with engaging and highly visual design
- Dynamic and relevant images, textual examples, graphs and maps
- Topic-based units written in accessible language with clear and concise explanations of key terms and concepts
- A variety of learning activities for regular revision and consolidation
- Case studies that describe and encourage in-depth investigation
- End-of-chapter glossary for reference and exam-style questions
- Written by an experienced author team:
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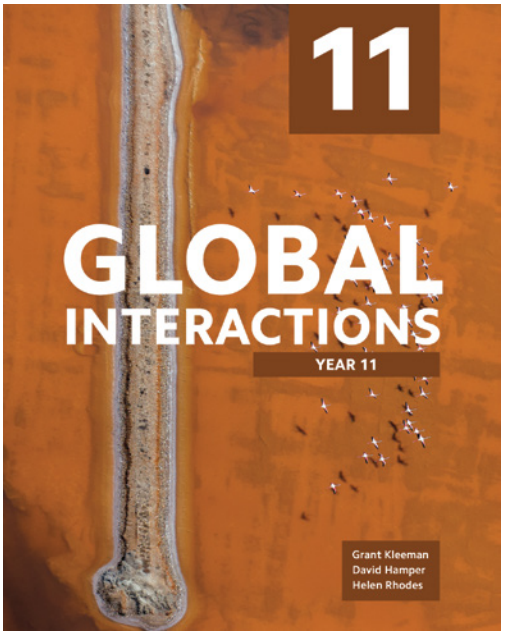

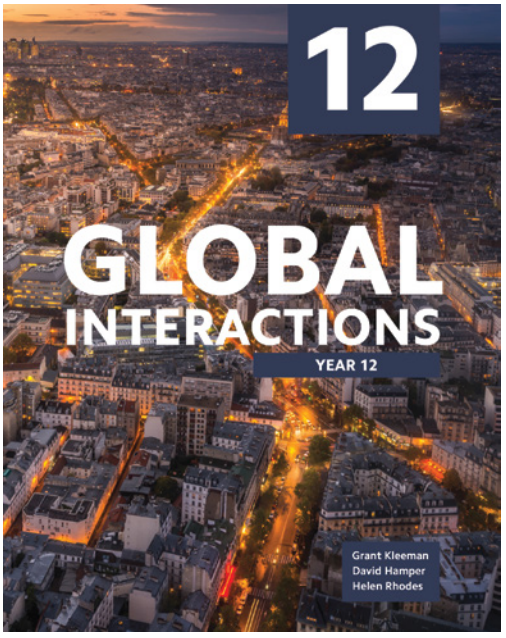

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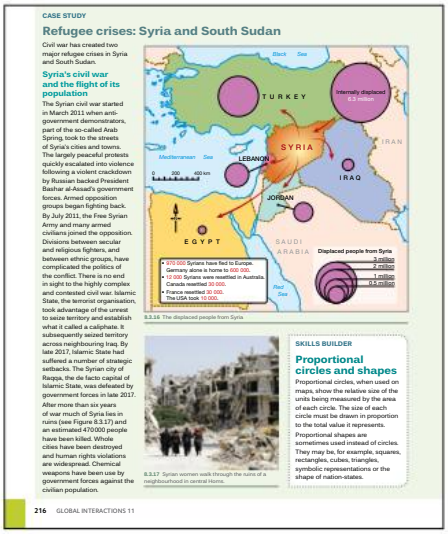
How to use

Case studies

Case study units relate to a specific event or location; and are written to extend students' knowledge and understanding.


CASE STUDY

Refugee crises: Syria and South Sudan

Civil war has created two major refugee crises in Syria and South Sudan.

Syria's civil war and the flight of its population

The Syrian civil war started in March 2011 when anti-government demonstrators, part of the so-called Arab Spring, took to the streets of Syria's cities and towns. The largely peaceful protests quickly escalated into violence following a violent crackdown by Russian backed President Bashar al-Assad's government forces. Armed opposition groups began fighting back. By July 2011, the Free Syrian Army and many armed civilians joined the opposition. Divisions between secular and religious fighters, and between ethnic groups, have complicated the politics of the conflict. There is no end in sight to the highly complex and contested civil war. Islamic State, the terrorist organisation, took advantage of the unrest to seize territory and establish what it called a caliphate. It subsequently seized territory across neighbouring Iraq. By late 2017, Islamic State had suffered a number of strategic setbacks. The Syrian city of Raqqa, the de facto capital of Islamic State, was defeated by government forces in late 2017. After more than six years of war much of Syria lies in ruins (see Figure 8.3.17) and an estimated 470 000 people have been killed. Whole cities have been destroyed and human rights violations are widespread. Chemical weapons have been use by government forces against the civilian population.

8.3.16 The displaced people from Syria

8.3.17 Syrian women walk through the ruins of a neighbourhood in central Homs.

SKILLS BUILDER

Proportional circles and shapes

Proportional circles, when used on maps, show the relative size of the units being measured by the area of each circle. The size of each circle must be drawn in proportion to the total value it represents.

Proportional shapes are sometimes used instead of circles. They may be, for example, squares, rectangles, cubes, triangles, symbolic representations or the shape of nation-states.

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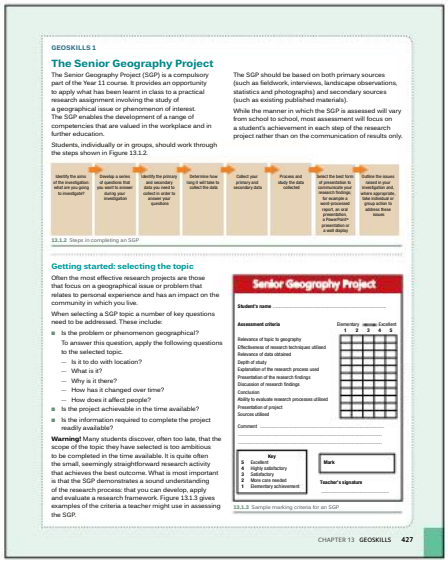
Skills builders

Skills builders are embedded in selected units and concentrate on key geographical skills and concepts.


GEOSKILLS 1

The Senior Geography Project

The Senior Geography Project (SGP) is a compulsory part of the Year 11 course. It provides an opportunity to apply what has been learnt in class to a practical research assignment involving the study of a geographical issue or phenomenon of interest. The SGP enables the development of a range of competencies that are valued in the workplace and in further education.

Students, individually or in groups, should work through the steps shown in Figure 13.1.2.

13.1.2 Steps in completing an SGP

The SGP should be based on both primary sources (such as fieldwork, interviews, landscape observations, statistics and photographs) and secondary sources (such as existing published materials).

While the manner in which the SGP is assessed will vary from school to school, most assessment will focus on a student's achievement in each step of the research project rather than on the communication of results only.

Getting started: selecting the topic

Often the most effective research projects are those that focus on a geographical issue or problem that relates to personal experience and has an impact on the community in which you live.

When selecting a SGP topic a number of key questions need to be addressed. These include:

- Is the problem or phenomenon geographical?
  To answer this question, apply the following questions to the selected topic:
  - Is it to do with location?
  - What is it?
  - Why is it there?
  - How has it changed over time?
  - How does it affect people?
- Is the project achievable in the time available?
- Is the information required to complete the project readily available?

Warning! Many students discover, often too late, that the scope of the topic they have selected is too ambitious to be completed in the time available. It is quite often the small, seemingly straightforward research activity that achieves the best outcome. What is most important is that the SGP demonstrates a sound understanding of the research process: that you can develop, apply and evaluate a research framework. Figure 13.1.3 gives examples of the criteria a teacher might use in assessing the SGP.

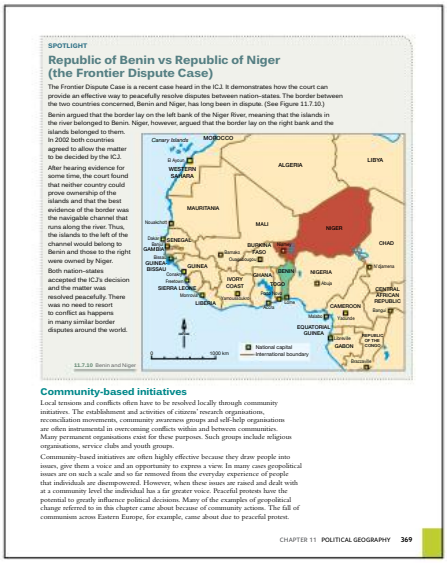
Senior Geography Project

13.1.3 Sample marking criteria for an SGP

CHAPTER 13 GEOSKILLS 427

Spotlight

Spotlight boxes focus attention on a place, an issue or a concept relating to the unit. They are designed to develop students' knowledge and understanding of the concepts and processes that are central to the study of geography at this stage of learning.


SPOTLIGHT

Republic of Benin vs Republic of Niger (the Frontier Dispute Case)

The Frontier Dispute Case is a recent case heard in the ICJ. It demonstrates how the court can provide an effective way to peacefully resolve disputes between nation–states. The border between the two countries concerned, Benin and Niger, has long been in dispute. (See Figure 11.7.10.)

Benin argued that the border lay on the left bank of the Niger River, meaning that the islands in the river belonged to Benin. Niger, however, argued that the border lay on the right bank and the islands belonged to them.

In 2002 both countries agreed to allow the matter to be decided by the ICJ.

After hearing evidence for some time, the court found that neither country could prove ownership of the islands and that the best evidence of the border was the navigable channel that runs along the river. Thus, the islands to the left of the channel would belong to Benin and those to the right were owned by Niger.

Both nation–states accepted the ICJ's decision and the matter was resolved peacefully. There was no need to resort to conflict as happens in many similar border disputes around the world.

11.7.10 Benin and Niger

Community-based initiatives

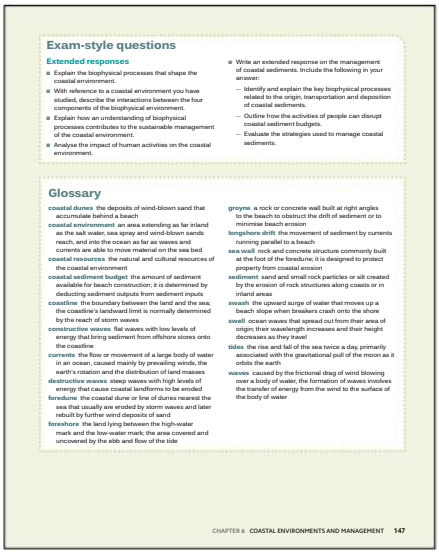
Local tensions and conflicts often have to be resolved locally through community initiatives. The establishment and activities of citizens' research organisations, reconciliation movements, community awareness groups and self-help organisations are often instrumental in overcoming conflicts within and between communities. Many permanent organisations exist for these purposes. Such groups include religious organisations, service clubs and youth groups.

Community-based initiatives are often highly effective because they draw people into issues, give them a voice and an opportunity to express a view. In many cases geopolitical issues are on such a scale and so far removed from the everyday experience of people that individuals are disempowered. However, when these issues are raised and dealt with at a community level the individual has a far greater voice. Peaceful protests have the potential to greatly influence political decisions. Many of the examples of geopolitical change referred to in this chapter came about because of community actions. The fall of communism across Eastern Europe, for example, came about due to peaceful protest.

CHAPTER 11 POLITICAL GEOGRAPHY 369

Exam-style questions

Exam-style questions are a variety of extended responses which enable students to practise and develop their exam skills.


Exam-style questions

Extended responses

- Explain the biophysical processes that shape the coastal environment.
- With reference to a coastal environment you have studied, describe the interactions between the four components of the biophysical environment.
- Explain how an understanding of biophysical processes contributes to the sustainable management of the coastal environment.
- Analyse the impact of human activities on the coastal environment.
- Write an extended response on the management of coastal sediments. Include the following in your answer:
  - Identify and explain the key biophysical processes related to the origin, transportation and deposition of coastal sediments.
  - Outline how the activities of people can disrupt coastal sediment budgets.
  - Evaluate the strategies used to manage coastal sediments.

Glossary

coastal dunes the deposits of wind-blown sand that accumulate behind a beach

coastal environment an area extending as far inland as the salt water, sea spray and wind-blown sands reach, and into the ocean as far as waves and currents are able to move material on the sea bed

coastal resources the natural and cultural resources of the coastal environment

coastal sediment budget the amount of sediment available for beach construction; it is determined by deducting sediment outputs from sediment inputs

coastline the boundary between the land and the sea; the coastline's landward limit is normally determined by the reach of storm waves

constructive waves flat waves with low levels of energy that bring sediment from offshore stores onto the coastline

currents the flow or movement of a large body of water in an ocean, caused mainly by prevailing winds, the earth's rotation and the distribution of land masses

destructive waves steep waves with high levels of energy that cause coastal landforms to be eroded

foredune the coastal dune or line of dunes nearest the sea that usually are eroded by storm waves and later rebuilt by further wind deposits of sand

foreshore the land lying between the high-water mark and the low-water mark; the area covered and uncovered by the ebb and flow of the tide

groyne a rock or concrete wall built at right angles to the beach to obstruct the drift of sediment or to minimise beach erosion

longshore drift the movement of sediment by currents running parallel to a beach

sea wall rock and concrete structure commonly built at the foot of the foreshore; it is designed to protect property from coastal erosion

sediment sand and small rock particles or silt created by the erosion of rock structures along coasts or in inland areas

swash the upward surge of water that moves up a beach slope when breakers crash onto the shore

swell ocean waves that spread out from their area of origin; their wavelength increases and their height decreases as they travel

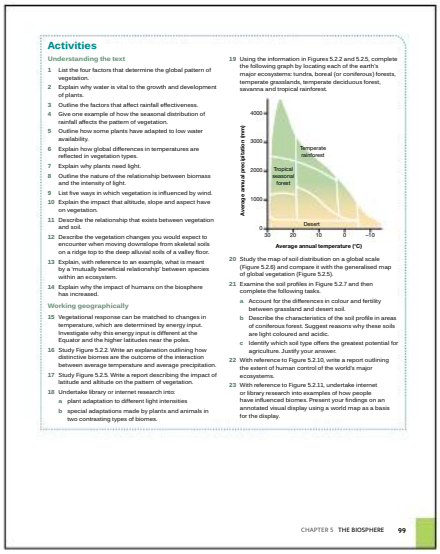
tides the rise and fall of the sea twice a day, primarily associated with the gravitational pull of the moon as it orbits the earth

waves caused by the frictional drag of wind blowing over a body of water, the formation of waves involves the transfer of energy from the wind to the surface of the body of water

CHAPTER 6 COASTAL ENVIRONMENTS AND MANAGEMENT 147

Activities

Activities have been carefully selected to cater for the full range of student abilities. Many activities are based on the stimulus material presented and aim to facilitate the development of the skills used by geographers.


Activities

Understanding the text

1 List the four factors that determine the global pattern of vegetation.
2 Explain why water is vital to the growth and development of plants.
3 Outline the factors that affect rainfall effectiveness.
4 Give one example of how the seasonal distribution of rainfall affects the pattern of vegetation.
5 Outline how some plants have adapted to low water availability.
6 Explain how global differences in temperatures are reflected in vegetation types.
7 Explain why plants need light.
8 Outline the nature of the relationship between biomass and the intensity of light.
9 List five ways in which vegetation is influenced by wind.
10 Explain the impact that altitude, slope and aspect have on vegetation.
11 Describe the relationship that exists between vegetation and soil.
12 Describe the vegetation changes you would expect to encounter when moving downslope from skeletal soils on a ridge top to the deep alluvial soils of a valley floor.
13 Explain, with reference to an example, what is meant by a 'mutually beneficial relationship' between species within an ecosystem.
14 Explain why the impact of humans on the biosphere has increased.

Working geographically

15 Vegetational response can be matched to changes in temperature, which are determined by energy input. Investigate why this energy input is different at the Equator and the higher latitudes near the poles.
16 Study Figure 5.2.2. Write an explanation outlining how distinctive biomes are the outcome of the interaction between average temperature and average precipitation.
17 Study Figure 5.2.5. Write a report describing the impact of latitude and altitude on the pattern of vegetation.
18 Undertake library or internet research into:
  a plant adaptation to different light intensities
  b special adaptations made by plants and animals in two contrasting types of biomes.
19 Using the information in Figures 5.2.2 and 5.2.5, complete the following graph by locating each of the earth's major ecosystems: tundra, boreal (or coniferous) forests, temperate grasslands, temperate deciduous forest, savanna and tropical rainforest.

Average annual precipitation (mm)
4000
3000
2000
1000
0
Temperate rainforest
Tropical seasonal forest
Desert
30 25 20 15 10 5 0 −5
Average annual temperature (°C)

20 Study the map of soil distribution on a global scale (Figure 5.2.6) and compare it with the generalised map of global vegetation (Figure 5.2.5).
21 Examine the soil profiles in Figure 5.2.7 and then complete the following tasks.
  a Account for the differences in colour and fertility between grassland and desert soil.
  b Describe the characteristics of the soil profile in areas of coniferous forest. Suggest reasons why these soils are light coloured and acidic.
  c Identify which soil type offers the greatest potential for agriculture. Justify your answer.
22 With reference to Figure 5.2.10, write a report outlining the extent of human control of the world's major ecosystems.
23 With reference to Figure 5.2.11, undertake internet or library research into examples of how people have influenced biomes. Present your findings on an annotated visual display using a world map as a basis for the display.

CHAPTER 5 THE BIOSPHERE 99

Understanding the text

These questions guide students towards an understanding of the content (knowledge and understandings) specified by the syllabus.

Working geographically

These tasks extend students beyond the text and involve them in a variety of learning experiences.

Using Global Interactions 11: Third Edition

Structure

This text is divided into two sections corresponding with the Stage 6 syllabus.

1 Biophysical interactions

This section investigates the nature and functioning of the four components of the biophysical environment, including the interactions between the components and the human impacts on them. It also focuses on the ways that an understanding of these processes contributes to sustainable management. Students develop this knowledge and understanding by studying a specific environment and a related environmental issue. Students are provided with two studies:

- Coastal environments and management
- Catchments and river regulation

2 Global challenges

The focus of this section is the social, cultural, political and environmental challenges occurring at a global scale. These challenges are investigated under the following headings:

- Population geography
- Natural resource use
- Cultural integration
- Political geography
- Geographies of development

Year 11 Course Outcomes matrix

Section of text	Syllabus outcomes											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Section 1: Biophysical interactions	✓	✓	✓			✓	✓	✓	✓	✓		✓
Section 2: Global challenges	✓			✓	✓	✓	✓	✓	✓	✓		✓

SECTION

1 Biophysical interactions

Geography is the study of earth's surface features and related human activity. Studying geography helps us make sense of our place in a rapidly changing world and engage with issues such as climate change, the management of scarce water resources, the challenges facing our great cities, global inequalities and political instability. It gives us the knowledge and understanding—as well as the language, skills and techniques—to grapple with the major issues as humans place ever-greater demands on the earth and its systems.

Geography studies real people in real places, and in doing so it shows how daily lives are shaped by local circumstances—not only the physical characteristics of place, but also the social, cultural, economic and political opportunities and constraints that exist. Geography seeks to understand each local place in a regional, national, international and global context.

Geography is a practical subject. It teaches skills needed in school, at home and in the workplace. Through geography, students learn about map use, data analysis and problem solving. They find out how to work alone and in a team. By undertaking fieldwork, they gain experience working directly in the real world. Students of geography also develop an appreciation of social and environmental responsibility.

Outcomes

Students:

P1 differentiate between spatial and ecological dimensions in the study of geography

P2 describe the interactions between the four components which define the biophysical environment

P3 explain how a specific environment functions in terms of biophysical factors

P6 identify the vocational relevance of a geographical perspective

P7 formulate a plan for active geographical inquiry

P8 select, organise and analyse relevant geographical information from a variety of sources

P9 use maps, graphs and statistics, photographs and fieldwork to conduct geographical inquiries

P10 apply mathematical ideas and techniques to analyse geographical data

P12 communicate geographical information, ideas and issues using appropriate written and/or oral, cartographic and graphic forms

Overview

This section focuses on a geographical investigation of biophysical processes and how an understanding of these processes contributes to sustainable management.

Chapter 1 Biophysical interactions: an introduction

Chapter 2 The atmosphere

Chapter 3 The hydrosphere

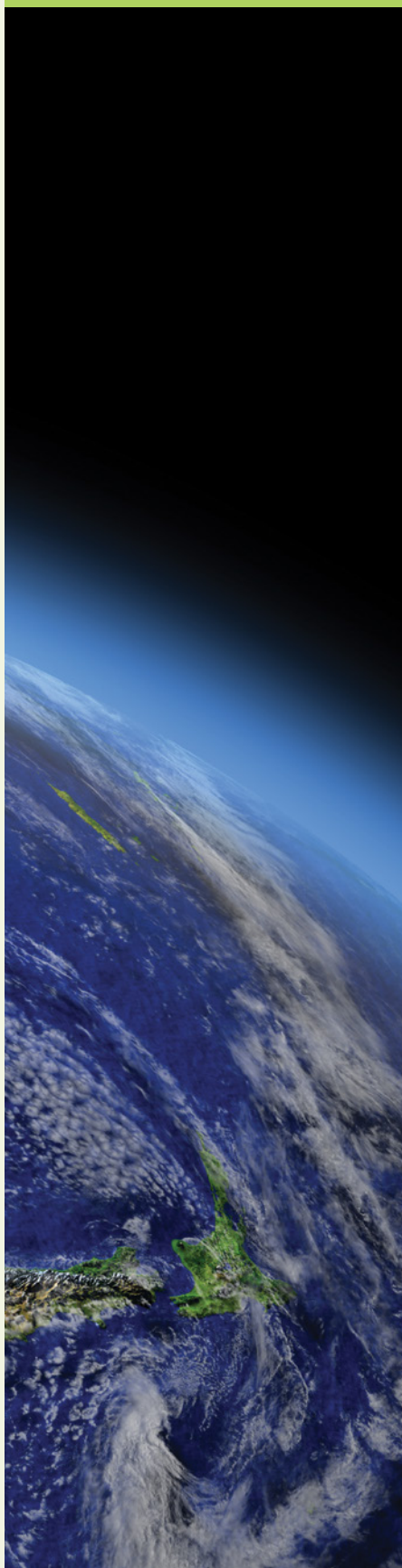
Chapter 4 The lithosphere

Chapter 5 The biosphere

Chapter 6 Coastal environments and management

Chapter 7 Catchments and river regulation

1.0.0 Australia from space



CHAPTER

1 Biophysical interactions: an introduction

Throughout the relatively short period of time that humans have occupied the planet, they have admired, and tried to understand, the natural wonders that surround them. However, the more knowledge we gain of the planet, the more we realise how much more remains to be learnt. Thirty years ago it was thought that there were only about 3 million species of living things on earth; recent sampling has pushed this estimate up to 30 million, a figure that may yet prove to be conservative. This uncertainty demonstrates just how poorly we understand the complexity of the earth's biophysical systems.

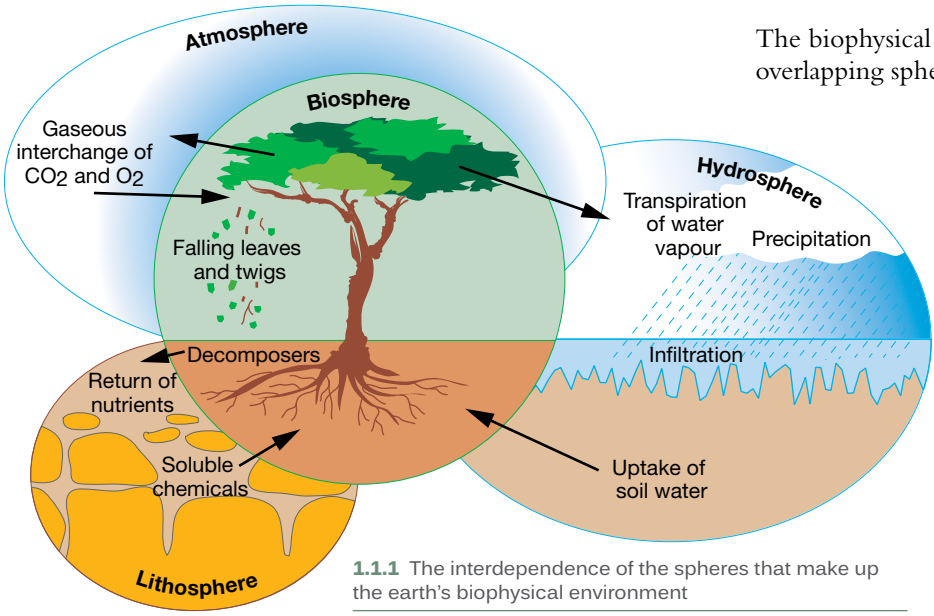
Geographers have a special role to play in investigations of the planet. They study all the phenomena that make up the biophysical environment, not as poets or artists but as scientists. Yet, where science fundamentally specialises, geography analyses the earth as a whole and seeks to understand the connections and interrelationships that exist.

> **Economic advance is not the same as human progress.**
>
> **John Clapman, English economist**

1.0.1 Lord Howe Island

UNIT 1.1

The components of the biophysical environment



1.1.1 The interdependence of the spheres that make up the earth's biophysical environment

The biophysical environment of the earth consists of four overlapping spheres, as shown in Figure 1.1.1:

- the atmosphere—the combination of gases and particles enveloping the globe
- the lithosphere—the earth's solid outer shell
- the hydrosphere—the interconnecting system of water in the atmosphere and lithosphere
- the biosphere—the earth's surface zone and its adjacent atmosphere in which all organic life exists.

Each sphere plays a vital role in sustaining life on earth. Most of the life on this planet exists in a thin film of air, water and rocks in a zone extending from about 61 metres below the earth's surface to about 61 000 metres above sea level.

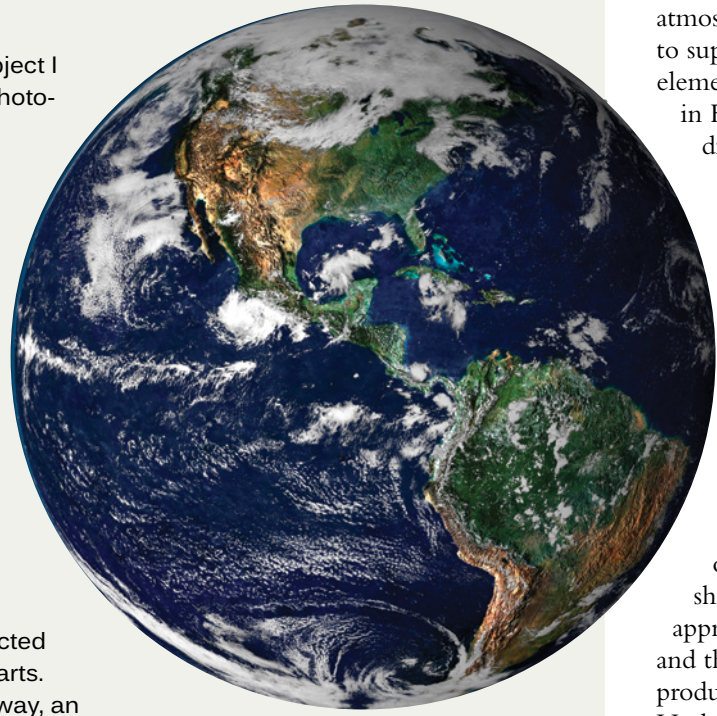
No other planets in the solar system have these four constituent parts. Some have no atmosphere, or are too hot or too cold to support life. Planet earth has all the elements necessary to support life, as seen in Figure 1.1.2. This life is amazingly diverse. Any geographical investigation of life reinforces the importance of the interaction between the spheres that constitute the biophysical environment. Such interactions are apparent at both a local and a global level.

A living organism

By Robert Lewis

The most beautiful object I have ever seen in a photograph, in all my life, is the planet earth seen from the distance of the moon, hanging there in space, obviously alive. Although it seems at first glance to be made up of innumerable separate species of living things, on closer examination every one of its working parts, including us, is independently connected to all other working parts. It is, to put it another way, an organism. It came alive, I shall guess, 3.8 million years ago today, and I wish it a happy birthday and a long life ahead, for our children and their grandchildren and theirs and theirs.

Robert Lewis, quoted in Norman Myers, *The Gaia Atlas of Planet Management*, Doubleday



1.1.2 The earth viewed from space

Interactions between the spheres

A study of the different aspects of the biophysical environment, as shown in Figure 1.1.3, leads to an appreciation of how the spheres interact and the many factors involved that produce recognisable patterns and features. Understanding the interactions between the spheres is necessary when attempting to improve our coexistence with nature, which is so important to our continued occupation of this planet.

Geographers are keen observers. When confronted with problems concerning the biophysical environment, they find it valuable to assess the relative importance of the processes involved. This inevitably leads to the interaction between the spheres.

The human element is only one part of the biosphere, but it is clearly apparent that the impact of humans on the biophysical environment must be recognised. Our studies will extend to the loss of flora and fauna on a global scale. The magnitude of this impact is increasing in proportion to technological development and population size.

Interactions on a local scale

Figure 1.1.4 illustrates the place of the tree within the biosphere and its interdependence with the other spheres. The imminent death of the tree in the image can be attributed to the loss of soil from around its root area. Soil contains the nutrients that are basic to the tree's survival. Further investigation at this site reveals that soil loss is due to the overexploitation of the land.

Ongoing decline in the health of trees at the site will result in associated changes in all the spheres, including the following:

- lithosphere—lower organic content within the soil; exposed soil that is subject to removal by wind and water erosion
- hydrosphere—reduced infiltration of water into the soil; increased surface run-off
- atmosphere—less water vapour gained from transpiration; altered microclimate, including less shade, higher temperatures and higher rates of evaporation
- biosphere—loss of habitat for native animals.

Problems such as those at the site do not occur in isolation. Change over time can have far-reaching consequences on many aspects of the biophysical environment.

1.1.3 The varied landscapes of the earth: **A** the Italian Alps, **B** Moroccan Desert, **C** Soan Island in the Caribbean, **D** Antarctica, **E** the Okavango Delta, **F** Yellowstone National Park

1.1.4 The tree in the foreground will soon die because of the soil erosion around its roots.

Land degradation arises because some humans perceive that the resources of the biophysical environment can be readily exploited. They give little consideration to the environmental impact of such activities. The original inhabitants of Australia perceived their environment very differently. They managed the land carefully for tens of thousands of years in ways that meant it could continue to sustain life for them. Indigenous Australians would have appreciated the richness of life on offer in the area.

The dying tree is symbolic of how modern Australians have misused the resources available to them. We are now confronted with the task of trying, in some human-modified environments, to recreate nature, because what we have created in its place is unsustainable.

Human impacts, global dimensions

> In the relentless human colonisation of every corner of this planet, from the Arctic to the Antarctic, we are witnessing the end, indeed the death, of natural environments. The water we drink, the air we breathe, the food we eat, are all modified by human activity. Our activities, and the seemingly inevitable degradations of the earth, have meant, in effect, the death of the natural world. We are seeing a trans-formation from a naturally 'managed' world to a managed 'natural' world.
>
> B.W. Boer, 'Living sustainably', The Architecture Show

The earth should no longer be seen in terms of isolated environments. Each environment is part of an interacting global environment, on which humans are having an increasing impact.

Human impacts on the biophysical environment have not only occurred relatively recently; for tens of thousands of years groups of indigenous people behaved in ways that often transformed ecosystems and led to the extinction of species. Such impacts were usually followed by long periods of environmental and ecological stability. During these times the elements of the biophysical environment adjusted to the human impacts. Many societies ultimately managed to live in harmony with nature. They utilised the land, marine environments and plants and animals in ways that did not greatly disturb the fragile ecological balance.

More recently, the Industrial Revolution and related technological advances have greatly intensified human impacts on the environment. Contemporary industrial societies have exploited the biophysical environment with little regard for its ecological limits. They have done so motivated by the pursuit of material wealth, consumption and economic development.

Humans have the ability to overcome the problems caused by the exploitation of the environment. We have the capacity to better manage and protect the global ecosystem and bring about a more prosperous future for all. This can be achieved not as individual countries working on their own but together, in a global partnership for sustainable development.

1.1.5 Despite their bad reputation for living off carcasses, vultures are a very hygienic species. Their head and neck are featherless to prevent any bacteria from the carrion they eat ruining their feathers. The sun then sterilises the exposed skin.

Vultures: ecosystem guardians

Vultures are scavengers. They swarm over dying animal carcasses (see Figure 1.1.5) and are a vital part of an ecosystem. Vultures are intelligent birds with a keen sense of smell that enables them to locate food. The acid in their stomach is extremely corrosive and this enables them to feed on carcasses infected with diseases such as anthrax, cholera, botulinum toxin and rabies that would be deadly to other animals.

SPOTLIGHT

A strong-beaked bird named after Barack Obama

The World Wide Fund for Nature's Living Amazon Initiative has discovered nearly 381 new species in the Amazon. The new species include: a fire-tailed titi monkey, a pink river dolphin and the little puffbird seen in Figure 1.1.6.

The puffbird or the western striolated-puffbird (*Nystalus obamai*) has been named in tribute of the former US President Barack Obama. The bird has a strong beak and well-defined eyes. Its habitat includes the upland forests and the protected areas in Peru, Brazil and Ecuador. When hunting for food it can sit patiently for over an hour before launching a sudden strike to catch its prey.

1.1.6 The western striolated-puffbird, *Nystalus obamai*, was discovered in the Amazon in 2017.

Vultures have an important role in disposing of rotting carcasses that can spread diseases, which is not often recognised. As a result of intentional and unintentional human activity, vultures are being pushed to extinction around the world. The use of the painkiller Diclofenac in India and Nepal by humans and in the livestock industry has caused thousands of vulture deaths. Meanwhile in Namibia and Kenya, farmers use Carbofuran, an extremely toxic pesticide, to target lions with the aim of protecting people and livestock. The pesticide causes animals to die painfully, and animals that ingest the pesticide then pass it on to the vultures.

Sustainable development

Sustainable development is achieved by enabling people's economic and social wellbeing (their quality of life) while also maintaining and protecting the quality of the biophysical environment.

The principles that guide sustainable development include a recognition that:

- improvements in healthcare, education and social wellbeing are necessary to reduce birth rates in developing countries and stabilise world population
- the earth's renewable resources should only be used in a way that does not reduce their usefulness for future generations
- decisions made today should not damage the prospects for maintaining or improving future living standards
- people should be involved in decisions that affect their lives
- priority should be given to the development of new technologies that are cleaner, more energy-efficient and use fewer natural resources
- steps should be taken to prevent further degradation of the land and biophysical resources
- the benefits of economic growth should be more evenly distributed
- sustainable development and good environmental management go hand in hand.

Activities

Understanding the text

1 Explain how the role of geographers differs from that of scientists.

2 Identify the four components of the biophysical environment. Give a brief description of each.

3 Explain where most life on earth occurs.

4 State two factors that have increased the magnitude of human impact on the biophysical environment.

5 Outline, in brief, the nature of the relationship that many indigenous people have with the biophysical environment.

6 Explain what has motivated contemporary industrial societies to exploit the biophysical environment.

7 Define the term sustainable development. What are its guiding principles?

Working geographically

8 Divide into four groups. Each group is to select one of the four components of the biophysical environment and then brainstorm the following:

- **a** the ways in which the selected component affects the activities of people
- **b** the ways in which the activities of people have affected the selected component.

Record the main points raised in your group's discussion on a large sheet of paper. Share your group's findings with the rest of the class.

9 Investigate the discovery of a new species. Prepare a media release detailing the attributes of the new species, its habitat, threats to its survival or actions undertaken to protect it.

Glossary

atmosphere the blanket of air surrounding earth

biosphere the living part of the planet that consists of a thin layer extending from just above the earth's surface to just below it; the combined ecosystems of the earth

hydrosphere the part of the earth that is composed of water, including clouds, oceans, seas, ice caps, glaciers, lakes, rivers, underground water supplies and atmospheric water vapour

lithosphere the upper zone of the earth's mantle and its inorganic mixture of rocks and mineral matter (including soil) in the earth's crust

sustainable development development that meets the needs and aspirations of the present generation without compromising the capacity of future generations to satisfy their needs and aspirations

CHAPTER

2 The atmosphere

The atmosphere is the gaseous layer that surrounds earth. It constitutes the transition between the planet's surface and the vacuum of space. The atmosphere consists of a mixture of gases: principally nitrogen, oxygen, carbon dioxide and water vapour. It extends some 500 kilometres above the surface of the earth. The atmosphere's lower level is called the troposphere. It houses the climate system that maintains the conditions required to sustain life on the planet's surface. The next atmospheric level, the stratosphere, exists 12 to 48 kilometres above earth. It contains the ozone layer that protects life on the planet by filtering harmful ultraviolet radiation emitted by the sun.

Since the Industrial Revolution, humans have been altering the composition of the atmosphere by burning fossil fuels. Concern has been growing about rising concentrations of carbon dioxide, methane, nitrous oxide and chlorofluorocarbons in the atmosphere because these greenhouse gases trap the heat energy emitted from the earth's surface which increases global temperatures. In addition, chlorofluorocarbons deplete the earth's protective ozone shield.

By developing our knowledge and understanding of atmospheric processes we are better placed to engage with the issue of global climate change.

> **Water and air, two essential fluids on which all life depends, have become global garbage cans.**
>
> **Jacques Cousteau, conservationist, scientist and film maker**

2.0.1 Comprising a thin layer of gases, the atmosphere envelops earth in a protective layer.

UNIT 2.1

Composition and structure of the atmosphere

When the earth was formed around 5 billion years ago, it did not have an atmosphere. Massive volcanic eruptions released gases and as the gases cooled the atmosphere developed. The composition of the atmosphere at that time was thought to have been 80 per cent water vapour, 12 per cent carbon dioxide, 7 per cent sulfur dioxide and 1 per cent nitrogen and other trace gases. Missing was the oxygen necessary for life to flourish. The intensity of incoming ultraviolet (UV) radiation also acted to prevent the development of life forms. Eventually, however, the levels of UV radiation began to decline. This triggered the types of chemical reactions that are believed to have led to the evolution of life on earth.

Composition of the atmosphere

Oxygen was introduced into the atmosphere when small organisms broke down carbon dioxide (CO_2) to use the carbon. Oxygen was emitted as a waste product of this process. The increasing concentrations of oxygen within the atmosphere absorbed greater amounts of UV radiation. This led to the earth's surface becoming warm and rich enough for life forms to flourish.

Oxygen and nitrogen together now make up 90 per cent of the atmosphere's volume. The remainder comprises other gases (such as ozone and carbon dioxide) as well as pollutants and particulates. The composition of the atmosphere is shown in Figure 2.1.1.

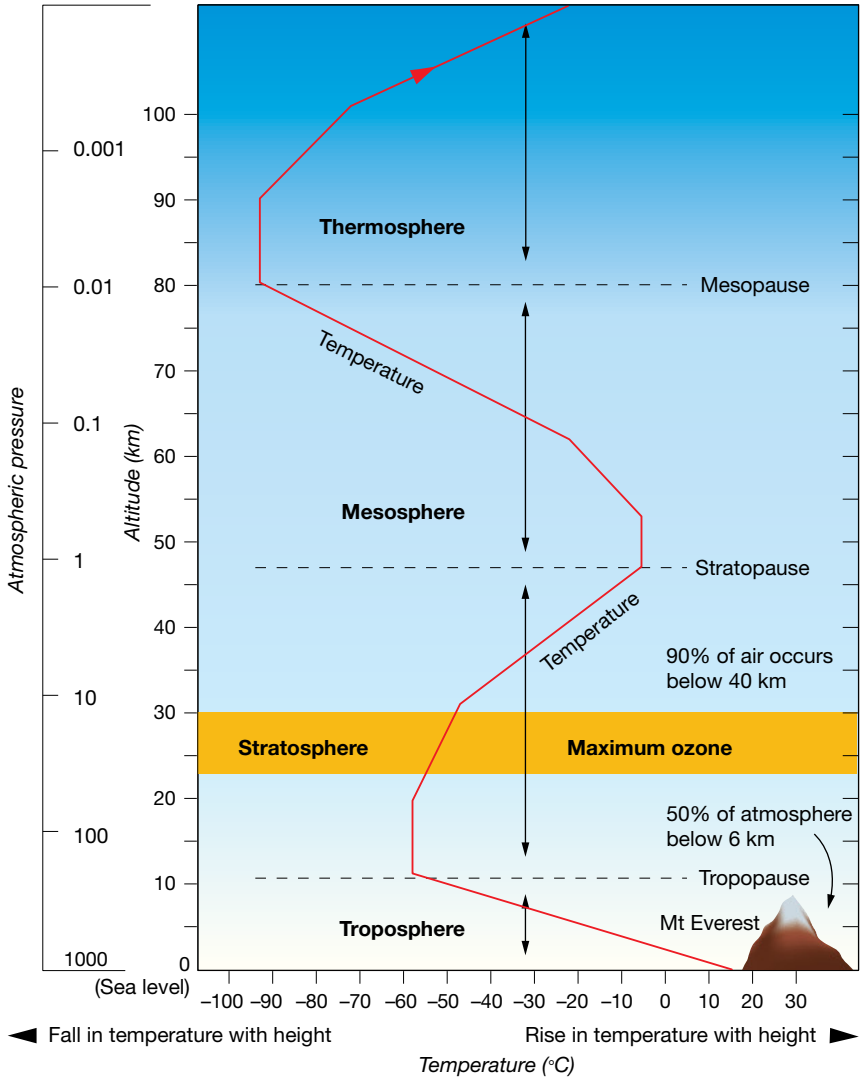
Composition of the atmosphere

Component	Composition by volume (%)	Importance
Permanent gases: ■ nitrogen ■ oxygen	 78.09 20.95	■ Nitrogen plays an important role in the growth of plants. ■ A product of photosynthesis, oxygen is reduced when the world's forests are destroyed.
Variable gases: ■ water vapour ■ carbon dioxide ■ ozone	 0.2–4.0 0.03 0.00006	■ Water vapour reflects and absorbs incoming radiation and provides the moisture for cloud formation and precipitation. ■ Carbon dioxide absorbs heat radiated from the earth's surface. ■ Ozone absorbs harmful incoming UV radiation.
Other gases: ■ argon ■ helium ■ krypton ■ neon	 0.93 traces traces traces	
Particulates: ■ dust	 traces	■ Dust absorbs/reflects incoming solar radiation and provides the condensation nuclei on which cloud formation depends; it is added to the atmosphere by volcanic eruptions and wind erosion.
Pollutants: ■ methane ■ nitrogen dioxide ■ sulfur dioxide	 traces traces traces	■ Methane contributes to global warming. ■ Sulfur dioxide mixes with atmospheric moisture to form acid rain; it is added to the atmosphere by industrial processes, power generation and car exhausts.

2.1.1 Composition of the atmosphere

The composition of the atmosphere has changed over time. Significant events throughout earth's history have altered the composition; for example, the impact of an enormous asteroid around 60 million years ago caused the extinction of the dinosaurs and altered the chemical composition of the atmosphere. More recently, human activities—such as the burning of fossil fuels—have led to a significant increase in carbon dioxide in the atmosphere (see Figure 2.1.2). This in turn is driving global climate change.

2.1.2 Human activities are leading to changes in the chemical composition of the atmosphere.



2.1.3 The layers of the atmosphere

Structure of the atmosphere

Earth's atmosphere has a layered structure. The layers shown in Figure 2.1.3 are based primarily on temperature characteristics.

The troposphere

Almost all weather and related processes take place in the troposphere, shown in Figure 2.1.4. It contains all the weather systems that produce precipitation, surface winds and the other climatic variables that impact on all living things.

The troposphere extends upwards from ground level to about 8 to 10 kilometres above the poles and 15 to 17 kilometres above the Equator. The top of the troposphere is called the tropopause. It forms the boundary between the troposphere and the stratosphere. Temperatures at the tropopause are very low; from –40°C to –80°C. The air within the troposphere is warmed by heat radiated from the earth's surface.

The stratosphere

The stratosphere extends from about 10 to 50 kilometres above the earth's surface. It is relatively calm compared with the troposphere. In the lower stratosphere, temperatures are relatively constant; they don't change much with altitude. In the upper stratosphere, temperatures increase with altitude. They reach about 0°C at the top of the stratosphere. This warming is caused by the absorption of solar radiation.

2.1.4 Almost all weather systems are found within the troposphere.

SPOTLIGHT

Weather or climate?

The terms 'weather' and 'climate' each have a different meaning. Weather refers to the day-to-day condition of the atmosphere at a particular place. It includes all the daily changes in temperature, precipitation, wind, sunshine, humidity (the amount of moisture in the air) and atmospheric pressure. Climate refers to the long-term weather pattern for a place or region. The factors that determine what type of climate a place will have include latitude, season, aspect, closeness to the sea, ocean currents and height above sea level (elevation). The climate for the Sahara Desert is dry and generally hot, however, on 7 January 2018, the weather condition was snow, as seen in Figure 2.1.5.

2.1.5 People sledding and sliding down the sand dunes in the Sahara Desert in Algeria after a freak snow storm

The mesosphere

The mesosphere extends about 80 kilometres above the earth's surface. Temperatures fall rapidly with elevation because there is no water vapour, cloud or dust to absorb incoming radiation. Temperatures are as low as –90°C and wind velocities (speeds) are as high as 3000 kilometres per hour, the strongest in the atmosphere.

The thermosphere

Within the thermosphere, the atmosphere becomes more tenuous or thinner with elevation. Temperatures rise rapidly, reaching as high as 1500°C. This is due to increasing concentrations of atomic oxygen in the atmosphere, which, like ozone, absorbs incoming UV radiation.

Activities

Understanding the text

1. Define, in your own words, the atmosphere.
2. Explain how the atmosphere was formed.
3. Outline how oxygen began to accumulate in the atmosphere.
4. Describe the troposphere. Why is it so important to humans?
5. Outline the composition of the atmosphere.
6. Discuss the factors that determine the amount of incoming solar radiation at particular locations on the earth's surface.

Working geographically

7. Using Figure 2.1.1, write a report on the role different gases play in the atmosphere.
8. Study Figure 2.1.3. Write a report outlining variations in temperature at each layer of the atmosphere.
9. Write a paragraph distinguishing between weather and climate.

UNIT 2.2

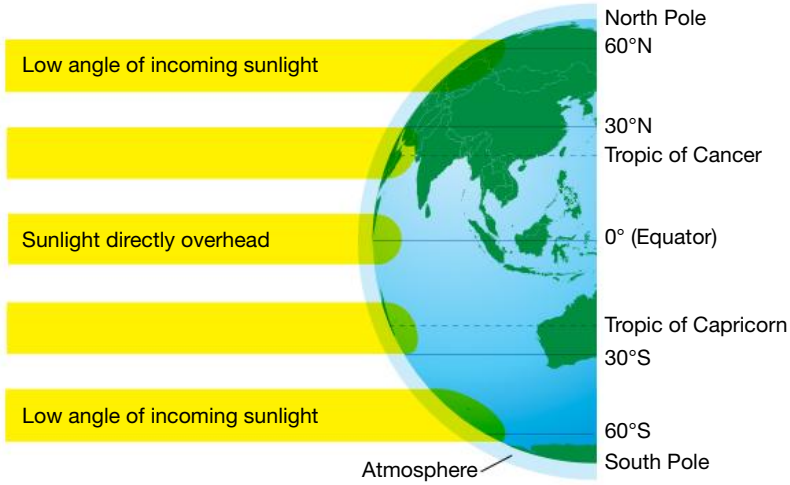
Atmospheric processes

Energy in the atmosphere

The sun is the earth's main source of energy. This energy is received as incoming short-wave solar radiation, which controls the planet's climate, weather and water cycle. Through its conversion into chemical energy via the process of photosynthesis in green plants, it supports all life on earth.

The amount of incoming solar radiation received (insolation) at a particular location on the earth's surface is determined by the following:

- **Distance from the sun:** The elliptical orbit of the earth around the sun can result in 6 per cent variation in the amount of insolation received by the earth at different places and times.
- **Latitude:** As seen in Figure 2.2.1, incoming solar radiation has twice the area to heat at 60° north and 60° south as it does at the Equator. Therefore, average temperatures are lower at higher latitudes.
- **Length of day and night:** Because the earth's axis is tilted at an angle of 23.5°, there are seasonal variations in the length of day and night. The shorter the day the less opportunity there is for the absorption of incoming solar radiation.

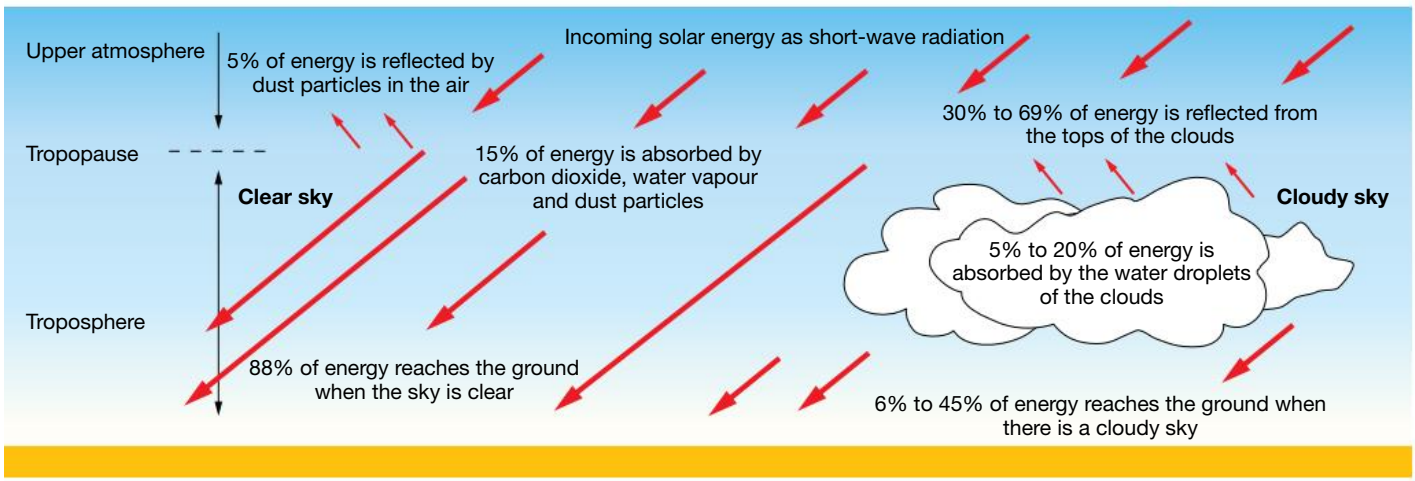


2.2.1 Latitude is a key factor in determining how much heat reaches the earth's surface.

The natural greenhouse effect

Not all incoming solar radiation reaches the ground; most is absorbed, reflected and scattered as it passes through the atmosphere. Some is absorbed by ozone, water vapour, carbon dioxide and particles of dust and ice present in the atmosphere. Some is also reflected back into space from clouds and, to a lesser extent, from the earth's surface, as shown in Figure 2.2.2.

The ratio between incoming radiation and the amount reflected back into space, expressed as a percentage, is known as the albedo. The albedo varies from less than 10 per cent over oceans and dark soil to 25 per cent over grasslands, 40 per cent over desert sands and 85 per cent over snow. The albedo increases where human land use activities have resulted in the removal of vegetation by land clearance and overgrazing. This may reduce the likelihood of cloud formation and precipitation and increase the risk of desertification.



2.2.2 The absorption and scattering of insolation, which creates a natural greenhouse effect

Scattering of the sun's energy occurs when incoming solar radiation is diverted by molecules of gas in the atmosphere. It takes place in all directions, with some radiation reaching the earth's surface as diffuse radiation.

Only 24 per cent of incoming solar radiation reaches the earth's surface directly; an additional 21 per cent reaches the surface as diffuse radiation. Incoming radiation is transformed into heat energy when it reaches the earth's surface. As it heats the ground, it radiates long-wave or infra-red energy back into the atmosphere. In the atmosphere, 94 per cent of this energy is absorbed by water vapour and carbon dioxide, creating a natural greenhouse effect.

The global heat budget

Generally speaking, the temperature of the earth remains relatively constant from year to year. This means that there is a balance between incoming insolation and outgoing terrestrial radiation. Features of this global heat budget include:

- a net gain in radiation everywhere on the earth's surface except at the poles, which have a high surface albedo
- a net loss in radiation throughout the atmosphere.

After taking incoming and outgoing radiation into account, there remains a net surplus of heat between 35° south and 40° north of the equator and a net deficit to the poleward side of these latitudes. This difference according to latitude is due to the larger size of the land masses in the Northern Hemisphere.

Overall, there is a positive heat balance within the tropics and a negative heat balance in the polar regions and at high altitudes. One outcome of this imbalance is the transfer of heat from the tropics towards the poles and to higher altitudes. If this transfer did not take place, the tropics would 'overheat'.

Two types of transfer take place:

- **Horizontal transfers:** Wind and ocean currents transfer heat from the tropics towards the poles. Winds account for 80 per cent of the heat transfer, and ocean currents for the remaining 20 per cent.
- **Vertical transfers:** Heat is transferred to the atmosphere from the earth's surface by terrestrial radiation, conduction, convection currents and the transfer of latent heat via condensation. If this transfer did not occur, the earth's surface would get hotter and the atmosphere colder.

Lapse rates

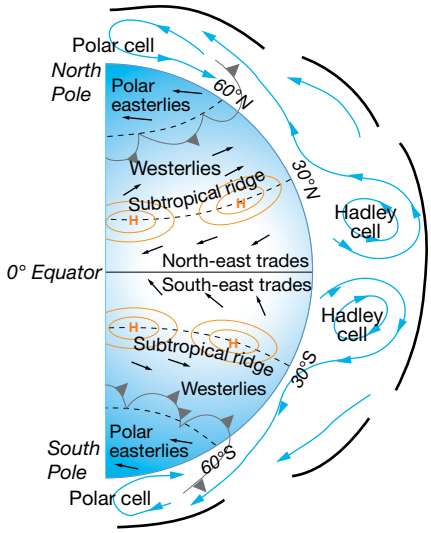
As altitude increases throughout the troposphere there is a decline in temperature. This temperature decline is called the lapse rate. On average, air temperature decreases by approximately 6.5°C for every 1000 metres of elevation. This concept is best demonstrated by way of example. At 8848 metres above sea level, the peak of Mt Everest would be 57.5°C colder than the average sea level temperature, if the average lapse rate were applied.

The actual lapse rate varies from place to place depending on air humidity. The rate that applies at any given place and time is known as the environmental lapse rate.

Movement of air

The air within the troposphere is never at rest. The sun heats the equatorial regions more quickly than the polar regions, causing movements of air within the troposphere at a global scale. These movements produce the distinctive climatic features experienced on the surface of the earth. The global pattern of atmospheric circulation is shown in Figure 2.2.3.

At the Equator, heated air rises. When it reaches the tropopause it moves towards the poles. At 30° north and south of the Equator, a body of descending air creates the subtropical high pressure belt, with its clear skies and dry, stable conditions. On the surface of the earth, some of the descending air moves back towards the Equator. The cells created by this pattern of circulation are known as Hadley cells.



2.2.3 Movement of wind around the earth

On the polar side of the Hadley cells the remaining air moves towards the poles. When this relatively warm air meets the cold polar air at the polar front, it pushes under and uplifts the warmer air. This forms an area of low pressure known as a polar cell. The polar front, therefore, marks the boundary between the warm tropical air masses and the cold polar air masses. The frontal zone is quite distinct and moves as a non-continuous band right around the planet.

In the upper troposphere, very strong winds reach speeds in excess of 200 kilometres per hour. (Military and commercial aircraft, such as that seen in Figure 2.2.4, take advantage of these winds; eastward flights are much faster than westward flights.) Within these wind systems are narrow bands of extremely fast-moving air known as jet streams. Jet streams assist in the rapid transfer of energy and can exceed speeds of 230 kilometres per hour.

2.2.4 Commercial aircraft use the strong westerly winds in the troposphere to help propel them faster in easterly flights.

Surface winds

Surface winds are caused by the movement of air from areas of high pressure to areas of low pressure. These winds are highly variable, both in terms of speed and direction, but have an overall global pattern.

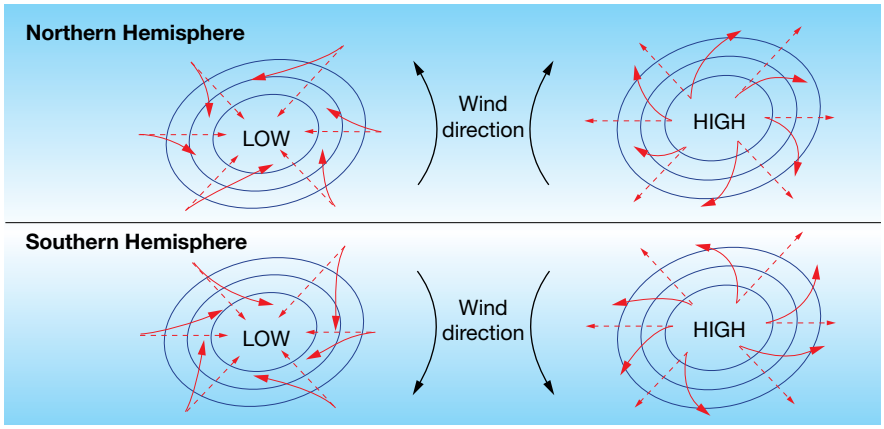
The Hadley cells, shown in Figure 2.2.3, produce descending air in the mid-latitudes on either side of the Equator. This air moves back towards the Equator as a surface wind. Air moving towards the Equator is deflected to the left in the Southern Hemisphere and to the right in the Northern Hemisphere by the Coriolis Effect. The result of these deflections is to give the winds a direction from south-east to north-west in the Southern Hemisphere, and from north-east to south-west in the Northern Hemisphere. These surface winds are referred to as the south-east trade winds and the north-east trade winds, respectively.

Air moving away from the Equator towards the poles is also deflected to the left in the Southern Hemisphere and to the right in the Northern Hemisphere. On the polar side of the Hadley cells, descending air moves towards the poles and is deflected. This results in a band of strong winds in each hemisphere. In the Southern Hemisphere such winds are known as the 'Roaring Forties' because of their persistence within the 40° to 49° band of latitude.

In the equatorial region, air rises and there are no strong horizontal surface winds. This results in a phenomenon known as the 'equatorial doldrums'. Another region of relatively calm weather is that below the descending air of the polar ends of the Hadley cells. Early mariners applied the term 'horse latitudes' to these zones. They were so named because their ships were often becalmed (rendered stationary due to lack of wind), so their animals died of starvation and had to be thrown overboard.

Pressure systems

Atmospheric pressure systems are areas of the atmosphere with relatively high or low barometric (air) pressure. They are often referred to simply as 'highs' and 'lows'. Large areas of permanent high and low pressure exist in bands around the earth, and these influence world climate patterns and ocean currents. See Figure 2.2.5.



2.2.5 Patterns of air movement in pressure cells

High pressure systems

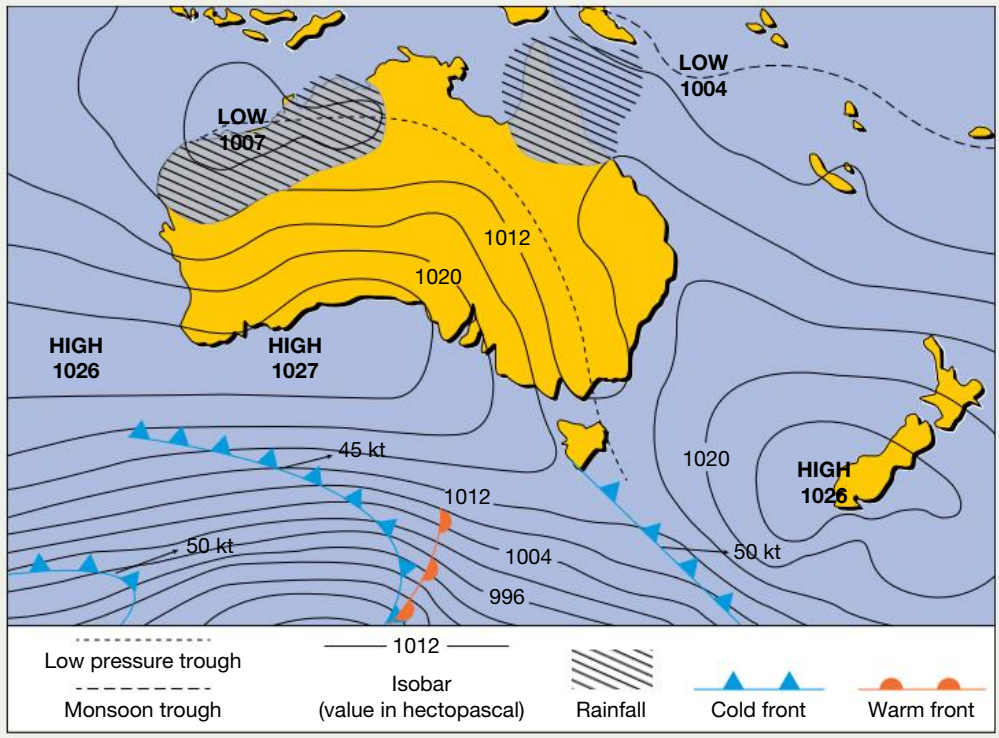
High pressure systems are sometimes referred to as anticyclones. An anticyclone is a large body of sinking air that produces an area of high pressure on the earth's surface. The source of the air is the upper atmosphere where there is very little moisture. Because descending air warms, weather conditions remain dry. When the pressure gradients remain gentle, wind velocities are low. (Pressure gradients are shown by the isobars on a synoptic chart.)

The weather in regions dominated by high pressure systems is characterised by stable atmospheric conditions, clear skies and gentle winds.

SKILL BUILDER

Synoptic charts

A synoptic chart (or weather map, shown in Figure 2.2.6) is a record of the atmospheric conditions experienced at a particular time in a particular place. They provide information relating to air pressure; the location of air masses and frontal activity (see below); the extent of cloud cover, wind speed and direction; and the distribution of rainfall. Using this information, it is possible to make predictions relating to temperature, humidity, ocean conditions and the likely sequence of weather in coming days.



2.2.6 Synoptic chart showing typical Australian summer weather patterns

Features of a synoptic chart

Synoptic charts display a number of features:

- **Isobars:** These are lines joining places of equal barometric pressure. Barometric pressure is measured in units called hectopascals (hPa). Finding the atmospheric (or barometric) pressure of a particular location requires you to refer to the value of adjacent isobars. The process is the same as that for estimating height above sea level using contour lines.
- **Pressure systems:** These are defined by the patterns formed by the isobars. High pressure systems are indicated where barometric pressure increases towards the centre of a set of enclosed isobars. Low pressure systems are indicated where the barometric pressure decreases towards the centre.
- **Cold fronts**: These are formed when a mass of cold air moves in and displaces warmer air. The resulting uplift of warm moist air means that the passing of a cold front is often associated with rainfall.
- **Warm fronts:** These occur when a mass of warm air moves in and displaces cold air.
- **Wind speed:** The closer the isobars, the greater the wind speed.
- **Wind direction:** Winds are named after the direction from which they come. For example, a wind coming from the south is called a southerly. Wind direction is determined largely by the location of pressure systems. In the Southern Hemisphere, winds blow in an anticlockwise direction from areas of high pressure. The winds associated with low pressure systems blow in a clockwise direction towards the centre.
- **Rainfall:** Areas in which rainfall has occurred in the previous 24 hours are highlighted by shading.

Low pressure systems

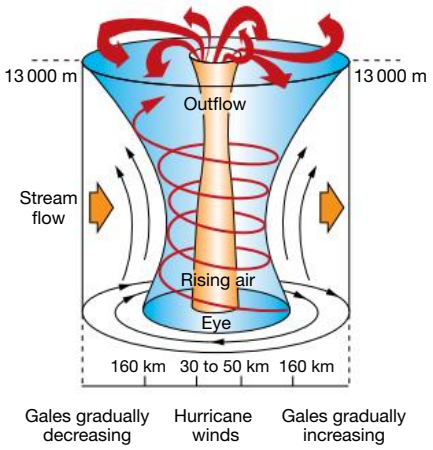
Low pressure systems are often referred to as cyclones. A cyclone is a large body of rising air that produces an area of relatively low atmospheric pressure. As the source of the air is close to the earth's surface, there may be considerable amounts of moisture. As moist air rises it cools rapidly, condensation takes place and the potential for precipitation increases. Wind velocities are relatively high because the pressure gradients are relatively steep. (This is indicated on synoptic charts by isobars that are close together.)

The weather in areas dominated by low pressure systems is characterised by unstable atmospheric conditions, cloudy skies, rain and strong winds (see Figure 2.2.7).

Tropical cyclones are intense low pressure systems. They develop over warm tropical oceans and their behaviour is often erratic and unpredictable. Once they cross a coastline they turn towards the pole, their intensity is reduced and they develop into what is known as a rain depression.

For tropical cyclones to form and move, there must be a continuous supply of heat and moisture to maintain the rising thermal currents, as shown in Figure 2.2.8. There must also be a large supply of moisture to provide the latent heat (released by the process of condensation) that drives the cyclone and facilitates the associated heavy rainfall. At the centre of the cyclone is the 'eye'. This is an area that is 30 to 50 kilometres in diameter and is characterised by subsiding air, light winds, clear skies and relatively high temperatures. The descending air warms quickly, increasing the cyclone's intensity.

2.2.7 Unstable weather is associated with low pressure systems.



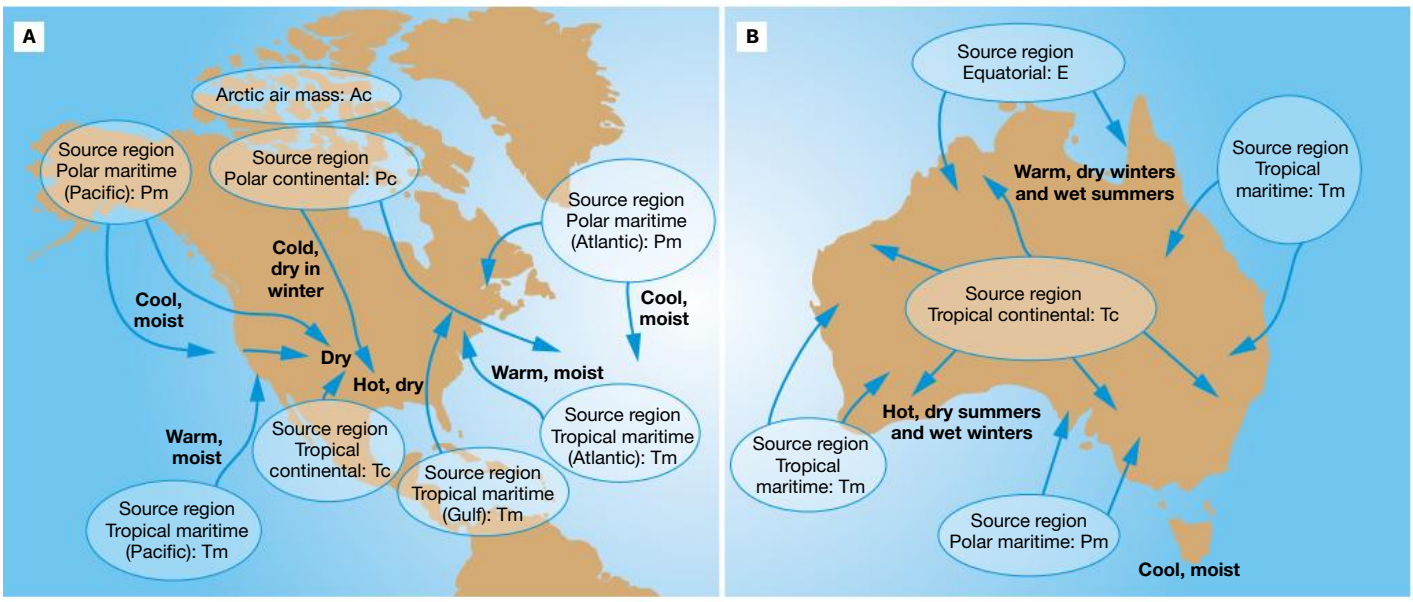
2.2.8 Formation of a cyclone

Air masses

Air is affected by the nature of the earth's surface over which it passes. A body of air that has been affected by a large area of the earth's surface, such as an ocean or a continent, is known as an air mass.

Air masses over large continental areas and oceans are affected by temperature and humidity. Air masses above oceans contain more moisture than those that form over continental areas. High pressure areas where air sinks towards the earth's surface near the tropics form warm air masses. High pressure areas near the poles form cold air masses.

Air masses that form over oceans are usually called maritime air masses and those formed over land masses are called continental air masses. Air masses that form over the Arctic and Antarctic ice fields are very cold and dry. They are called the Arctic air mass (Ac) and the Antarctic air mass (Aac). The air masses that influence the climates of North America and Australia are shown in Figure 2.2.9.



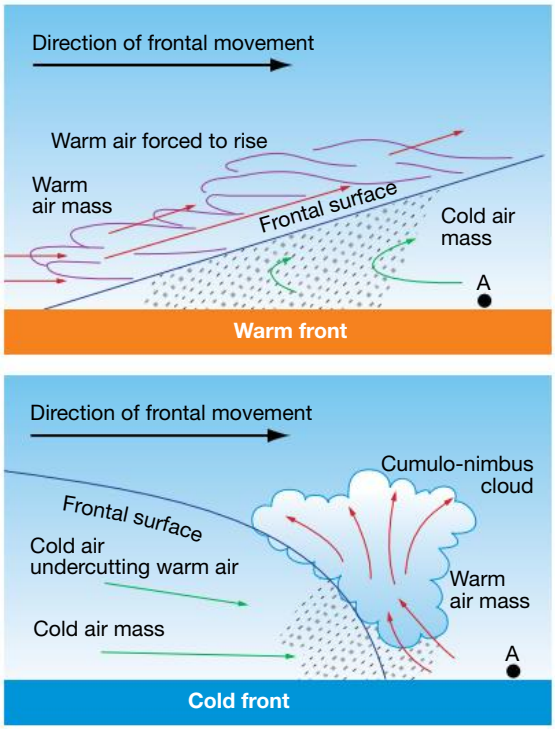
2.2.9 Air masses that influence North America (**A**) and Australia (**B**)

2.2.10 A storm front

The areas where air masses form are known as source regions. There are five main source regions. They are tropical maritime (Tm), polar maritime (Pm), tropical continental (Tc), polar continental (Pc) and equatorial (E).

Air is drawn from these five source regions by the pattern of air movement associated with high and low pressure systems. This plays a major role in determining the weather and longer-term climatic conditions experienced at a particular location.

When two air masses from different source regions meet, the air from each does not mix straight away. This is because they have different temperatures and densities. The point where two air masses meet is known as a front, as shown in Figure 2.2.10. A warm front develops when warmer or more moist air is forced to rise over colder or drier air. A cold front develops when advancing cold air undercuts a body of warm air. In both cases the rising air is cooled and condensation results in the formation of clouds. Figure 2.2.11 demonstrates how warm and cold fronts form. Precipitation often accompanies the passing of a front.



2.2.11 Warm and cold fronts

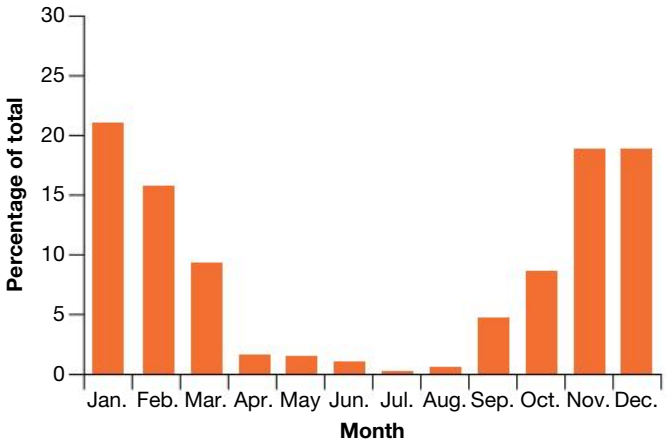
Storms

Each year thousands of thunderstorms occur in New South Wales. Of these, about 100 are classified as 'severe' or likely to cause damage. Severe thunderstorms are those that produce any of the following:

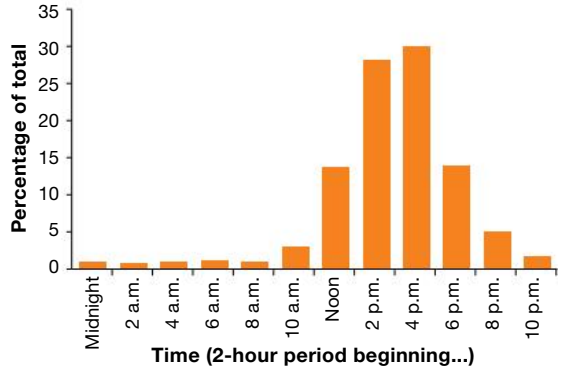
- hailstones with a diameter equal to or greater than 2 centimetres
- wind gusts of 90 kilometres per hour or more
- flash flooding.

While severe thunderstorms can occur at any time during the year, they are more likely to occur between the months of September and March. (See Figure 2.2.12.) The incidence of severe storms during this period is primarily due to the increase in energy provided by the sun during the warmer spring and summer months, together with weather patterns that are favourable for storm development.

In addition to these seasonal variations there is a marked pattern of storm activity on a daily basis. As the day heats up and warm, moist air rises, it becomes unstable in the late afternoon and storm activity peaks between 2 p.m. and 6 p.m, as shown in Figure 2.2.13.



2.2.12 Monthly distribution of storms in Sydney



2.2.13 Time distribution of storms in Sydney

Conditions under which storms develop

The three conditions required for the development of thunderstorms are a source of moist air, an unstable atmosphere and a mechanism to initiate their development. Moist air is important because it condenses to form cloud. As condensation takes place, heat energy is released. This makes the rising air more buoyant and promotes further cloud growth. Unstable atmospheric conditions allow developing clouds to rise to great heights in the atmosphere. The mechanisms that initiate thunderstorms are fronts, troughs and regions of low pressure. Landform features, such as mountain ranges, may also promote storm development.

The severity of a storm depends largely on the rate at which air rises. Severe storms occur when the atmosphere is very unstable and the upward movement of air is very rapid. Sometimes several storm cells, at different stages of their life cycle, are found within the same storm system. These 'multicellular' storms produce hail, strong winds and the possibility of flash flooding. In some cases, severe storms develop into long-lived thunderstorms called supercells. A supercell is a rare but unusually severe type of thunderstorm whose structure, behaviour, intensity and longevity are quite different from those of ordinary thunderstorms. These storms are associated with very large hail, extraordinary wind gusts and heavy rainfall.

Lightning and thunder

Lightning occurs when electrical energy is discharged during thunderstorms (see Figure 2.2.14). Sometimes the lightning flash is between cloud and the earth. This is called forked lightning. At other times it occurs within the cloud and is known as sheet lightning. Thunder is the sound caused by the electrical discharge. Usually we hear the thunder after we see the flash of light. This is because sound travels slower than light.

Within thunderstorms there is a fast upward movement of air and moisture. This separates the positively and negatively charged particles. The top of the storm clouds usually has a positive charge, while the middle and bottom layers may have a negative charge. The ground below usually has a positive charge. When the difference is great enough, an enormous electrical spark jumps between the two charges; this is the flash of lightning. Some lightning flashes contain up to 30 million volts.

2.2.14 Lightning strike over Sydney

Hailstorms

One of the most damaging types of storms is a hailstorm. Hail is nothing more than frozen water that forms into chunks of ice due to very cold conditions in the upper atmosphere. Most hail melts before it reaches the ground. However, in hailstorms the hail reaches the ground while still in large chunks.

Hailstorms are common in Sydney and from time to time these storms create tremendous damage. For example on Anzac Day in 2015 a series of thunderstorms across western Sydney caused huge damage. More than $420 million was paid out by insurance companies to repair damage. A whole warehouse building was destroyed when the weight of the hail on the flat roof caused it to cave in, as shown in Figure 2.2.15. Another large storm in early 2017 caused massive damage, particularly to parked cars, leading to further multi-million dollar claims.

2.2.15 This factory lost its roof and was badly damaged in Emu Plains, Sydney, during severe storms on 15 January 2015.

SPOTLIGHT

Hurricane Irma

Hurricane Irma formed in the Caribbean in September 2017. It quickly became a Category 5 hurricane, the most powerful, and it is now considered to be the most powerful Atlantic hurricane ever. The storm raged across the Caribbean wreaking havoc across the small island communities (see Figure 2.2.16) before smashing into the west coast of Florida as a Category 4 hurricane.

In Florida, millions were forced to evacuate their homes ahead of the storm and a week after the hurricane more than 12 million people were left without power. Tragically, numerous elderly people died in the extreme heat following the storm after they were unable to use their air conditioners.

In addition to extreme winds created by the hurricane a massive storm surge forced the sea inland, creating flooding across low lying coastal areas, seen in Figure 2.2.17.

Climate change contributed to the impact of Hurricane Irma in three ways:

1. Sea levels are rising, especially in Florida. During Hurricane Irma storm surges were 6 metres above normal tide levels
2. Rising temperatures means that the atmosphere holds more moisture and means there is more rainfall during hurricanes
3. Slowing down of weather patterns, meaning storms move more slowly and cause more damage.

2.2.16 Debris from destroyed homes litter the historic district on the Dutch Island of St Maarten following a direct hit by Hurricane Irma, a Category 5 storm that lashed the Caribbean, September 2017.

2.2.17 Hurricane Irma caused a major storm surge that impacted on coastal communities, such as Fort Lauderdale.

Activities

Understanding the text

1. Describe the concept of solar insolation.
2. Explain the key factors in determining the rate of solar insolation.
3. Define the term albedo.
4. Outline the operation of the global heat budget.
5. Describe the processes that lead to the development of a Hadley cell.
6. Describe the relationship between atmospheric pressure and the movement of air across the earth's surface.
7. Describe both high and low pressure systems and the weather conditions normally associated with them.
8. Define the term air mass. Name two types of air masses.
9. Explain the difference between a warm front and a cold front.
10. Distinguish between a 'severe' thunderstorm and other storms.

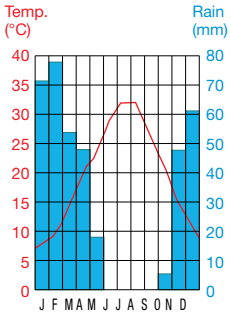
Working geographically

11. Write an explanation outlining why the temperature of the atmosphere declines with increasing altitude.
12. Study Figure 2.2.5. Write a paragraph describing the pattern of air movement associated with high and low air pressure systems in the Northern and Southern Hemispheres.
13. Using the information in Figure 2.2.9, write an explanation outlining how air masses can affect weather conditions in different parts of North America and Australia.
14. Collect a series of Australian synoptic charts covering at least five consecutive days. Trace the passage of high and low pressure systems across the continent. Note the weather conditions associated with the passage of these pressure systems and write two or three paragraphs explaining what has occurred.
15. Write a paragraph describing the conditions that lead to the development of thunderstorms.
16. Using the information in the text and your own research, prepare a digital presentation on the impact of Hurricane Irma.

UNIT 2.3

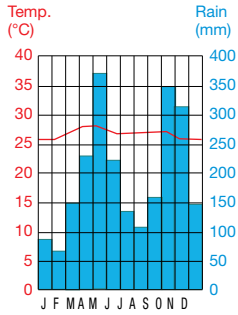
World climate patterns

Mosul, Iraq



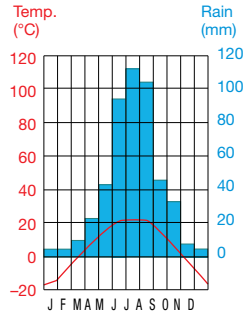
Annual average:
temperature 19.6°C
rainfall 384 mm

Colombo, Sri Lanka



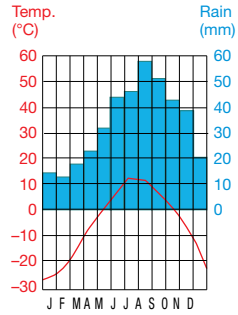
Annual average:
temperature 27°C
rainfall 2365 mm

Harbin, China

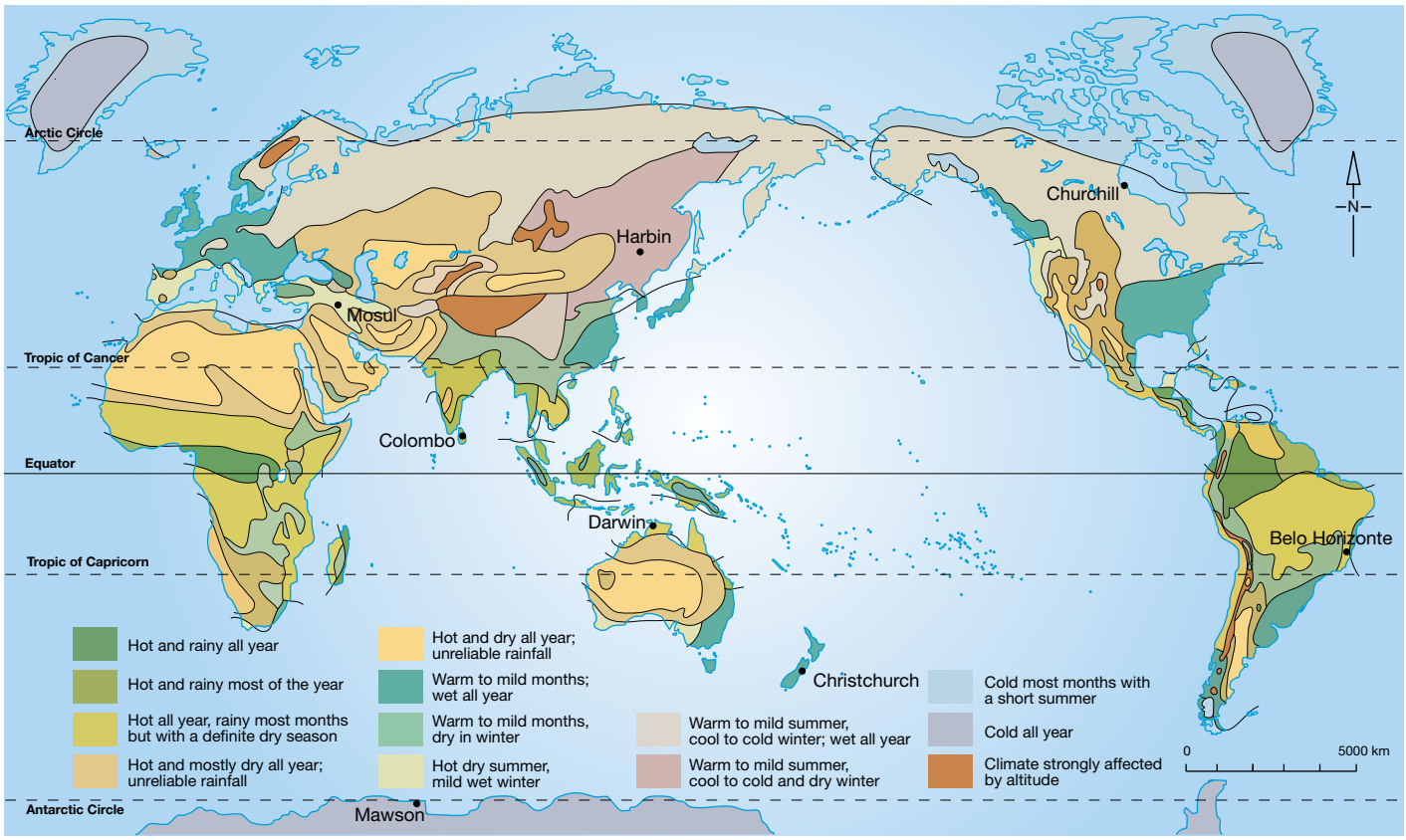


Annual average:
temperature 3°C
rainfall 488 mm

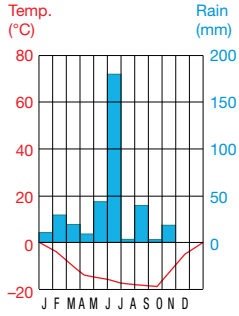
Churchill, Canada



Annual average:
temperature –7°C
rainfall 402 mm

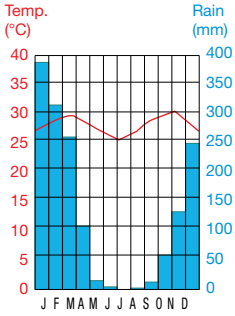


Mawson, Antarctica



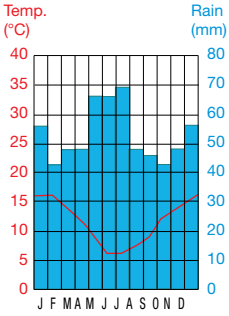
Annual average:
temperature –11°C
rainfall 362 mm

Darwin, Australia



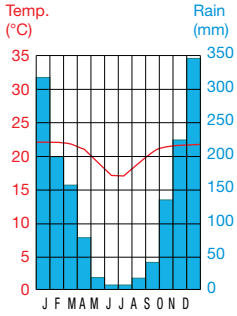
Annual average:
temperature 28°C
rainfall 1491 mm

Christchurch, New Zealand



Annual average:
temperature 11°C
rainfall 638 mm

Belo Horizonte, Brazil



Annual average:
temperature 20.6°C
rainfall 1561.5 mm

2.3.1 World climate zones

Major factors affecting the world pattern of climate

Figure 2.3.1 shows the pattern of climate across the globe. Five main factors determine this pattern. These are:

- variations in the amount of incoming solar radiation (insolation) reaching different parts of the earth's surface
- the revolution of the earth around the sun and earth's daily rotation on its axis
- the composition of the atmosphere
- the distribution of the continents and oceans
- topography.

Insolation variations

The amount of incoming solar radiation reaching the earth's surface varies with latitude, seen in Figure 2.3.2. Near the Equator the sun's rays are almost vertical and are concentrated on a small area of the earth's surface. Closer to the poles the sun's rays strike the earth's surface at an angle. This spreads the sun's rays over a larger area and results in less solar energy per unit area.

The relatively large input of heat near the Equator warms the air, which then rises because heated air has a lower density than cold air. As the warmer air rises, it moves northwards and southwards towards the poles, carrying heat away from the Equator. As it does, it cools and begins to descend. These cool masses of air then flow back towards the Equator as surface winds, to fill the void left by the rising air. This circular pattern of air movement moderates global air temperatures.

Variations in solar insolation

Latitude	Insolation percentage
0° (Equator)	100.0
10°	98.6
20°	94.5
30°	88.0
40°	79.2
50°	68.5
60°	57.0
70°	47.4
80°	43.0
90°	41.6

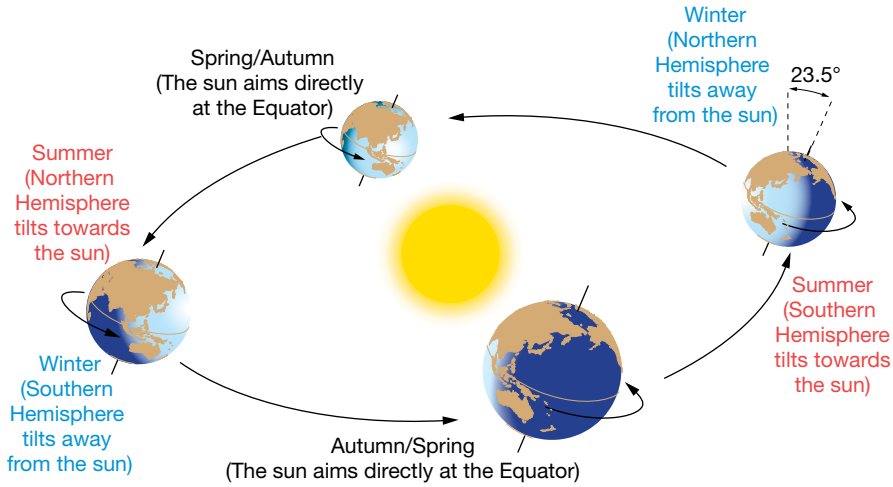
2.3.2 Variations in solar insolation resulting from latitude

The earth's revolution and rotation

Other than at the Equator, where temperatures remain fairly constant throughout the year, average temperature patterns vary with the seasons. Seasonal variations occur because of the earth's annual revolution around the sun on an axis tilted at 23.5°. When the earth's South Pole tilts towards the sun, the sun's rays strike the Southern Hemisphere more directly and intensely than they do in winter when the South Pole is tilted away from the sun. This means that the Southern Hemisphere experiences summer while winter conditions prevail in the Northern Hemisphere. This is shown in Figure 2.3.3.

The forces generated by the earth's rotation on its axis break up the general pattern of air circulation from the Equator to the poles. This creates six separate belts of moving air: three to the north of the Equator and three to the south of the Equator.

The revolution of the earth around the sun and the angle of the earth's axis also result in a variation in the length of night and day. The longer the day, the greater the amount of incoming solar radiation that can reach the earth's surface and therefore the more solar energy there is available for plant production.



2.3.3 The revolution of the earth around the sun impacts on climate.

Composition of the atmosphere

The composition of the atmosphere plays a major role in determining the earth's temperature and, therefore, its climate. In the troposphere, for example, carbon dioxide and water vapour are important in regulating temperatures. They let in the radiant energy of the sun but prevent some of it from escaping back into space. This creates what is often referred to as a 'natural greenhouse effect'.

If this natural greenhouse effect did not exist, the earth would be a cold and lifeless planet, with an average atmospheric temperature of just –18°C.

2.3.4 The Atacama Desert runs along the western coastline of South America. Cold ocean currents here create low evaporation rates and therefore very little rainfall.

Distribution of the continents and oceans

Ocean currents also influence climate, especially in coastal areas. As warm ocean currents experience relatively high rates of evaporation, the coastal areas adjacent to them are likely to experience relatively high levels of precipitation, especially where the prevailing wind blows onshore.

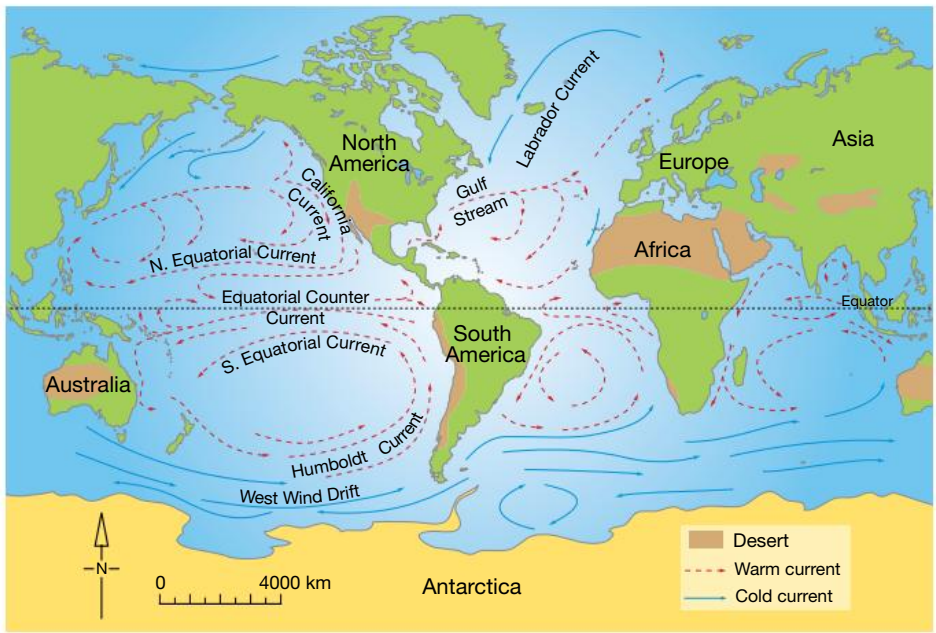
Cold ocean currents are accompanied by relatively low levels of evaporation, and the air above them tends to contain little moisture. Figure 2.3.4 shows the Atacama Desert on the western coastline of South America. The earth's largest deserts adjoin coastal areas that are influenced by cold ocean currents, as shown in Figure 2.3.5.

Topography

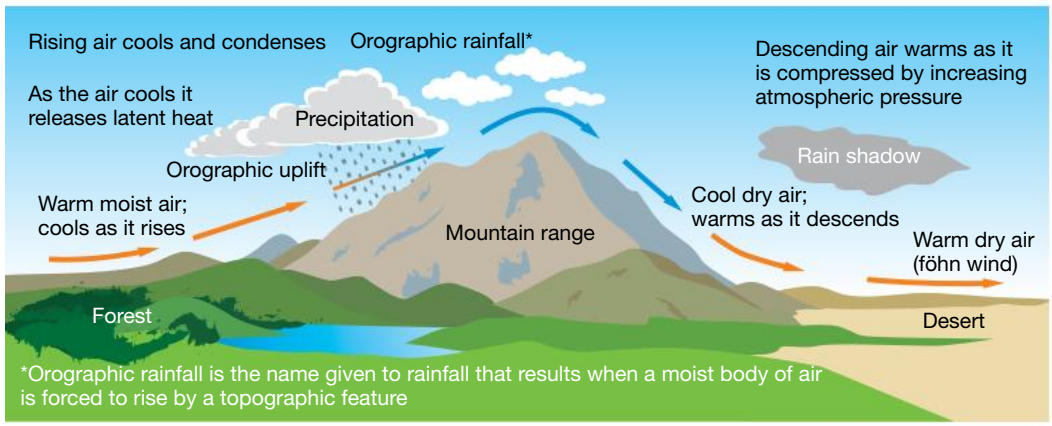
Because of their altitude, mountainous areas tend to be cooler than adjacent areas at lower altitudes. The summit of Mt Kilimanjaro, Africa's highest mountain, is typically covered with snow, even though it is located just to the south of the Equator. Human-induced climate change, however, means that the snow caps on Mt Kilimanjaro are less permanent than they once were.

Mountain ranges also interrupt the movement of prevailing winds as well as the movement of moisture-laden air. When moist air is forced to rise it cools and expands. This causes it to lose most of its moisture as either rain or snow on the mountain range's windward side (the side exposed to the wind). This process produces what is known as the rain-shadow effect or orographic rainfall as seen in Figure 2.3.6.

As the drier air flows down the leeward slope (the side sheltered from the wind) it is compressed and becomes warmer. Thus, deserts and semi-arid areas are often found on the leeward side of large mountain ranges. Products of the rain-shadow effect include the Mojave Desert, to the east of the Sierra Nevada Mountains in the United States, and the semi-arid regions adjacent to the Himalayas in Asia and the Andes in South America.



2.3.5 Ocean currents play a key role in climate.



2.3.6 Impact of topography on climate

SPOTLIGHT

The Western Ghats

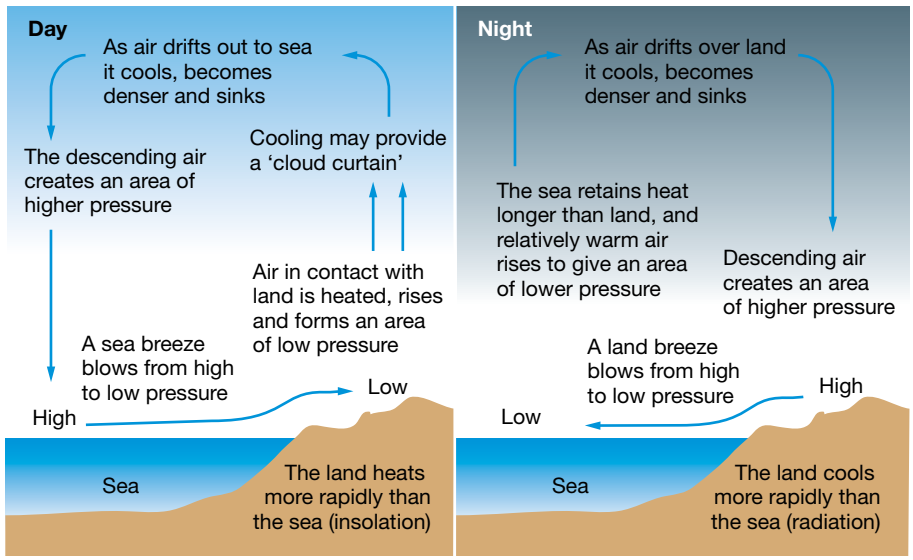
Located on the western edge of India, the Western Ghats mountain range acts as a barrier to the moisture-rich monsoons that flow across the coastline from the Indian Ocean. As the moisture-laden clouds rise over the Western Ghats, rains fall on the seaward western side. The environment on this western side is lush and highly productive, as seen in Figure 2.3.7. On the leeward or eastern side of the mountain, the vast dry Deccan Plateau stretches out. Here, rainfall is far less and the biophysical environment is in stark contrast, as seen in Figure 2.3.8.

2.3.7 Lush moisture-rich forests dominate the western side of the Western Ghats mountain range.

2.3.8 India's Deccan Plateau. This hot, dry environment lies on the leeward side of the Western Ghats mountain range.

Land and sea breezes

Land and sea breezes result from the differential heating of the sea and the adjacent land surface. The resulting differences in atmospheric pressure, although small, are significant enough to initiate a movement of air. As illustrated in Figure 2.3.9, a sea breeze builds up in the late morning and dies off in the evening. At night, the sea retains heat longer than the adjacent land surface. Therefore, the atmospheric pressure over the sea drops slightly as thermal currents create uplift. The land breeze begins soon after sunset and dies off at sunrise.

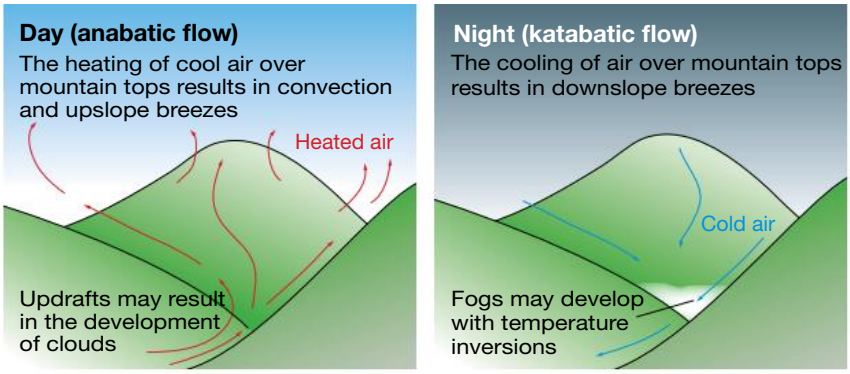


2.3.9 Formation of land and sea breezes

Anabatic and katabatic winds

When valley sides are heated by the sun, the surrounding air is heated and expands. As the air rises, it creates a zone of relatively low atmospheric pressure. By mid-afternoon a strong uphill, or anabatic, wind develops, as seen in Figure 2.3.10.

At night, the valley sides and floor lose heat through radiation. The surrounding air becomes cooler and increases in density. As it does so, it begins to flow down the valley sides as a mountain, or katabatic, wind. This process often gives rise to temperature inversion (a reversal of the normal behaviour of temperature in the troposphere, in which a layer of cool is overlain by a layer of warmer air). If the air contains enough moisture, a fog may develop in the valley.



2.3.10 Anabatic and katabatic winds

Activities

Understanding the text

1 Explain how variations in the amount of incoming solar radiation reaching the earth's surface affect climate.

2 Outline how the revolution of the earth around the sun and its daily rotation on its axis affect climate.

3 Explain the relationship between the temperature of ocean currents and the climate experienced by nearby land surfaces.

4 Outline how topography affects climate.

5 Explain the cause of land and sea breezes.

6 Describe the differences between anabatic and katabatic winds.

Working geographically

7 Study the climate graphs in Figure 2.3.1.
- a Locate each of the climatic stations on the world map and name the climate type experienced by each.
- b Name the station that has the:
  - i lowest annual rainfall
  - ii highest annual rainfall
  - iii highest average monthly rainfall recording
  - iv highest average monthly temperature
  - v lowest average monthly temperature
  - vi greatest seasonal variation in temperature
  - vii smallest seasonal variation in temperature
  - viii greatest seasonal variation in rainfall
  - ix smallest seasonal variation in rainfall.
- c List those stations that experience a climate characterised by summer rainfall and winter drought.
- d List those stations that experience high rainfall throughout the year.

8 Study the map in Figure 2.3.1.
- a Comment on the longitudinal spread of those climates that are hot and wet for most of the year.
- b Describe the distribution of hot and dry climates.
- c Describe the distribution of those places that experience hot dry summers and mild wet winters.
- d State the climate experienced by the following geographical locations:
  - i Northern Australia
  - ii Sub-Saharan Africa
  - iii Tasmania
  - iv Alaska
  - v Northern India
  - vi United Kingdom
  - vii Papua New Guinea
  - viii Northern Russia.

9 Study Figure 2.3.5. Write a report describing the pattern of the earth's ocean currents and the relationship between cold currents and the earth's deserts.

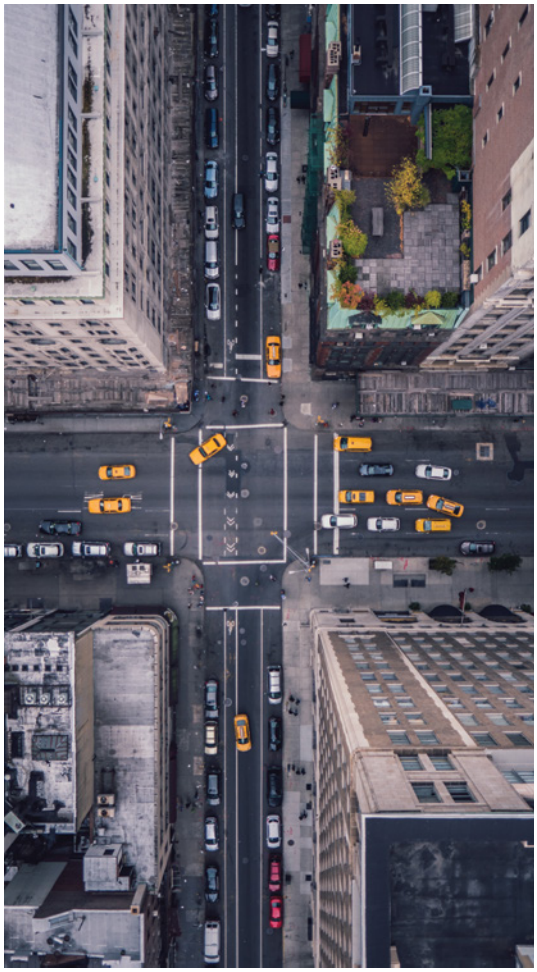
10 Study Figure 2.3.6 and explain the:
- a formation of orographic rainfall
- b existence of deserts and semi-arid environments on the leeward side of large mountain ranges.

11 Using the Western Ghats as an example, write a report on the interaction between the topography, the atmosphere and the biophysical environment.

12 Study Figure 2.3.10. Write an explanation outlining the processes associated with the formation of anabatic and katabatic winds.

UNIT 2.4

The development of microclimates



2.4.1 Canyons created by the tall buildings and narrow streets of cities like New York create wind tunnels.

Significant climatic differences often occur over relatively small areas. The study of these climatic differences is known as microclimatology. The most widely studied microclimates are those associated with large urban centres. Other microclimates occur naturally and result from differences in factors such as aspect and type of land surface.

Urban microclimates

Large urban centres experience climatic conditions that are significantly different from those of surrounding rural areas. Cities generate more dust and other particles on which droplets of moisture form. Cities also create heat, alter the pattern of radiation, change the composition and moisture content of the air, and affect the pattern of air flow.

Sunlight

Despite having higher average temperatures, large urban centres often receive less sunshine and have more cloud cover than surrounding rural areas. Atmospheric particulates may absorb and reflect as much as 50 per cent of insolation, especially in winter when the sun is lower in the sky.

Humidity

The relative humidity of urban air is often lower than that of the surrounding areas. The lack of vegetation in urban areas limits evapotranspiration (a combination of the processes of transpiration and evaporation, which involves removal of water from an area with vegetation and into the atmosphere).

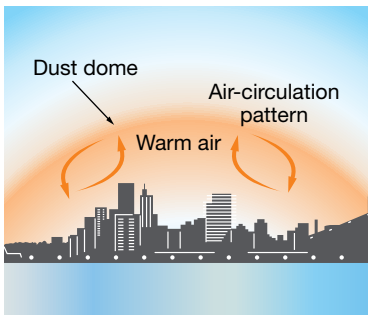
Cloud formation and precipitation

Large urban centres experience an increased rate of cloud formation and higher precipitation. This is a result of the larger number of condensation nuclei present in the atmosphere, combined with the convection currents generated by higher urban temperatures. Cloud cover may be as much as 10 per cent heavier over large urban areas, and strong thermal currents can increase the likelihood of thunder by 25 per cent and hail by as much as 400 per cent.

Wind

Wind velocities within urban areas are generally lower than those experienced in surrounding districts; on average, as much as 30 per cent lower. Buildings and other urban structures create surface friction and form windbreaks.

Large buildings also form 'canyons' through which winds are channelled at higher velocities (see Figure 2.4.1). These are often called wind tunnels. Buildings also cause small-scale disturbances, such as eddies.



2.4.2 Urban heat island

Urban heat islands

Large urban centres alter the local (and sometimes regional) climate. They are generally warmer, rainier, foggier and cloudier than surrounding rural areas. Urban building materials and roads tend to be non-reflective and have a high capacity to absorb and retain heat. They absorb and store heat during the day and release it slowly at night. Additional heat is generated by factories, power stations, motor vehicles and people themselves. Rainfall runs off surfaces so fast that little surface water is available to cool the air through evaporation. This combination of effects creates an urban heat island. (See Figure 2.4.2.)

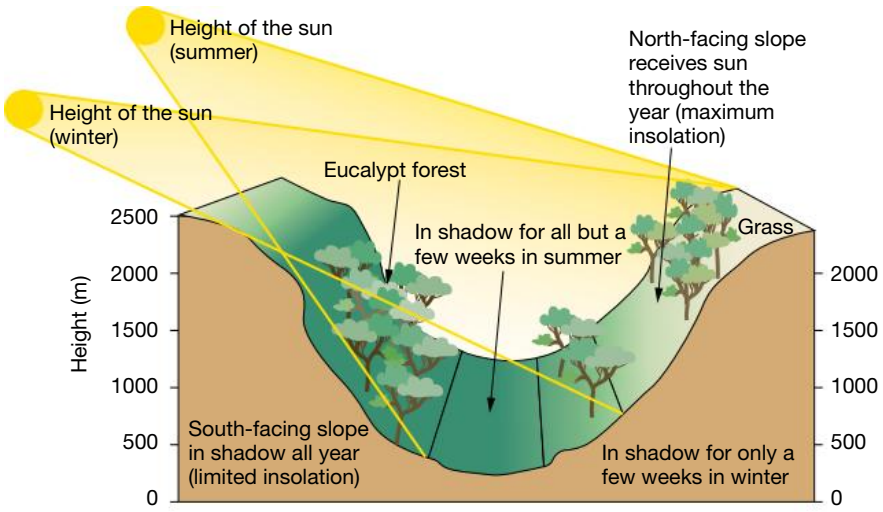
In summer, large cities can be up to 5°C warmer than surrounding suburbs and rural areas. In winter, urban temperatures can be up to 1–2°C higher. One indicator of warmer urban temperatures is the lower incidence of winter frosts experienced by urban centres compared with surrounding rural areas.

Under calm conditions, temperatures are highest in the centre of the urban area and decrease towards the outer suburbs and rural areas. The added heat can destabilise the atmosphere and change the way air circulates around cities. Mostly during the warmer months, the added heat creates wind circulations and rising air that can produce or enhance existing clouds. Under the right conditions, these clouds can develop into rain-producers or storms.

The dome of heat traps atmospheric pollutants (especially tiny solid particles). This contributes to higher urban temperatures. Dust and other particulates act like a blanket, reducing the amount of radiation, and creating a dust dome above urban areas. If wind speeds increase, the dust dome spreads out to form a dust plume, which can spread the city's pollutants for hundreds of kilometres.

Aspect-induced microclimates

Aspect refers to the direction in which a slope faces. Slopes that face the Equator have a northerly aspect in the Southern Hemisphere and a southerly aspect in the Northern Hemisphere. These slopes receive more direct sunlight than slopes that face towards the poles. Slopes with an easterly aspect receive their direct sunlight during the morning when temperatures are usually lower. Western-facing slopes receive their direct sunlight during the hottest part of the day. Slopes not exposed to direct sunlight have a cooler, moister microclimate than those exposed to longer periods of direct sunlight. (See Figure 2.4.3.)



2.4.3 Impact of aspect on climate

In mountainous regions, agricultural land uses and settlements are usually found on the sides of the valleys that receive most direct sunlight. Vegetation patterns also respond to the differences in exposure to sunlight. Along Australia's eastern seaboard, for example, it is not unusual to find pockets of rainforest or wet sclerophyll forest on slopes that have a southerly or easterly aspect. In Australia's Snowy Mountains, ski slopes are those that face either east or south. On these slopes, snow conditions are better for longer periods of time.

Microclimates resulting from differences in land surfaces

Different land surfaces often produce quite distinctive microclimates. Forested areas, for example, absorb and trap larger amounts of incoming radiation compared with more exposed surfaces. The canopy of leaves acts as a blanket, seen in Figure 2.4.4. As a result, forests have a small diurnal range of temperature (the difference between the daily maximum and minimum). Forests have a higher level of relative humidity due to evapotranspiration. Precipitation is also higher due to the moisture pumped into the air by trees. Wind velocities are reduced in forests because trees act as a windbreak.

2.4.4 Land surface can play a significant role in microclimates.

SKILLS BUILDER

Microclimates in your local community

2.4.5 Thermometers are used to collect data on air temperature.

1. Using a thermometer (see Figure 2.4.5), measure and record the air temperature at various locations within the school grounds. Examine the nature of each area in which your individual recordings were made and try to account for the different temperatures recorded. Compare your results, and plot the locations of the recording sites on a map of the school.
2. Investigate the impact on wind flow of large buildings in the school by using light strips of cloth pinned to the top of sticks hammered into the ground.
3. As a class, measure and record variations in temperature and rainfall within your local community. Use a thermometer at a prearranged time to measure the temperature of the air in your backyards. Then construct simple rain gauges to record the amount of rainfall experienced in your backyards within a predetermined period of time. Record your findings on a map of the local community. Examine the findings and note any variation in the temperature and rainfall patterns.
4. Locate a small valley with slopes that have a southerly and northerly aspect. Measure the air temperature on each slope and compare your results. Note any differences in the vegetation types found on each slope.
5. If you live in a rural-based urban centre compare the number of frosts experienced in the town with the number experienced in the surrounding district. You may have classmates who live in the surrounding district who could provide you with this information. If you live in a city, contact the Bureau of Meteorology to find out how many days of frost were experienced in the previous 12 months.

Activities

Understanding the text

1. Define the term microclimatology.
2. Explain how urban areas create their own microclimates. In your answer make specific reference to temperature, sunlight, humidity, precipitation and wind velocity.
3. Explain how aspect can produce a microclimate.
4. Explain how a specific type of land surface can produce its own distinctive microclimate.

Working geographically

5. Study Figure 2.4.2. Write a paragraph explaining how urban heat islands form.
6. Examine Figure 2.4.3 and complete the following activities.
   - **a** Describe the relationship between altitude and the formation of shadows.
   - **b** How do you think the environment at the floor of the valley would differ from that at the top of the slope? Explain your thinking.

UNIT 2.5

Human impacts on the atmosphere

The earth's atmosphere exists in a state of dynamic equilibrium. Any disturbance to this equilibrium impacts on the atmospheric balance and the balance of the biosphere as a whole. In relatively recent times gases generated as by-products of human activities are being released into the atmosphere, causing pollution and other impacts.

While the effects of atmospheric pollution have been well known for decades, urban dwellers are still exposed to unacceptably high levels of toxic pollutants; forests and waterways continue to be degraded by acid deposition; and the earth's protective ozone layer has been damaged by human-produced chemical gases. Carbon dioxide emissions associated with the burning of fossil fuels are dramatically altering the composition of the atmosphere leading to climate change on a global scale.

Issues that transcend international boundaries

One of the major issues associated with atmospheric pollution is the disparity between the source of pollutants and their atmospheric and terrestrial impacts. Once a pollutant is released into the atmosphere, its distribution is a function of the prevailing winds and weather patterns. Pollutants are thereby dispersed over thousands of kilometres, making their emission relevant to countries throughout a region. Acid rain is one example of a 'transboundary' pollutant.

The explosion in one of the four reactors of the Chernobyl nuclear power plant in the Ukraine in 1986 is another example. The disaster resulted in nuclear fallout throughout Europe and even in parts of the United States and Japan. This increased the risk of cancer and damaged plant and animal life in the affected regions.

Air pollution

Air pollution can cause breathing difficulties and other health problems in humans, aggravating diseases such as asthma and pneumonia and contributing to the development of cancer and emphysema. Air pollution also harms plants and animals.

Two of the most serious causes of air pollution are the oxides of sulfur and nitrogen. A major source of these compounds is the burning of fossil fuels (coal, oil and natural gas) in industry and transportation. These pollutants are often associated with high levels of toxins (such as lead, zinc and ground-level ozone, a component of smog).

Urban air quality

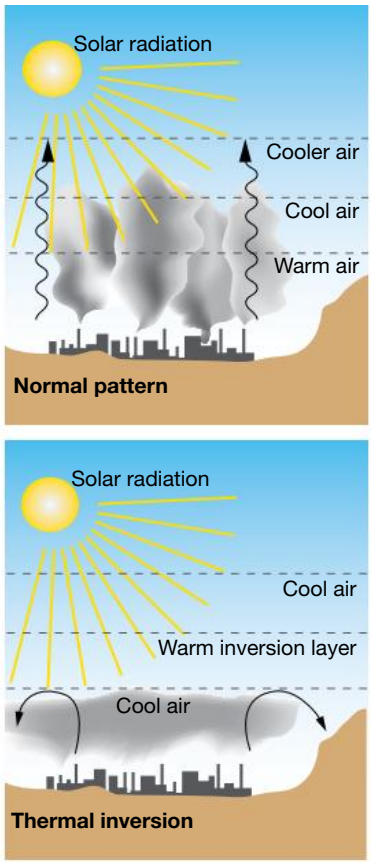
Smog

Car exhaust fumes are the main source of smog in urban areas (see Figure 2.5.1). The action of sunlight on the mixture of hydrocarbons and nitrogen oxides results in a range of secondary pollutants, the main one being ozone. Ozone is a colourless gas, which in high concentrations causes eye irritation and can induce allergic reactions (such as asthma and hay fever) or chronic disorders (such as bronchitis and cardiac conditions). Smog can also cause extensive damage to urban trees, and to forests adjacent to urban centres.

Smog is a major environmental issue in most large urban centres. It is particularly severe in those cities where prevailing meteorological conditions and topography restrict the movement of air (see Figure 2.5.2). Those cities include Athens, Bangkok, Los Angeles, Mexico City and Tokyo. Atmospheric pollution, including smog, is a major problem in those cities. In many cities, government authorities have been forced to institute measures to address the problem. Vehicle-free days and strict emission controls are among the strategies used.

2.5.1 Bangkok's notorious traffic is a major cause of air pollution in the city.

2.5.2 The mountains surrounding Mexico City act like a bowl trapping smog in the city.



2.5.3 Temperature inversion traps pollution below a layer of warm air.

Smog becomes a critical issue in areas that are subject to frequent temperature inversions. London is famous for the thick fogs, known as 'pea soupers', which in the past were caused by these inversions. These fogs were made much worse by heavy smog, caused by traffic and the burning of coal for home heating. In the twenty-first century, better pollution control in London has significantly reduced these fogs.

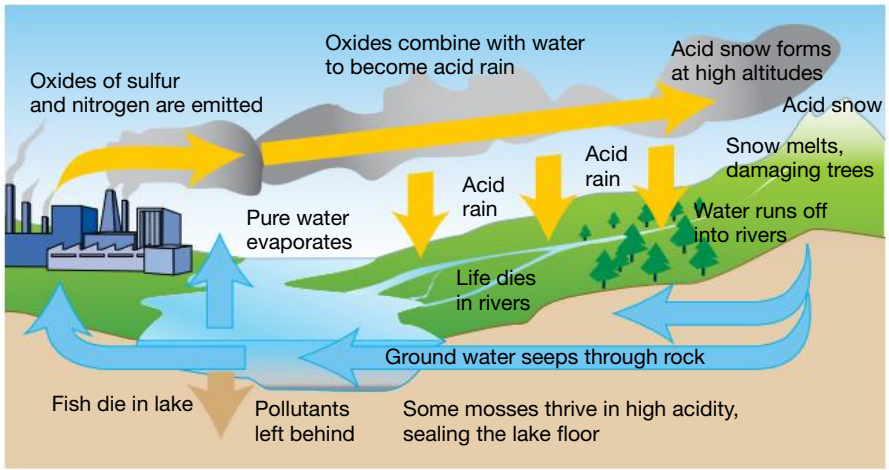
Temperature inversion occurs when weather conditions trap a layer of dense, cool air beneath a layer of less dense, warm air in an urban basin or valley. In Figure 2.5.3, a layer of warm air covers the region, preventing pollutants from escaping in upward-flowing air currents. If the temperature inversion were to last for several days, the amount of ground-level pollution could build up to harmful, even lethal, levels.

Los Angeles is another city that is notorious for its smog. The city's geographical features create conditions that are ideal for the formation of a temperature inversion. These features are its prevailing wind pattern and surrounding mountains. Controls on vehicle emissions have achieved some success in reducing the level of air pollution.

Sydney's relatively high levels of atmospheric pollution are closely linked to its high traffic density, meteorological conditions and topography. Peak levels of ozone are recorded in the calmer weather conditions that prevail in summer and autumn. Sydney's topographical features exacerbate the problem. The elevated topography to the west and north often acts as a barrier to the dispersal of pollutants. South-western Sydney has one of the highest rates of asthma of anywhere in the world. This is partly due to the way topography causes pollutants from across the city to move in a south-westerly direction.

Acid rain

One of the most serious outcomes of air pollution is acid rain. Industrial and vehicle-exhaust emissions of sulfur and nitrogen oxides combine with moisture in the atmosphere to form sulfuric and nitric acids. Pollutants are distributed into the atmosphere according to the prevailing weather patterns and can be dispersed thousands of kilometres from their original source. Eventually the acidic compounds fall back to earth as 'acid' rain or snow. Figure 2.5.4 shows how acid rain is formed, while Figure 2.5.5 shows the effects of acid rain on a forest in Germany.

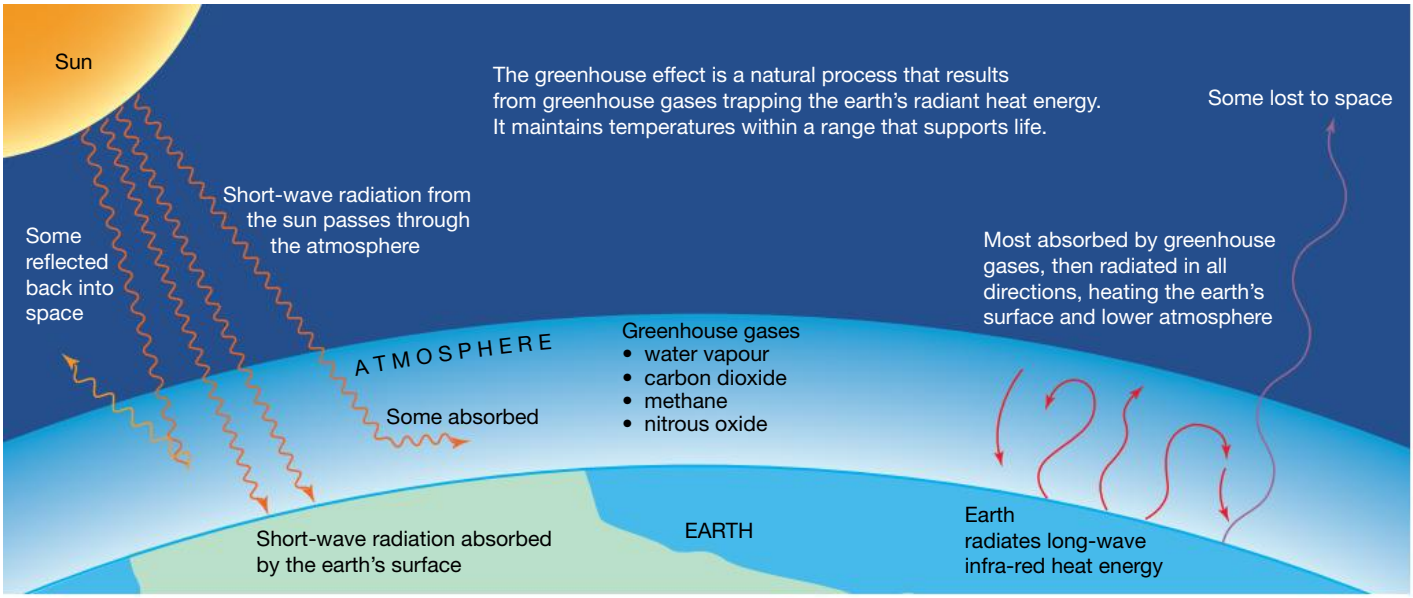


2.5.4 The creation and effects of acid rain

2.5.5 This German forest is suffering the consequences of acid rain.

Climate change

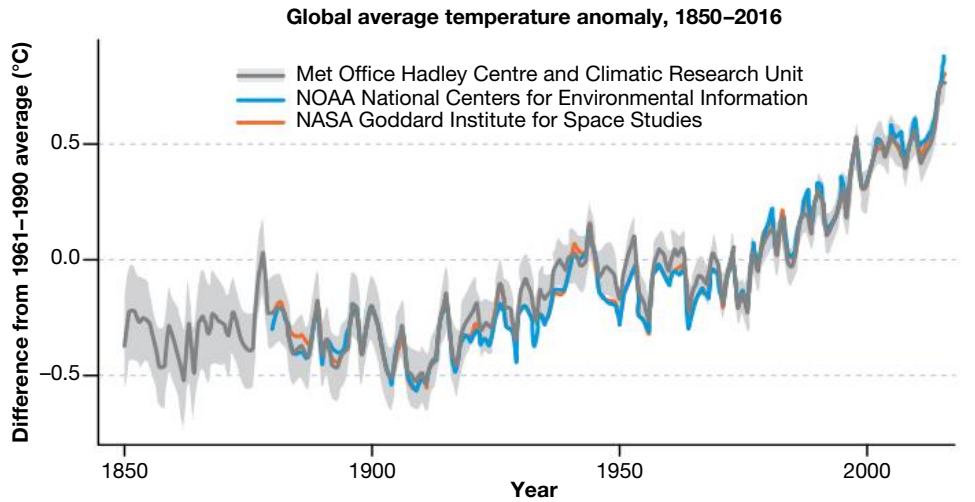
Increases in global temperatures, rising sea levels, melting glaciers and shrinking areas of sea ice are all part of the mounting evidence that the earth's climate is changing. The vast majority of scientists are convinced that humans are to blame for these changes. Burning fossil fuels and farming are just two of the activities that release heat-trapping gases into the atmosphere. Once in the atmosphere, these greenhouse gases absorb the heat that comes from the earth and radiate it back to the planet's surface. This enhances the earth's natural greenhouse effect, illustrated in Figure 2.5.6.



2.5.6 The enhanced greenhouse effect

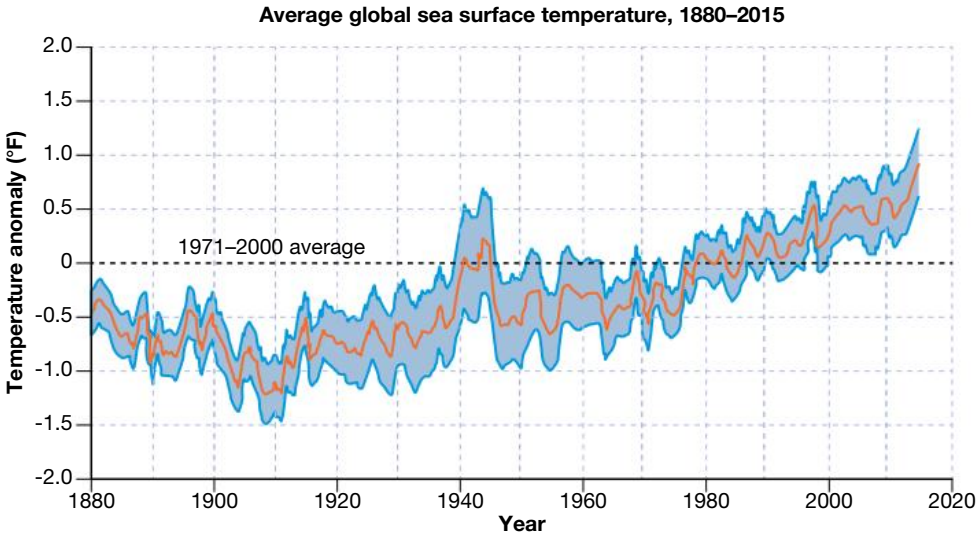
Data collected by NASA shows that since the late nineteenth century the earth's average temperature has increased by 1.1°C. Most of this warming has taken place in the last three to four decades. For example, the 17 years between 2001 and 2016 saw the 16 warmest years ever recorded. Figure 2.5.7 shows data from three scientific sources about changes in the earth's average temperature. The average as measured between 1961 and 1990 is shown by the 0°C line. As can be seen, the trend is an upward one with the rate of increase become greater.

This warming is already having an impact on the earth's climate. Much of this additional heat is being absorbed by the world's oceans. As shown in Figure 2.5.8, the surface of the oceans has been getting warmer. A key consequence of this warming is increasing frequency and intensity of storms. This was seen in 2017 with Hurricane Irma, the most powerful Atlantic hurricane in history, which was followed just a fortnight later by Hurricane Maria, another very powerful storm.



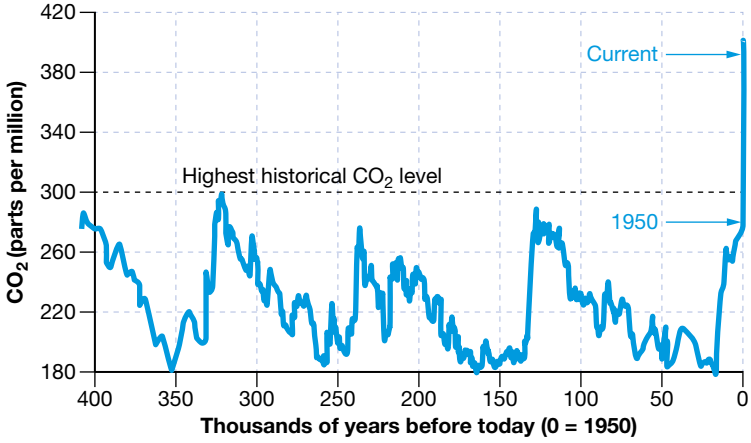
Source: UK government's Met Office, graph contains public sector information licensed under the Open Government Licence v1.0

2.5.7 Global temperature anomalies



2.5.8 Average sea surface temperatures

In Antarctica and the Arctic NASA earth scientists have been able to drill down into ice caps to get a long history of the earth's climate. Their research has shown a very dramatic increase in the amount of carbon dioxide that is contained in the ice cores, showing that there is a corresponding increase in the amount of the gas in the atmosphere, as shown in Figure 2.5.9. This increase corresponds with significant industrial development that saw the burning of fossil fuels (see Figure 2.5.10).



2.5.9 NASA data showing the increase in carbon dioxide in ice core samples

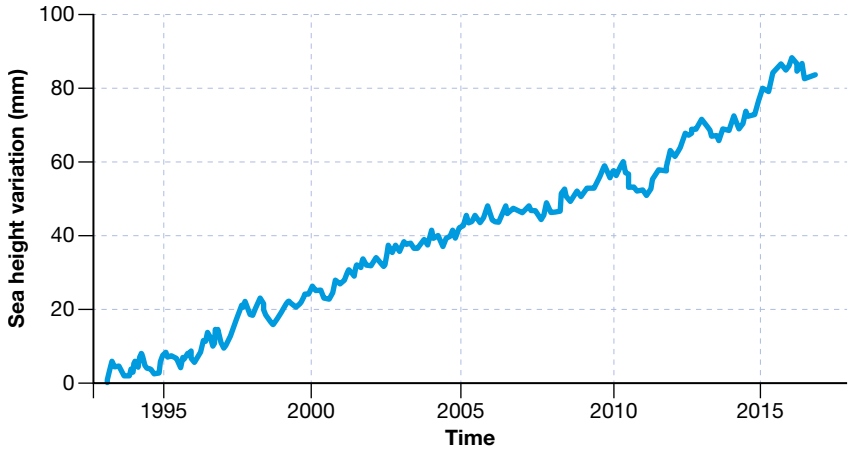
2.5.10 Increases in carbon dioxide coincide with the introduction of industrialisation that led to the burning of fossil fuels such as coal.

Consequences of climate change

As the earth continues to warm in coming decades the impacts of climate change will become more apparent. By 2017, sea levels were rising at an average rate of 3.4 millimetres per year, with that rate of increase growing (see Figure 2.5.11). This will have several significant impacts:

- Low lying areas will be subject to more intense inundation during large storm events.
- Areas that were once not impacted by storm surges will see more regular flooding.
- Important coastal habitats such as salt marshes will be lost as they can only tolerate occasional inundation.

Warming climates will also have an impact on the way that both air and sea currents operate. These currents act like giant conveyors of heat moving warm air and water away from the Equator and towards the poles. Counter currents bring cooler water and air towards the Equator from the poles. These currents, such as the famous Jet Stream that flows northwards from the warm waters of the Caribbean up the east coast of the US, help to regulate temperatures. Currents are driven by complex factors of which temperature is a key; therefore, changes in temperature could see a change to the currents and this in turn will have dramatic impacts on local climate.



2.5.11 Sea level rise

For example, if the Jet Stream did not run, cold water and air would flow southwards over much of eastern Canada and the USA, dramatically cooling the climate and in turn making the area far less habitable. Therefore climate change, although driven by warming, will result in some areas becoming much colder.

Another significant impact of climate change will be changes in rainfall patterns. In Australia, the driest and warmest winters ever recorded up to that point were seen in 2017. In fact 260 separate weather records relating to temperatures and lack of rain were broken over the 2017 winter in Australia. Scientists at the Climate Council reported in that year that as climate change continued, modelling showed that the southern part of Australia would experience more spells of very dry weather. This is concerning given the bulk of the population lives in the south and the region is the main focus of the Australian agricultural industries. (See Figure 2.5.12.)

Scientists argue that global climate change will lead to more frequent heat waves, bigger storms (including more intense tropical cyclones, or hurricanes) and more widespread drought. Even minor increases in average temperatures can threaten entire ecosystems. The world's coral reefs and animal species such as the polar bear are threatened with extinction. Higher sea levels will result from melting of glaciers and the polar ice caps and will increase coastal erosion. Up to 10 per cent of the world's population lives in coastal regions that have an elevation less than 10 metres above sea level, making them vulnerable to a rise in sea level.

2.5.12 Climate change will see an increase in drought in Australia, especially in southern Australia.

Dealing with climate change

Climate change is a global problem and needs a global solution. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP), both of which are United Nations organisations. The IPCC is made up of around 1000 scientists drawn from more than 100 countries. The IPCC has the task of collecting and analysing data relating to climate change and its social, economic and political impacts. The IPCC does not conduct its own research but examines the research of other scientists.

The IPCC came to worldwide attention in February 2007 when it released a report called 'Climate Change 2007: Fourth Assessment Report'. In this report, the IPCC stated that climate change was occurring and that there was no doubt that these changes were due to human activity. This was an important development because until that time the IPCC had said that it could not be 100 per cent certain that climate change was human induced. The 2007 report placed added pressure on the world's governments to take immediate action to address the potentially devastating impacts associated with climate change. Since this time the IPCC has produced two further reports each showing that climate change is continuing and that the rate of change is also increasing.

The United Nations Framework Convention on Climate Change is the most important attempt to deal with climate change on a global scale. The convention first came into being in 1992 at the Rio Earth Summit. In 1997 the convention was strengthened by setting targets for countries to reduce greenhouse gas emissions. This became known as the Kyoto Protocol. In late 2015, delegates from around the world met in Paris to negotiate further on emission reductions. By this time it was clear that more drastic action was needed to address climate change.

The Paris meeting led to the so-called Paris Agreement that saw signatory countries agree to an aim of keeping the increase of global temperatures to less than 2°C. In order for this to happen there will need to be financial and technological transfers from more developed countries to less developed countries to support their transition away from fossil fuels. The Paris Agreement drew controversy from some who saw it as unfair.

2.5.13 Renewable energy such as this wind and solar farm is the key to reducing greenhouse gas emissions.

2.5.14 LED lights are more efficient than traditional incandescent light bulbs and reduce energy demands.

For example, in 2017 US President Donald Trump announced that the US would withdraw from the Agreement because he argued it unfairly impacted on the US economy. Many business, political and community leaders in the US attacked this decision saying that climate change was the biggest threat to US economy, not the costs associated with dealing with it.

At a more local level there have been many initiatives to reduce the impact of climate change (see Figure 2.5.13). For example, the growth of renewable energy sources reduces the need to burn fossil fuels, such as coal. South Australia, for example has become a leader in this area partnering with US technology firm Tesla to install large batteries that store energy produced from renewables to be used when demand is high.

Small steps taken by individuals, such as reducing energy use and switching to green energy sources, are also important. For example, considerable energy savings can be made simply by households and businesses using LED lighting instead of traditional light bulbs. LED lights, such as the one seen in Figure 2.5.14, are four to seven times more efficient and use much less power.

Activities

Understanding the text

1 List the main environmental issues associated with human interactions with the atmosphere.
2 Explain why these issues 'transcend international boundaries'.
3 Outline the main sources of atmospheric pollutants.
4 Describe the nature of photochemical smog and how it impacts on the wellbeing of humans.
5 Define the term temperature inversion.
6 Explain the link between temperature inversions and high levels of atmospheric pollution.
7 Describe the processes that lead to the formation of acid rain.
8 Describe the effects of acid rain.
9 Define climate change in your own words.
10 Outline some of the main consequences of climate change.
11 Describe the work of the IPCC.
12 Outline strategies for reducing the effects of climate change.

Working geographically

13 As a class discuss strategies for reducing smog in large cities of Australia. Record your ideas in the form of a mind map or other graphic organiser.
14 Study Figure 2.5.3 and the text. Write an explanation outlining the formation of a temperature inversion and its relationship to atmospheric pollution.
15 Study Figure 2.5.4. Write a report on the formation of acid rain and its impacts.
16 Study Figure 2.5.6. Summarise the greenhouse effect in a paragraph.
17 Using Figures 2.5.7 and 2.5.8, describe the impact of climate change on temperatures.
18 Study Figure 2.5.9. Describe the trends shown in the graph. What correlations are evident between this data and that shown in Figures 2.5.7 and 2.5.8?
19 Using Figure 2.5.11 and the text, describe the impact of climate change on sea levels.
20 Climate change is causing southern Australia to become drier. As a class, brainstorm the consequences of this for both the environment and human activities.
21 Conduct research into the Paris Climate Agreement and the United Nations Framework Convention on Climate Change. What is the current status of the agreement?
22 Divide the class into small groups. In your group, consider what steps could be taken to reduce the impact that your school has on climate change. Prepare a presentation of your ideas and share them with your classmates and your school's leaders.

Exam-style questions

Extended responses

- Analyse the factors that determine the world pattern of climate.
- Account for local variations in climate.
- Explain the impact that large cities have on climate at a local scale.
- Outline the consequences of people's interactions with the atmosphere.
- Write an extended response on global warming. In your response:
  - outline the causes of global warming
  - speculate on the possible impacts of global warming
  - explain how the rate of warming might be slowed.

Glossary

acid rain precipitation containing excessive amounts of acid that is formed when oxides of sulfur and nitrogen, released by the combustion of fossil fuels, mix in the atmosphere

atmosphere the transparent, odourless mass of air surrounding the earth

atmospheric pollution a change in the chemical composition of the atmosphere that affects the wellbeing and activities of all living things; also known as air pollution

atmospheric pressure systems of the atmosphere with relatively high or low barometric pressure; often referred to as highs and lows

conduction energy transfer from one material to another by direct contact

convection currents movements within a medium caused by differences in temperature

evapotranspiration the processes of evaporation and transpiration

fossil fuels energy sources formed in past geological times from organic materials; examples include coal, petroleum and natural gas

greenhouse effect the trapping and build-up of heat in the troposphere, near the earth's surface; some of the heat that is radiated towards space from the earth's surface is absorbed by water vapour, carbon dioxide, ozone and several other gases and radiated back towards the surface

greenhouse gases gases in the earth's atmosphere that contribute to the greenhouse effect; for example, carbon dioxide, ozone, methane and nitrous oxide

insolation the solar radiation that reaches the earth's surface

lapse rate the decline in temperature that occurs with increasing altitude throughout the troposphere

microclimate a small, localised area within a larger climatic region in which the atmospheric characteristics differ significantly from those of the major climate

ozone a colourless gas that is the product of the reaction between oxygen and the sun's ultraviolet radiation

ozone layer the layer of gaseous ozone in the stratosphere that protects life on earth by filtering out harmful ultraviolet radiation from the sun

photochemical smog a complex mixture of air pollutants produced in the atmosphere by the reaction of hydrocarbons and nitrogen oxides under the influence of sunlight

solar radiation energy received from the sun and on which all life depends

temperature inversion this occurs when a layer of dense cool air becomes trapped under a layer of less dense warm air; if prolonged, air pollution in the trapped layer may build up to harmful levels

terrestrial radiation stored heat emitted as longwave radiation by the earth, including from its land, oceans and atmosphere

troposphere the innermost layer of the atmosphere in which most of the earth's weather occurs

urban heat island a phenomenon of urban settlements where relatively warm atmospheric temperatures prevail in the most heavily built-up areas and decrease outward towards the fringes

wind a movement of air from areas of relatively high atmospheric pressure to areas of relatively low atmospheric pressure; winds are named after the direction from which they are blowing

CHAPTER

3 The hydrosphere

Although water covers almost 70 per cent of the earth's surface, it is not a limitless resource. Every drop of water that exists on the planet today was here in one form or another on the day our planet came into being.

Water comes in many forms. The salty oceans contain more than 97 per cent of all the water on earth and play an important role in diluting and degrading the pollutants that may flow into them. Polar ice caps and icefloes are the next largest component of the earth's surface water (2.7 per cent). They are an important influence on the world's climate and provide essential habitat to many unique life forms.

The rest of the fresh water on earth (0.3 per cent) is what we see every day. Rivers, streams and creeks transport the run-off flowing from snow and ice melt, storms or floods. This run-off, together with groundwater, also provides an important source of fresh water for domestic, industrial and agricultural purposes. Wetlands and marshes are of exceptional ecological value—from cleansing the water we drink (removing sediments and contaminants), to long-term storage for slow uptake of groundwater (recharge), and to protecting us from floods and droughts.

> **Water is the driving force of all nature.**
>
> **Leonardo da Vinci**

3.0.1 Nearly 70 per cent of earth is covered by water.

UNIT 3.1

The water cycle

Water is always moving. Its state and geographical location are always changing. This has been the case since its formation.

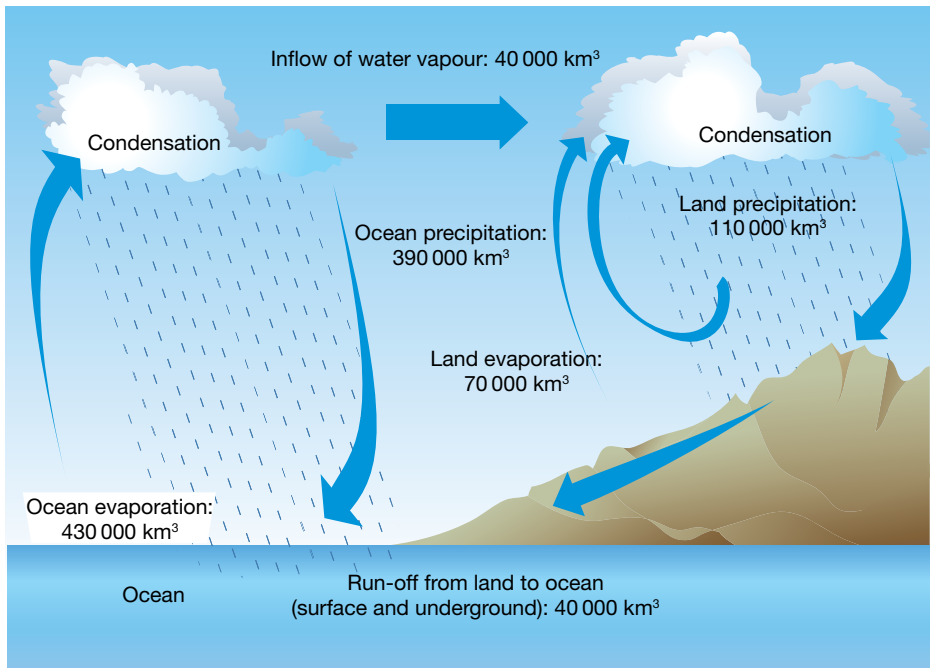
Consider the 4.6-billion-year history of the earth as a 24-hour clock. At 2.00 a.m. the planet was still being born. Heat from atomic decay in the planet's pressurised core, combined with the heat generated by continual meteorite impacts, fused the earth into a ball of magma, rich in iron. The heat in the interior of the planet drove oxygen and hydrogen atoms from the materials in which they were contained, and the newly formed molecules came to the surface in upwellings of magma. Steam rose from the crust as lava and emerged through the fractures in the surface. The water vapour rose and cooled and soon clouds enveloped the planet. Violent electrical storms churned through the atmosphere.

When the surface had cooled sufficiently, the rains came. The first droplets fell at about 2.30 a.m. The storms continued until around 3.05 a.m., having lasted for about 112 million years. The result was a planet mostly covered by a shallow sea, muddy with sediment washed from the land—a land with no plants and no soil.

The same water has been circulating since the early days of the planet, driven by the energy of the sun. At a global level, the hydrological (water) cycle is a closed system. No water is added and none is taken away. What changes is the distribution of the water, its geographical location and sometimes its form, as seen in Figure 3.1.1.

Approximately 430 000 cubic kilometres (km^3) of water evaporates annually from the surface of the oceans. Another 70 000 cubic kilometres evaporates from the land. This gives a total of approximately 500 000 cubic kilometres.

Since the amount of water vapour in the atmosphere remains relatively constant, an equivalent amount is precipitated back to the earth's surface. However, its distribution varies. Precipitation over the oceans is approximately 390 000 cubic kilometres; precipitation over the land is approximately 110 000 cubic kilometres, compared with its evaporation of 70 000 cubic kilometres. This gives a net transfer from the oceans to the land of 40 000 cubic kilometres a year. This transfer sustains all the terrestrial life within the biosphere.



3.1.1 Vast quantities of water is transferred within the water cycle.

However, far more water exists than is transferred annually (see Figure 3.1.3). Water is stored in a number of forms and for varying periods of time. Just over 2.6 per cent of the earth's water is fresh water; that is, free of salt. Figure 3.1.2 shows the sources of fresh water.

Global distribution of fresh water

Storage	State	Volume (km³)	Percentage of fresh water	Percentage of total water on earth
Ice caps and glaciers	Solid	28 200 000	76.5	2.14
Groundwater: ■ 800 m deep ■ 800–4000 m deep	 Liquid Liquid	 3 740 000 4 710 000	 10.1 12.8	 0.27 0.34
Lakes	Liquid	125 000	0.34	0.00091
Soil moisture	Liquid	69 000	0.19	0.005
Atmospheric vapour	Gas	13 500	0.037	0.01
Rivers and marshes	Liquid	1 500	0.004	0.0091
Total sources		36 859 000	100	2.665

3.1.2 Global distribution of fresh water in its various states

SKILLS BUILDER

Proportional circles

Proportional circles, such as those in Figure 3.1.3, show the relative size of the units being measured by the area of each circle. The size of each circle must be drawn in proportion to the total value it represents.

Proportional shapes are sometimes used instead of circles. They may be squares, rectangles, cubes, triangles, symbols or the shape of nation-states, for example.

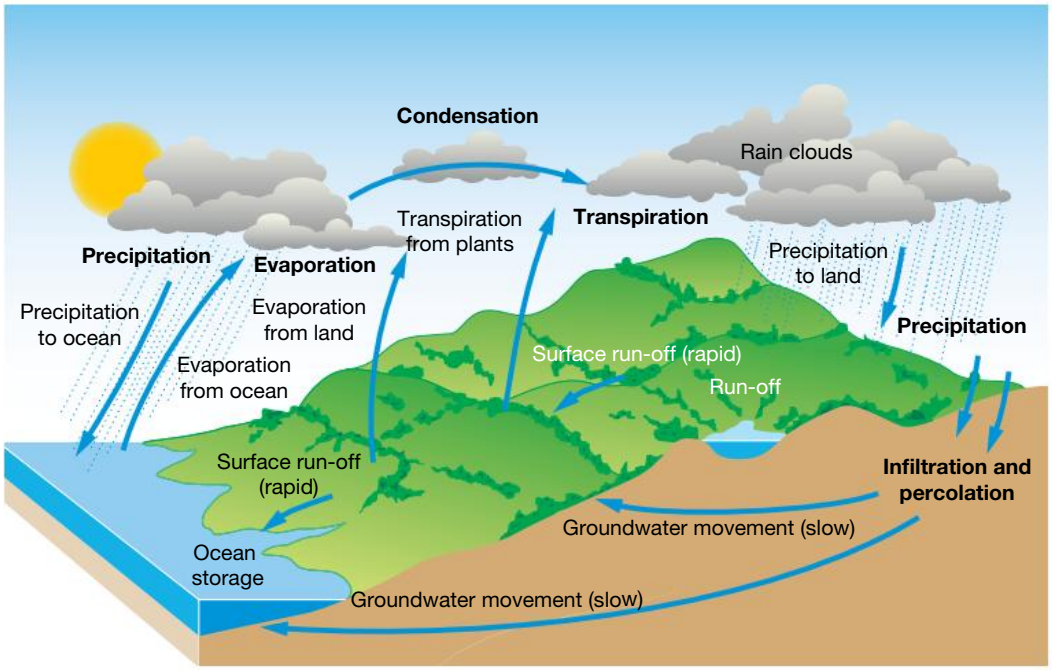
Key processes in the water cycle

Figure 3.1.4 demonstrates the key processes associated with the water cycle.

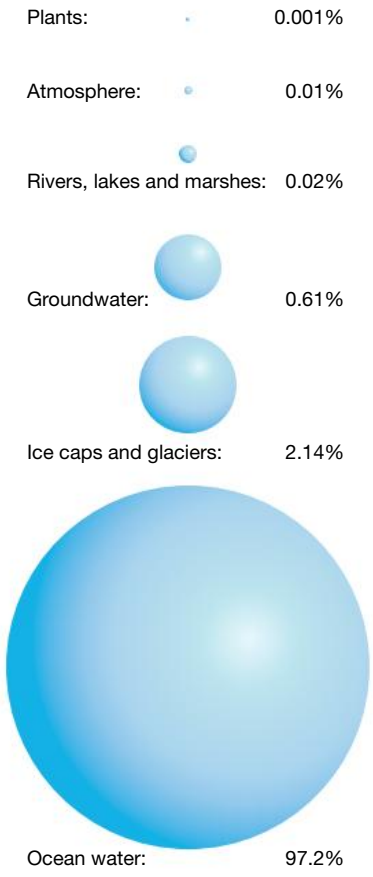
Condensation

Condensation is the process by which water changes from a gaseous state back into a liquid state. This process can only take place when there are solid objects on which moisture can be deposited. Dust particles in the atmosphere act as condensation nuclei; without them there would be no condensation. Condensed water may be visible as cloud, dew or mist.

The rate at which condensation takes place depends on the original air temperature (which influences the air's capacity to hold water), the amount of moisture or humidity in the air and the rate of atmospheric cooling.



3.1.4 Key processes in the water cycle



Total supply of water: 1 385 000 000 km³

3.1.3 Where water is stored

Condensation is a warming process because the latent heat absorbed during evaporation is returned to the atmosphere. Air, therefore, is capable of moving not only moisture from one place to another, but also heat. The larger the amount of moisture in the atmosphere, the greater the amount of energy (as heat) it can store and transfer.

The temperature to which the air needs to be cooled before it becomes saturated (100 per cent humidity) is known as its dew point. When the dew point is below freezing, water vapour changes directly to ice or frost. This process is known as sublimation.

Evaporation

Evaporation is the physical process by which moisture is lost directly to the atmosphere from a body of water due to the sun's heat or the effects of air movements. The rate of evaporation depends on temperature, wind velocity, level of humidity and hours of sunshine. Evaporation is a cooling process because it involves a transfer of heat energy from the body of water to the atmosphere.

3.1.5 This morning mist over a rainforest is caused by transpiration—moisture is lost from the leaves of plants as they are warmed by the sun.

Transpiration

Transpiration is a biological process in which water is lost from the pores of the leaves of plants, as seen in Figure 3.1.5. The rate of transpiration depends on the time of year, the type and amount of vegetation and the length of the growing season. The amount of water vapour in the air is known as humidity.

Precipitation

Precipitation results when large masses of moist air are cooled rapidly below dew point. With continued condensation, water droplets or ice crystals become larger and heavier. Eventually they become so heavy that the atmosphere can no longer support them and they precipitate. Types of precipitation include rain, sleet, snow and hail.

Infiltration

When precipitation occurs, the soil becomes moist and absorbent. Water enters the soil and the water percolates (passes through successive layers of the soil profile). The rate at which this occurs depends on the amount of water already in the soil. It is also determined by the soil's porosity and structure, and the amount and type of vegetation cover. The speed at which water passes through soil is called its infiltration capacity. Infiltrating water eventually collects above an impermeable layer of rock or fills all pore spaces, forming a zone of saturation. The upper level of the saturated material is known as the water table. Water may gradually be transferred horizontally as groundwater flow or base flow.

Activities

Understanding the text

1 Explain the main states in which water can be found.
2 Write your own definition of the water cycle.
3 Describe the process of condensation.
4 Differentiate evaporation from transpiration.
5 Outline the forms that precipitation takes.

Working geographically

6 Study Figures 3.1.1 and 3.1.4.
  a List all the storages that are part of the:
    i lithosphere
    ii biosphere
    iii atmosphere.
  b Explain how water reaches the atmospheric store.
  c Explain why some parts of the lithosphere contain water and others do not.
  d How does water reach the ocean from the lithosphere?
7 Using the information in Figure 3.1.2, write a report summarising the main storages of fresh water on earth.
8 Study Figure 3.1.3.
  a In which form is water most commonly found?
  b Where is fresh water most common?
  c Where is water found in a gas form?
  d Calculate the amount of water currently found in ice caps and glaciers.
9 Study Figure 3.1.4. Prepare a short factual report on the operation of the water cycle.

UNIT 3.2

The global water budget

The earth's water budget is the summation of the hydrosphere's inputs, outputs and net changes over a particular period of time. The amount of water within the global water cycle is 1385 million cubic kilometres, of which less than 3 per cent is fresh water. This may sound a small amount, but the total quantity of fresh water on earth is far greater than that required by the earth's human population.

The main sources of water used by humans make up less than 1 per cent of the fresh water total. Yet this is still more than enough water for everybody. It is estimated that the annual renewable supply of water available for use is around 3000 cubic metres per person. Compare this with the worldwide average water use of 750 cubic metres per person.

The location, quantity and quality of water resources are largely determined by the relationship between climate (precipitation and evaporation) and biophysical features, such as geology.

Figure 3.2.1 shows that a continent such as South America, which has high rainfall in equatorial areas, has high run-off. This accounts for the vast river systems and plentiful water supplies found in much of the continent, particularly on the eastern coast where the mighty Amazon Basin is found.

With mid-latitude continents, the pattern is a very different one. Australia not only has the lowest rainfall and run-off proportional to area of all the continents, but also has the lowest percentage of run-off proportional to rainfall incidence. In other words, in Australia evaporation and transpiration are so high that the amount of rain that ends up as streamflow is meagre. This leaves the continent with few major river systems and is one of the reasons why the centre of Australia is so dry.

Average annual rainfall and run-off

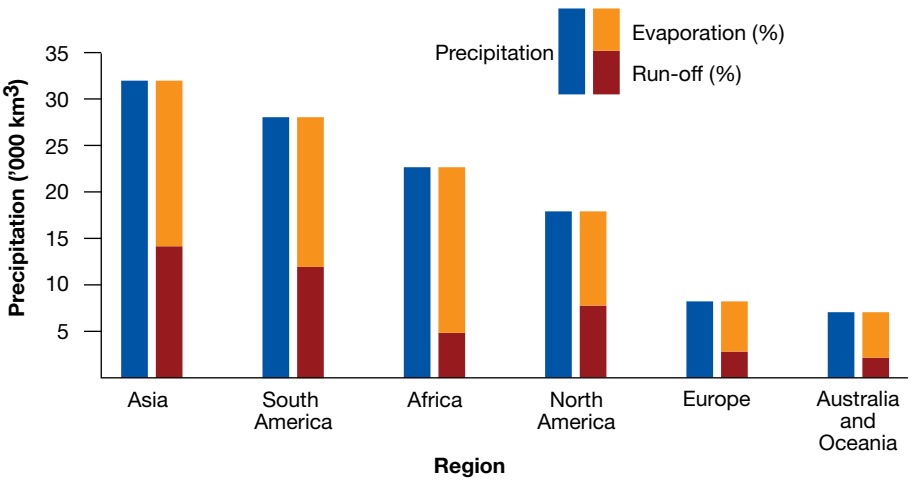
Continent	Area (km^2)	Average rainfall (mm)	Average run-off (mm)	Average run-off (km^3)	Percentage (run-off)
Africa	30 300 000	690	260	7900	38
Asia	45 000 000	600	290	13 000	48
Australia	7 700 000	465	57	440	12
Europe	9 800 000	640	250	2500	39
North America	20 700 000	660	340	6900	52
South America	17 800 000	1630	930	16 700	57
Antarctica and Greenland	17 100 000	150–200*	160*	2800*	*

*Data uncertain

3.2.1 Average annual rainfall and run-off for each continent

Global and continental variations in water budgets

The total amount of water within the water cycle is fixed. Despite this, water is unevenly distributed both in terms of place and seasonal pattern. Continental water budgets vary as a result. The size and location of the continents produce particular interactions between the lithosphere and the general atmospheric circulation. These specific interactions affect the climate of the world in general, and the climate at any particular continental location. Among the characteristics of climate are the amount of rainfall and its distribution (see Figure 3.2.2).



3.2.2 Annual evaporation and run-off rates for each continent

These characteristics influence the biosphere through the limits that water availability places on plant growth. The world patterns of climate and vegetation, therefore, are the result of specific interactions between the atmosphere, lithosphere and hydrosphere. There is a strong link between precipitation, evaporation rates and run-off. This in turn impacts, for example, on the ability of rivers to form (see Figure 3.2.3).

Different patterns of continental crust produce different patterns of atmospheric circulation, and therefore different patterns of climate and vegetation on both the global and continental levels. These differences affect the distribution of water among the various stores within the water cycle.

Changes in water budgets over time

Global and continental water budgets show spatial change over long periods of geological time. Around 330 million years ago, all the major land masses of the world began to gather on one side of the planet. Continental drift gradually united them into one huge land mass, Pangaea, stretching almost from pole to pole.

The continental gathering of Pangaea disrupted global weather patterns. In the south, the Gondwana section of Pangaea was slowly carried across the South Pole, producing an Ice Age that lasted for 80 million years. The massive size of the continent produced extreme climates, with few areas of moderation. The northern and southern regions were colder than Siberia; the deserts were hotter than the Sahara; and in the interior, the temperature range between a hot summer's day and a cold winter's night was probably greater than 50°C. The climate overall was probably hotter, drier and more seasonal than that of any other era. This may have contributed to the extinction of more than half the families of the world's land vertebrates around 260 million years ago. The hot, dry climate may also have influenced the transition from a world dominated by amphibians to one dominated by reptiles. Reptiles are better adapted to drought than are amphibians.

About 180 million years ago Pangaea began to break up. From 65 to 55 million years ago, Australia separated from Antarctica and drifted northwards. Sixty-five million years ago Australia lay approximately between 40°S and 70°S. Today Australia lies approximately between 10°S and 40°S. Such lithospheric changes have exposed Australia to new sets of atmospheric interactions. Over time, these have considerably altered the continental water budget and the biosphere. Australia has drifted into drier latitudes; the rainforests have contracted; drought-adapted plants, such as eucalypts, have flourished and spread; all of which has resulted in a new and radically different Australia (see Figure 3.2.4).

Continental water budgets also exhibit variations over much briefer time spans, such as days, weeks, months and years. These variations and their resulting floods and droughts can have devastating effects on both people and the biosphere as a whole.

3.2.3 The Mekong River is a vast system that drains large sections of South-East Asia. Vast rivers form when run-off rates are high, such as in this part of Asia.

3.2.4 Australia's gradual move northwards due to continental drift has contributed to the drying of the continent.

Activities

Understanding the text

1 Describe the composition of the global water budget.

2 Outline the factors that determine the location, quantity and quality of water resources.

3 Explain the absence of very large river systems in Australia.

4 Explain why continental water budgets vary.

5 Describe the climatic effects produced by the formation of Pangaea.

6 Describe how continental drift has affected Australia's climate.

Working geographically

7 Study Figure 3.2.1. Calculate the differences between Australia and South America in terms of average rainfall and run-off.

8 Study Figure 3.2.2.

- **a** Which continent receives the greatest precipitation?
- **b** Which of the continents featured has the least precipitation?
- **c** Which continent has the highest rate of run-off?
- **d** Which continent has the greatest rate of evaporation?
- **e** What are the implications of this data for agriculture in Africa?

9 Write an explanation of how the distribution of water within the global water budget is the result of specific interactions between the different spheres of the biophysical environment.

Floods

A river floods when its discharge is greater than the capacity of the river channel. The excess water spills over the river's banks and onto its floodplain. Different types of floods are as follows:

- **Slow-onset floods:** These develop over a series of days and last for one or more weeks. They can result in the loss of stock and crops and cause damage to roads.
- **Rapid-onset floods:** These occur more quickly and in the mountain headwater areas of large rivers. They may only last for one or two days but are often very destructive.
- **Flash floods:** These occur when intense storms drop large amounts of water within a brief period of time. They can occur with little warning and can reach their peak in only a few minutes.

Factors affecting river discharge

The rate of river discharge impacts on the scale of any flood. This rate is impacted by two major factors—precipitation and the nature of the river catchment itself.

Precipitation

Precipitation determines the amount of water in the system in the following ways:

- **Type of precipitation:** If the precipitation falls as snow, it may be days or even weeks before it melts and runs off into waterways. If the melting is rapid and the soil underneath frozen, large amounts of run-off can cause flash flooding.
- **Intensity of rainfall:** During storms the intensity of rainfall often exceeds the capacity of the ground to absorb it all. Excess run-off flows quickly overland and into waterways, rapidly increasing discharge.
- **Frequency of rainfall:** The rate of infiltration is affected by the amount of water already in the soil. If the soil is still wet from earlier rain, it will quickly become saturated. If the soil has had an opportunity to dry out, it will be able to absorb new rainfall. Floods are more likely to occur after an extended period of wet weather.

SPOTLIGHT

Flash floods in the Lockyer Valley

In 2011, southern Queensland experienced very significant rainfall leading to extensive flooding, including in the very heart of Brisbane. In the Lockyer Valley south-west of Brisbane, flash floods brought devastation and death.

Twelve people were killed in the small town of Grantham about a hundred kilometres from Brisbane. The town of less than 400 people resembled a war zone (see Figure 3.2.5) after a huge wall of water measuring 8 metres high washed through. Residents in the town were expecting some flooding but the scale of the flash flood took everyone by surprise, leaving many people unprepared. Following the tragedy it was announced that the entire town would be gradually moved to higher ground.

3.2.5 Cars and debris accumulate around the main bridge in Grantham following a flash flood.

SPOTLIGHT

2017 Houston Floods

Houston (population 4.6 million, and the fourth largest city in the United States) suffered massive floods in August 2017, following unprecedented rains associated with Hurricane Harvey that formed in the Gulf of Mexico. During the floods more than 13 000 rescues were performed by authorities.

Figure 3.2.6 shows the scale of the flooding, which in parts was estimated to have reached over 5 metres. City officials estimated that more than 100 000 homes were directly impacted by the flooding. Factories, oil refineries and chemical plants were also flooded. Damage caused by the flood was estimated at well over US$200 billion.

The 2017 floods came after another major flooding event in 2016 that was considered an historic flood and caused well over US$1 billion in damage. Geographers investigating the rise in recent major floods in the Houston area have laid the blame on the city's urban growth and the impacts of climate change. Hurricanes are driven by warm waters which are getting warmer due to climate change.

Poor urban planning has seen development on flood plains around the city's rivers and streams. Covering an area of 1500 square kilometres, the city has sprawled ever outward and areas that once protected the city from flooding have been lost. Wetlands and grasslands around the city once absorbed huge quantities of rainfall. For example, in the north-west of Houston more than 70 per cent of wetlands have been lost to urban development. Hard surfaces now take the place of the wetlands, which has massively increased run-off and therefore flood risk.

3.2.6 These photographs show a similar location on Interstate 10, one of the main freeways into Houston.

Characteristics of the river catchment

The nature of the river catchment itself impacts on what happens to the water once on the ground, as outlined below:

- **Rock type:** Permeable rocks, such as sandstone, readily absorb water and reduce the amount of run-off. Flooding is more common in catchments dominated by impermeable rocks, such as granite.
- **Soil:** Sandy soils have large air spaces that enable water to infiltrate the soil. Soils with a high clay content are less able to absorb water. Clay particles are very small and fit together tightly. This makes it difficult for water to infiltrate, causing the water to accumulate on the surface.
- **Slope gradient:** On gently sloping land, rainfall has time to infiltrate before it runs off. On steep slopes, rainfall runs off before it can be absorbed.
- **Vegetation:** Vegetation slows the flow of water across the earth's surface and encourages infiltration. This, in turn, reduces the risk of flooding.
- **Land use:** Agricultural land uses can affect the rate of run-off. Ploughing parallel to the contours of the land (contour ploughing) can, for example, reduce run-off. The compaction of the soil by stock and farm machinery can have the opposite effect. The compacted soil forms an impermeable layer, encouraging run-off. The buildings, paving and roads of urban areas form an impermeable layer that encourages the rapid run-off of precipitation. Drainage systems guide this run-off into local waterways.

Drought

Droughts are prolonged periods of below-average rainfall (see Figure 3.2.7). Regions with low average rainfall are more likely to experience droughts than places with high average rainfall. Droughts inhibit the growth of crops and natural vegetation.

Severe droughts can also contribute to land degradation. Wind erosion takes place when bare, dry soil is no longer bound together by the roots of trees, grasses and other plants. Loss of precious topsoil can leave a site unable to produce crops or pasture, and prone to desertification. Even drought-breaking rains can erode the soil by washing away unprotected topsoil.

The effects of drought on the human population vary according to the socioeconomic situation of the people in the area. In one community a drought may merely result in restrictions on car-washing, the use of garden sprinklers and the ability to top up swimming pools. In another, it can result in famine and death.

3.2.7 A severe drought from 2013 to 2017 saw the water storage plummet in Lake Mead, the largest reservoir in the US.

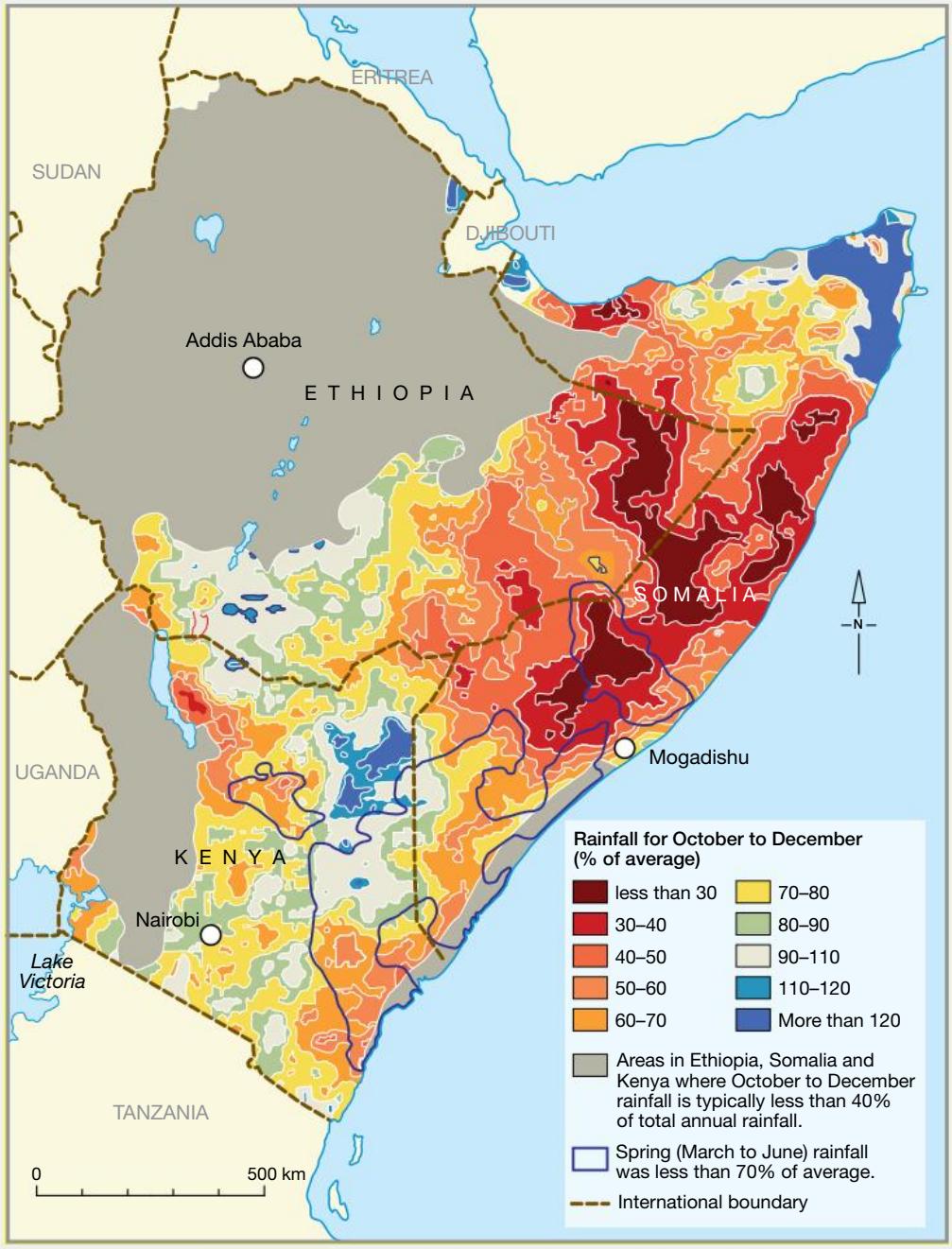
SPOTLIGHT

Drought in the Horn of Africa

The Horn of Africa lies on the north-east of the continent and is home to some of the most impoverished nations on earth. Drought is no stranger to this region where poor harvests have led to widespread death. The World Health Organization (WHO) estimate that a drought in Somalia in 2011 led to the death of more than 260 000 people.

By 2017 the Horn of Africa was again in severe drought facing the third year of very low rainfall. As can be seen in Figure 3.2.9, much of the Horn of Africa received very much below average rainfall in 2016 and the pattern continued into 2017. Countries across the region—including Somalia, Sudan, Djibouti, Uganda, South Sudan, Eritrea and Kenya—suffered the worst drought since 1945. The impact of the drought was made worse by security issues and unrest across much of the region as civil wars and insurgencies by Islamist terror groups raged. By mid-2017, more than 17 million people across the Horn were facing food shortages and even starvation (see Figure 3.2.8). In 2017, more than 40 per cent of Somalia's population faced severe food shortages and children were most at risk.

3.2.8 Persistent drought across the Horn of Africa has devastated crops and livestock, leading to widespread famine.



3.2.9 Rainfall variations for October to December 2016 in the Horn of Africa.

Source: FEWS NET/USGS CHIRPS

GEOSKILLS

Choropleth maps

Choropleth maps use shading and colour to show the quantity or density of features, such as population, rainfall and temperature. Different ranges of values are selected for the feature and a colour or shade allocated to each range of values. When drawing choropleth maps, each area that falls within a particular range is allocated the appropriate colour or shade until the overall pattern is revealed. Shadings grade from the deepest colour/highest density downwards.

When interpreting choropleth maps it is important to remember that considerable differences can exist within an area, even though areas may have the same colour or type of shading. World maps, for example, usually present data for particular nation–states. National borders often become the boundaries between different ranges of values, resulting in generalisations, and localised variations in the feature being mapped may be neglected.

Water scarcity

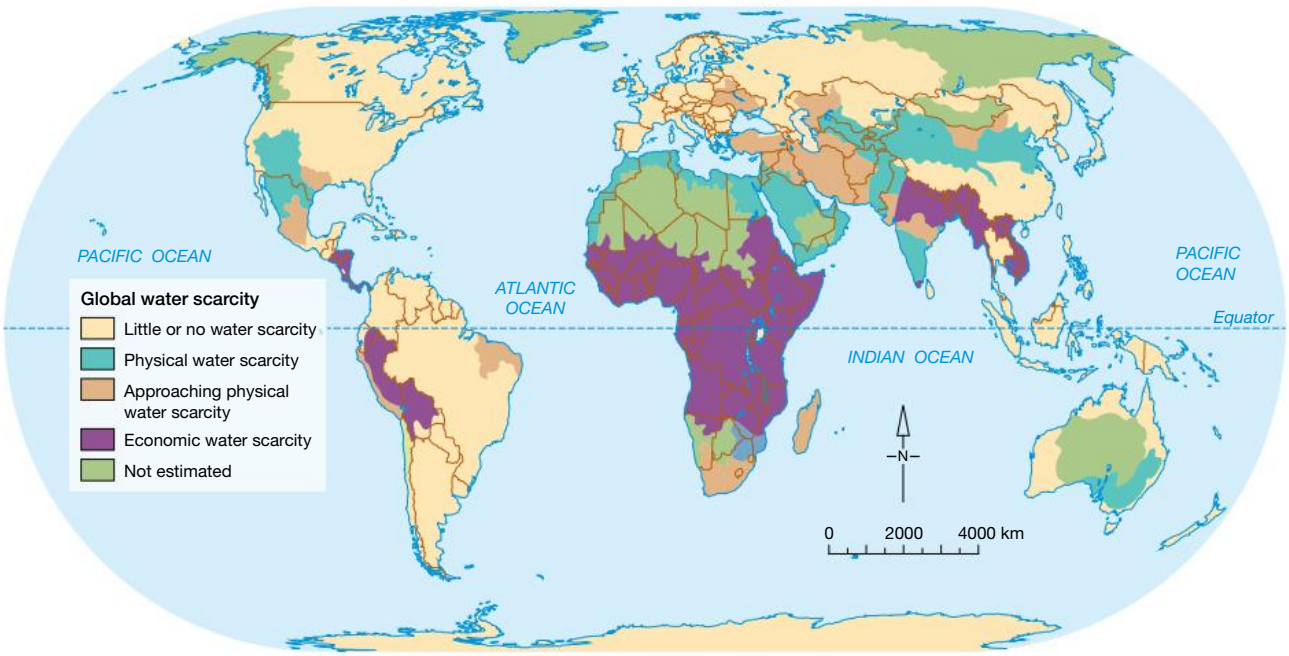
The amount of water on earth is finite. While the amount of water on earth stays the same, the number of people wanting to access this water is growing, meaning that there is less water per person.

In total there is still more than enough water to go around. However, around one-third of the world's population lives in a country considered to be water stressed and by 2025 this figure is predicted to increase to two-thirds. Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water scarcity simply means that there is insufficient water to maintain sufficient food production and to meet the domestic, environmental and industrial water needs of communities. Figure 3.2.10 shows global physical and economic water scarcity.

Water scarcity is often an economic problem and it is usually the poor that suffer the most when water is scarce. Water shortages create economic hardship when families are required to buy water or need to trek long distances to fetch it, taking them away from more economically productive activities such as tending to crops and stock. Shortages can also result in people drinking contaminated water. This can lead to disease, ill health and even death, which also bring further economic difficulties.

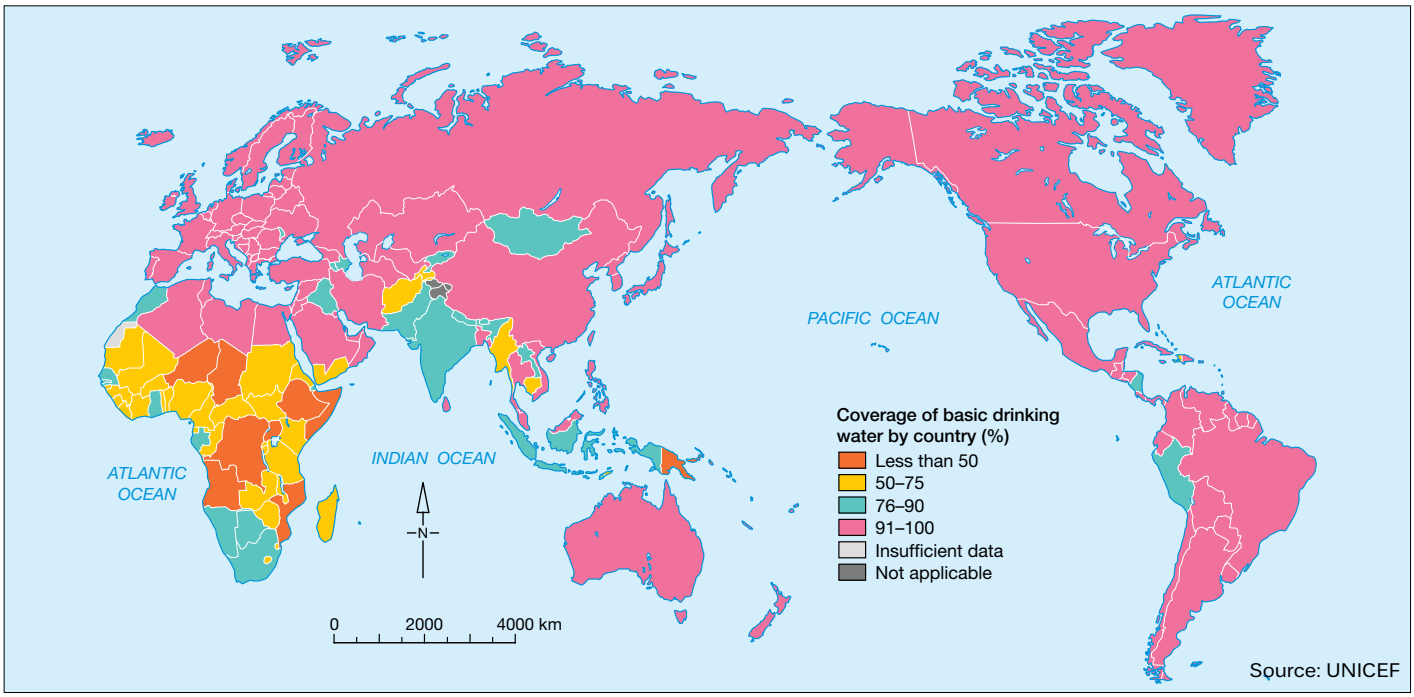
The solutions to water shortages are very complex. Building more dams is one common suggestion. Here in Australia, several dams have been proposed in recent years as the country deals with a massive drought. However, dams are enormously expensive to build and maintain. They also cause serious environmental and indeed social damage to the ecosystems and communities where they have been built. The use of groundwater is another common suggestion. However, groundwater supplies can take thousands of years to accumulate and their use must be carefully managed to ensure they remain sustainable.

One of the easiest and most cost-effective strategies to deal with water scarcity is reducing water use. Vast quantities of water are wasted, especially in developed countries. Improved irrigation techniques can save billions of litres of water. Treating sewage and storm water to enable the water to be recycled is also a viable option. Measures such as these can significantly reduce the amount of water wasted. These approaches are sometimes called 'invisible dams' as they have the same effect on water supply as building new dams but without the financial and environmental costs.



3.2.10 Water scarcity

Source: *World Water Development Report 4*, World Water Assessment Programme (WWAP), March 2012, UN Water



3.2.11 Proportion of the world's population with access to improved drinking water

Access to clean water

Access to clean water is associated with water scarcity. Once considered an unlimited and essentially free resource, clean water is becoming a scarce and valuable commodity. While most countries still have adequate supplies, the depletion of groundwater reserves, excessive use and pollution will limit what is available in the future.

Access to clean water is a major issue in the developing world. Lack of infrastructure prevents around 850 million people worldwide from accessing clean and safe drinking water (see Figure 3.2.11). As a result, each year up to 10 million people die from water-related diseases, such as cholera. Millions more experience periods of ill health.

Access to safe drinking water is also an important economic issue. Easy access to free or very cheap water is a major way to alleviate poverty and improve the situation for women. As Figure 3.2.12 shows, in many developing countries women and children are responsible for finding and carrying the household's daily water supplies, often from distant wells.

3.2.12 Throughout much of the developing world, women and children are responsible for collecting and carrying water.

Activities

Understanding the text

1 Outline the different types of floods.
2 Explain how precipitation affects river discharge.
3 Describe the role of rock and soil type on river discharge rates.
4 Define the term drought.
5 Outline the main impacts of drought.
6 Explain the meaning of the term water scarcity.
7 Outline the economic and social consequences of water scarcity.
8 Describe strategies for reducing water scarcity.
9 Explain the consequences of a lack of access to clean water.

Working geographically

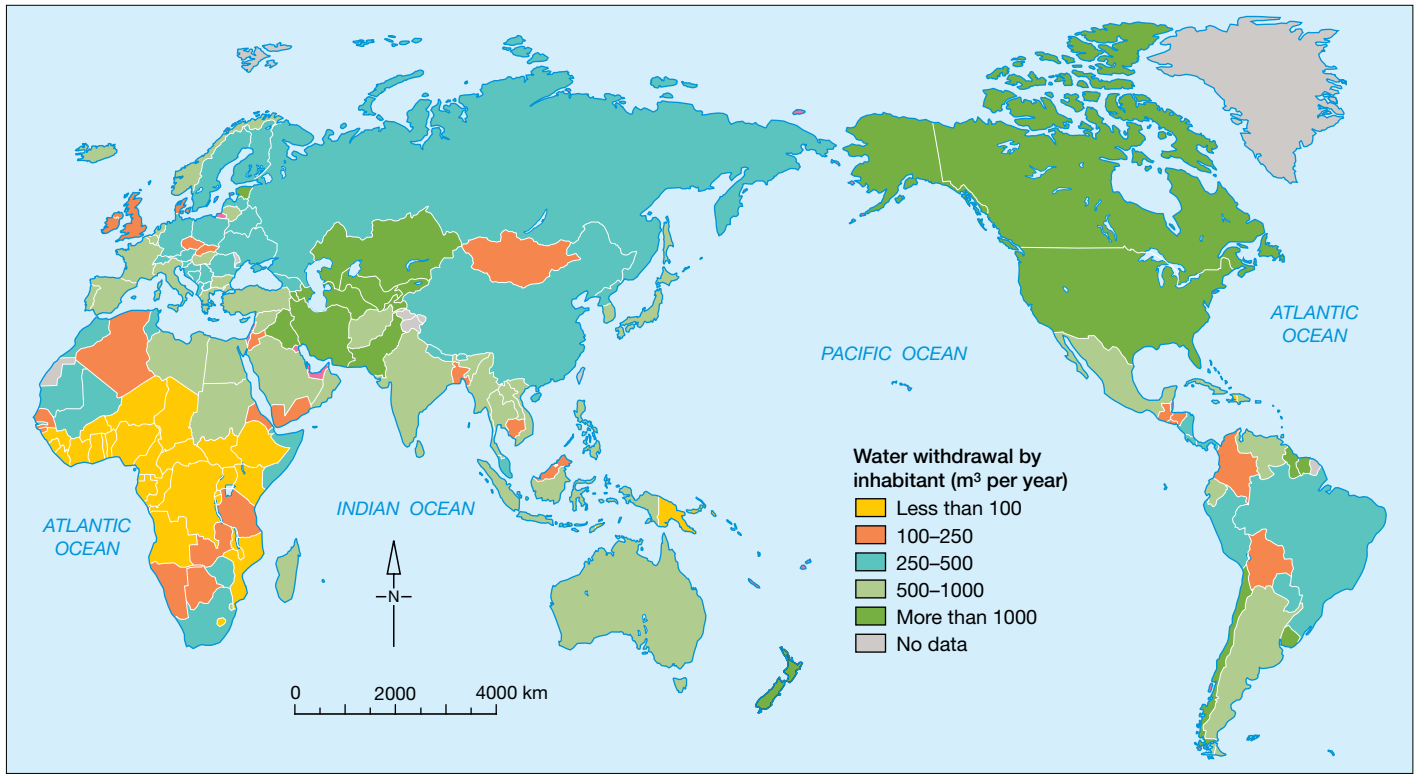
10 Use Figure 3.2.6 and the information in the text to answer the questions.
   a Write a brief report outlining the impact of the 2017 Houston flood.
   b Explain how human activities contributed to the severity of the flood.
11 Study Figure 3.2.9.
   a Explain what information this map is showing.
   b Describe the rainfall patterns shown in the map.
12 Study Figure 3.2.10. Write a report describing the spatial dimensions of water scarcity.
13 Study Figure 3.2.11.
   a Describe the spatial patterns shown in this map.
   b As a class, discuss the link between economic development and access to clean water.
   c Brainstorm strategies for addressing the issue of access to clean water.

UNIT 3.3

Human impacts on the hydrosphere

The uneven distribution of fresh water both globally and regionally means that management of water resources is important. Management entails the collection, storage, allocation and distribution of water to meet domestic, agricultural and industrial needs. The rising demand for water and the aspirations of countries to higher levels of economic development pose new challenges for water management.

About 70 per cent of all water consumed by humans is used in agriculture, with about 20 per cent in industry and the remaining 10 per cent used for domestic purposes. As the human population globally expands so does the demand for water. We are currently consuming around 9.025 billion cubic metres of fresh water annually (1 cubic metre equals 1000 litres). In the last 50 years, the demand for fresh water has more than tripled and it is estimated that demand is growing at around 64 billion cubic metres per year. As Figure 3.3.1 demonstrates, this demand is uneven across the globe, with highly developed countries using far more water than less developed nations.



Source: AQUASTAT Geographic Projection, Food and Agriculture Organization of the United Nations

3.3.1 Amount of water withdrawals per capita

Industry and mining

Industrial processes account for around 20 per cent of all fresh water used globally. Industrial withdrawals are rising, particularly as industrial development accelerates in many countries of the developing world, especially in China and India. This acceleration has created demands for water for power generation, mining, processing and manufacturing. In European countries (especially Germany, France and the United Kingdom) industry accounts for 60–80 per cent of total water demand. Industrial water is used mainly for cooling, processing and other activities that may pollute or heat the water, but not consume it.

Pollution of water is one of the main impacts of industry on the hydrosphere. Industrial accidents can lead to devastating inflows of pollution. There are countless examples of this. Some have become infamous.

The Tisza River flows through Hungary and Romania. In February 2000 it gained international attention after a massive industrial accident left the river heavily polluted. A dam holding polluted water at a mine in Romania broke, releasing around 20 000 tonnes of mud containing heavy metals, such as lead, copper and zinc. The toxic bloom flowed down creeks and eventually flowed into the Tisza River in Hungary. As the wave of pollution spread down the river, the toxins settled into the mud on the riverbed and thousands of dead fish floated to the surface. Pollution in the river remains high as toxins continue to be released from the riverbed.

In November 2005, another industrial accident led to huge environmental damage. Located in the Jilin Province of China, the Songhua River flows through northern China and into the Harbin and Heilong Rivers which then flow into Russia. Millions of Chinese and Russians rely on these rivers for drinking water. A massive explosion at a chemical factory adjacent to the river released a toxic bloom of benzene and nitrobenzene into the Songhua River. Benzene is a known cancer-causing chemical. The bloom eventually extended more than 80 kilometres down the river system. This contaminated the water supply of many towns and cities lining the river, including the Chinese city of Harbin, with a population of more than 1 million. In addition, millions of fish and other aquatic lifeforms were killed by the toxic bloom.

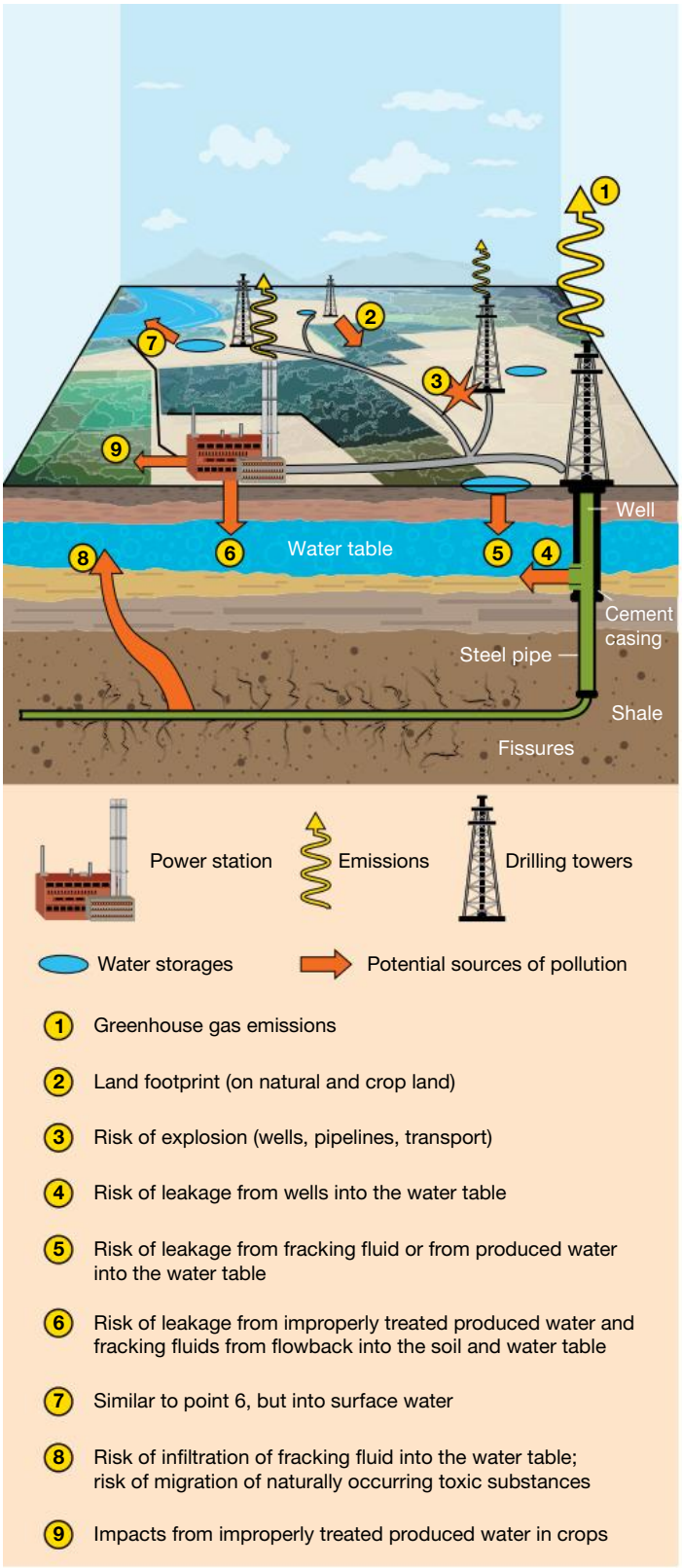
Hydraulic fracturing

Hydraulic fracturing, often referred to as fracking, has been used in the gas industry since the 1940s. More recently it has been used to extract gas from seams of coal.

The first stage of fracking is to drill a well, which is lined with a steel casing. The steel casing is perforated at intervals along its length. A fluid made up of water, sand and chemicals is then injected through the perforations under very high pressure. This has the effect of fracturing the coal seam and the surrounding rock. These fractures typically extend for 200 to 300 metres from the well. The sand in the fluid helps hold open the fracture as the fluid and the gas is extracted back out through the well.

One of the main impacts of fracking is the huge amount of water used in the process. For most wells, between 500 000 to 3 million litres of water is used in the fracking process. The US Environmental Protection Agency in 2010 found that fracking activities used around 400 billion litres of water. Since then more than 35 000 new wells have been established with more than 1.3 million wells created through fracking in the US today.

Another major impact of fracking is associated with the chemicals used in the fracking liquid. Up to 350 different chemicals are used in the liquid and some of these include highly toxic compounds like benzene, toluene and 2-butoxyethanol. Although most of the liquid is returned to the surface some remains, which can contaminate groundwater aquifers. These are the main source of drinking water in many rural communities. Waste fracking liquid is another major source of water contamination. The waste liquid is stored and this can leak into rivers and streams. Figure 3.3.2 summarises the main impacts of fracking.

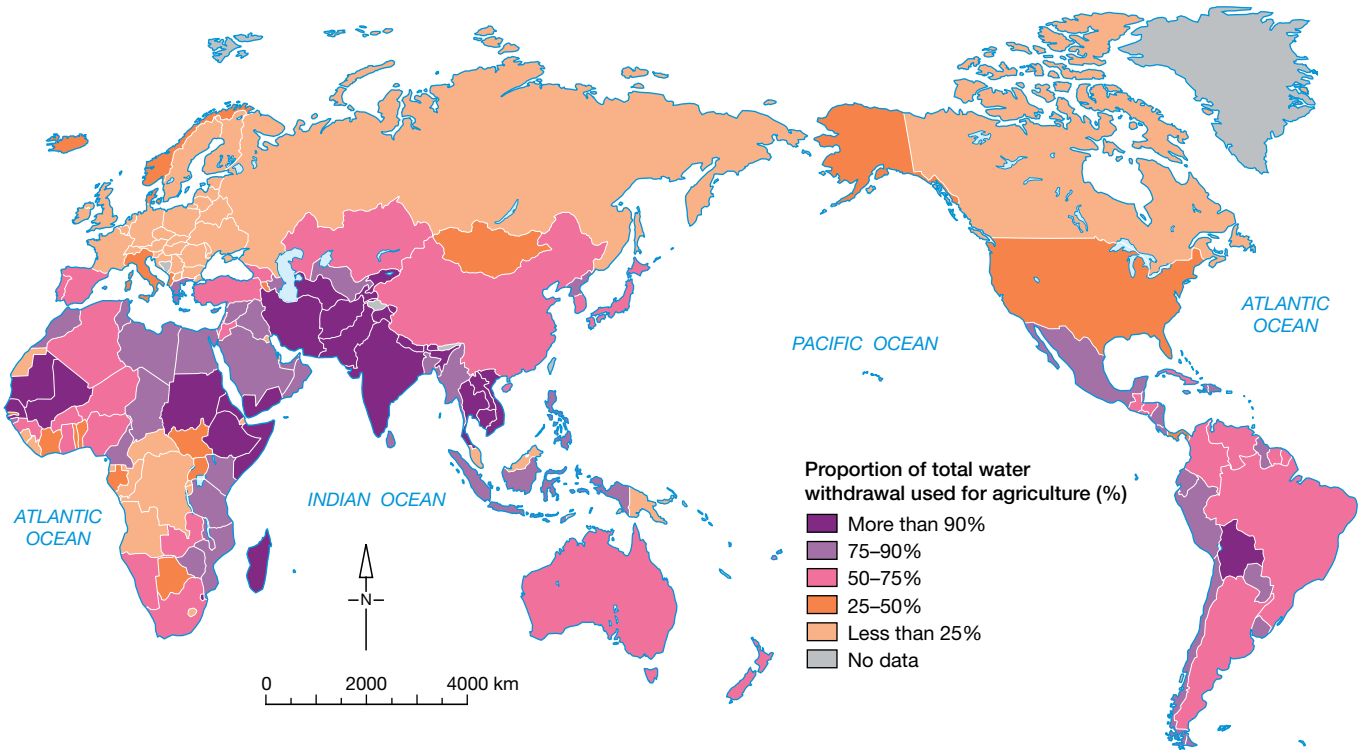


Source: UNEP, GRID-Geneva, 2012

3.3.2 Fracking and its impacts on the hydrosphere

Agricultural water use

Agriculture is by far the biggest user of water globally. Well over three quarters of the world's crop land is rain-fed, but the remainder is under irrigation and this uses around two-thirds of annual fresh water consumption. Figure 3.3.3 shows the proportion of water that countries use for agricultural activities.



Source: AQUASTAT Geographic Projection, Food and Agriculture Organization of the United Nations

3.3.3 Percentage of water used for agriculture

Many irrigation programs transfer water out of river systems by transferring it, often vast distances, through a complex system of canals and pipelines. This is the system used in the irrigation areas of the Riverina region in south-east Australia. Such a system is inefficient as considerable water is lost to evaporation in open canals.

Another method to obtain water for irrigation is to exploit underground aquifers—enormous underground lakes that can hold huge quantities of water. For example, Australia's Great Artesian Basin covers an area of more than 22 per cent of the country (see Figure 3.3.4). The Basin has long been exploited for irrigation and to provide water for towns and livestock. Although aquifers such as the Great Artesian Basin hold huge quantities of water they can become depleted. The water in the aquifers has built up over thousands of years and uncontrolled extraction can lead to them drying out, leading to droughts. This is becoming a significant issue in arid areas, particularly in the Middle East and parts of North America, as seen in Figure 3.3.5.

Dam construction

Humans have sought to regulate the flow of rivers for thousands of years. The oldest known dam is the Sadd el-Kafara in Egypt. It was built out of earth and rock about 3000 BCE. Today, approximately 40 000 large dams obstruct the flow of the world's rivers. Most of these have been built in the last 60 years.

3.3.4 The Great Artesian Basin covers more than 22 per cent of Australia's landmass.

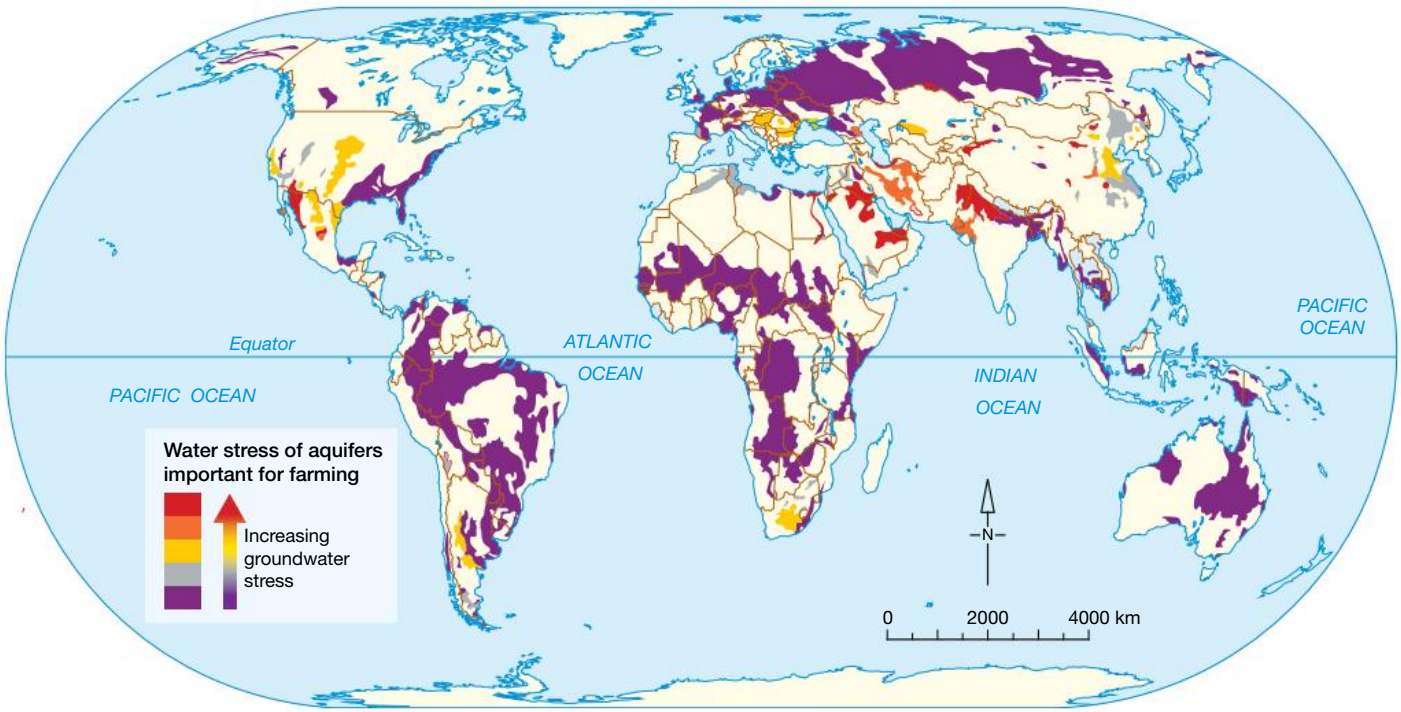
Activities

Understanding the text

1. Outline the main ways humans use water.
2. Explain how water is obtained for irrigation activities.
3. State what an aquifer is.
4. Explain why the use of aquifers should be carefully managed.
5. Explain what hydraulic fracturing involves.
6. Outline the main impacts of fracking.

Working geographically

7. Write a short answer response describing the spatial patterns shown in Figure 3.3.1.
8. Study Figures 3.3.3 and 3.3.5.
   - **a** What links are evident between these two maps?
   - **b** In small groups, consider the consequences of reducing the amount of land irrigated and brainstorm strategies for making irrigation more efficient. Share your ideas with the class.



3.3.5 Aquifers under stress due to over extraction

Source: T. Gleeson, Y. Wada, M. F. P. Bierkens & L. P. H. van Beek, Research letter: 'Water balance of global aquifers revealed by groundwater footprint', 9 August 2012, Macmillan Publishers Limited

Activities

Understanding the text

1 Describe the impacts of climate change on the hydrosphere.

2 Outline how climate change is affecting rainfall patterns in Australia.

Working geographically

3 Using examples, prepare a short answer response on the impact of industrial water use on the hydrosphere.

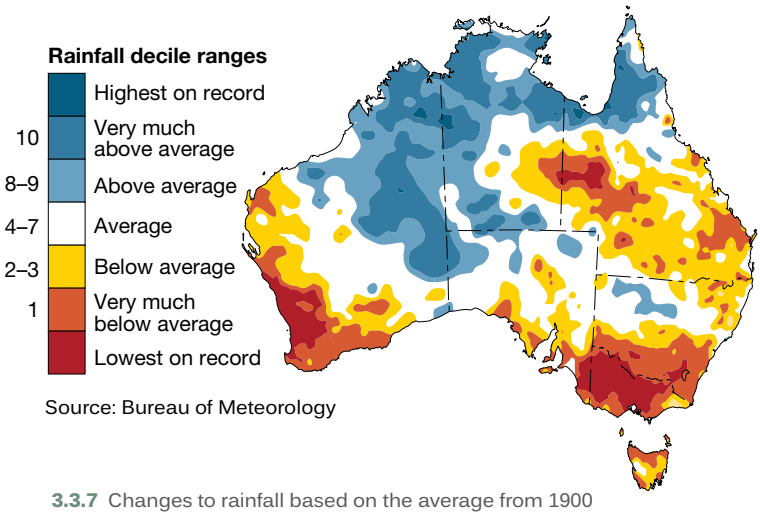
4 Conduct a class debate on the topic: 'Energy is crucial for our society; therefore, fracking is a necessary evil.'

These dams have many environmental and social impacts:

- People are forced to move as their homes and farmland are flooded.
- Historical sites are inundated.
- The waters of the dam flood agricultural land and wildlife habitats.
- The damming of rivers cuts off the supply of fertile silt to the floodplain, resulting in reduced fertility and soil depth.
- Pressure created by the huge mass of water can trigger earthquakes.
- Dams disrupt the migratory habits of fish species.
- The seasonal pattern and volume of flow is altered.
- River and floodplain ecosystems that depend on the river's flooding cycle are seriously affected; many native plant and animal species depend on variations in river flow for reproduction, hatching, migration and other important life-cycle stages.
- The reduction in the volume of nutrients and fresh water reaching river estuaries seriously degrades the habitat where 80 per cent of the world's fish catch originates.
- The river, deprived of its sediment load, seeks to recapture it by eroding the downstream channel and banks, undermining bridges and other riverbank structures.
- Sediment trapped behind the dam wall gradually reduces the storage capacity of the dam.
- The reduction in sediment flows leads to increased coastal erosion.
- Riverbed deepening lowers the water table, threatening vegetation and local wells on the floodplain.
- The loss of riverbed gravel deprives bottom-dwelling fish and crustaceans of a habitat.
- Regular flooding is required to flush out backwater channels and replenish wetlands.
- The release of very cold water from the base of dams disrupts the ecology of riverine ecosystems.
- Large reservoirs in tropical countries increase the incidence of waterborne diseases, such as malaria.

Dams have a number of functions. They enable us to produce electricity (hydropower provides nearly one-fifth of the world's electricity); supply water for agriculture, industry and households; control flooding; and assist in river navigation by providing a more regular flow of water. See Figure 3.3.6.

3.3.6 China's 3 Gorges Dam spans the Yangtze River and is the largest in the world.



Source: Bureau of Meteorology

3.3.7 Changes to rainfall based on the average from 1900

Climate change

Climate change associated with human activities is impacting on all aspects of the environment, including the hydrosphere. One of the main impacts relates to changing rainfall patterns. Climate change is causing some areas to receive more rainfall leading to increased flooding. In other places, changes to the climate have resulted in a drying of the landscape.

Rainfall in Australia is highly variable and is influenced by El Niño and La Niña phenomena which are associated with ocean currents in the Pacific Ocean. Despite this natural variability, studies have shown that the long-term rainfall averages are beginning to change in Australia. Rainfall is becoming more intense across northern Australia while southern Australia is becoming drier, as shown in Figure 3.3.7. This has significant consequences for agriculture as the south is the main agricultural region for the country.

CASE STUDY

Humans and the Rhine River

The Rhine is one of the world's great inland waterways (see Figure 3.3.8). From its headwaters in the Swiss Alps it passes through Austria, Germany, France, Luxembourg and the Netherlands before entering the North Sea at Rotterdam. The Rhine's mean discharge is 2200 cubic metres per second and its catchment covers an area of 165 000 square kilometres. Each year some 10 000 ships, carrying 250 million tonnes of cargo, ply its waters, as shown in Figure 3.3.9.

The Rhine's catchment hosts Europe's largest concentration of industry, agriculture and hydropower generation. Some of the continent's largest urban centres rely on the water supplied by the Rhine and its tributaries. Approximately 50 million people live within the catchment.

In the last 150 years, the hydrology of the river has changed dramatically (see Figures 3.3.10 and 3.3.11). Humans have sought to exercise greater control over the river. The Rhine has been deepened and straightened and now transfers water 50 per cent quicker than before the human intervention.

The waters of the Rhine are used for a variety of industrial processes, by farmers for agriculture and by those living in the urban centres that line the river and its tributaries. All these uses discharge waste water back into the river.

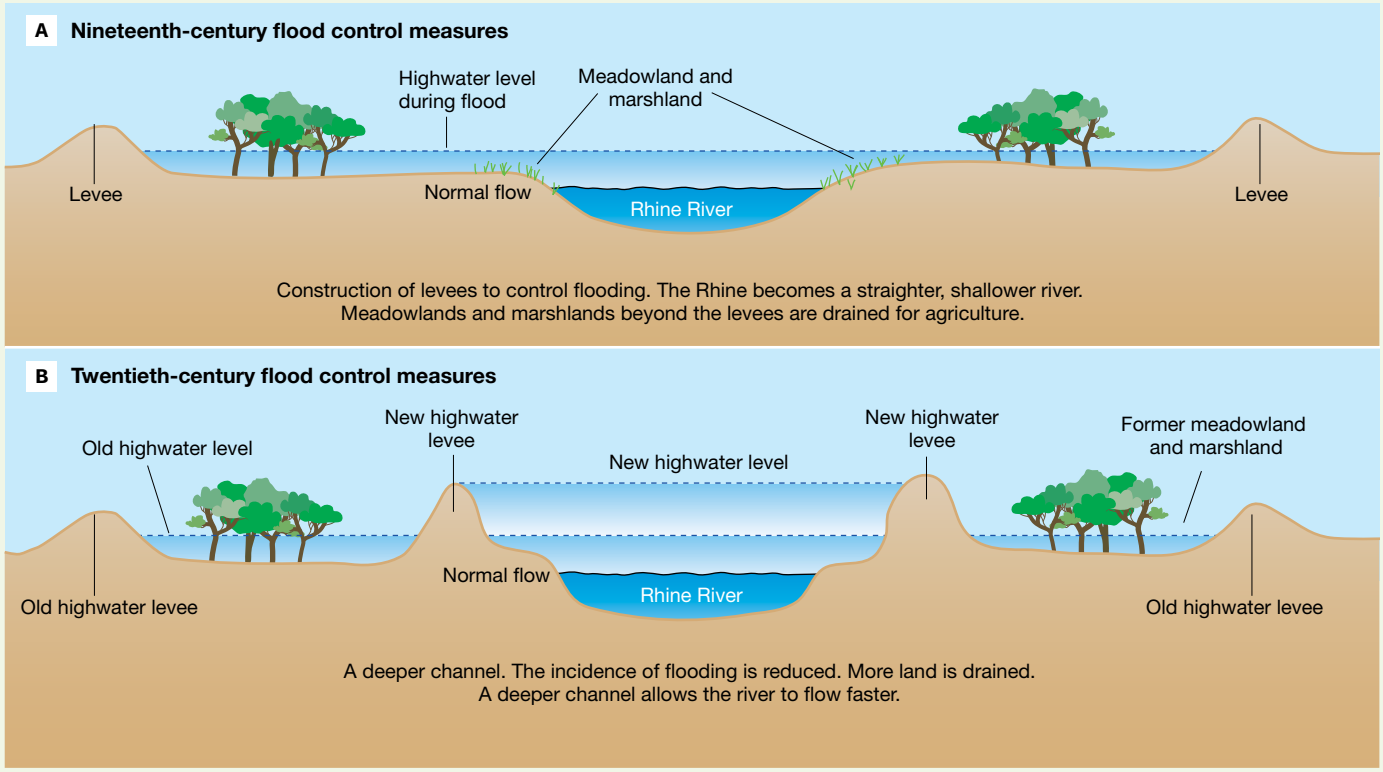
The main pollutants include nutrients, toxic chemicals, warm-water discharge and salt. The phosphates and nitrates found in detergents and agricultural fertilisers promote the growth of algal blooms.

3.3.8 The Rhine River is Europe's most important river system.

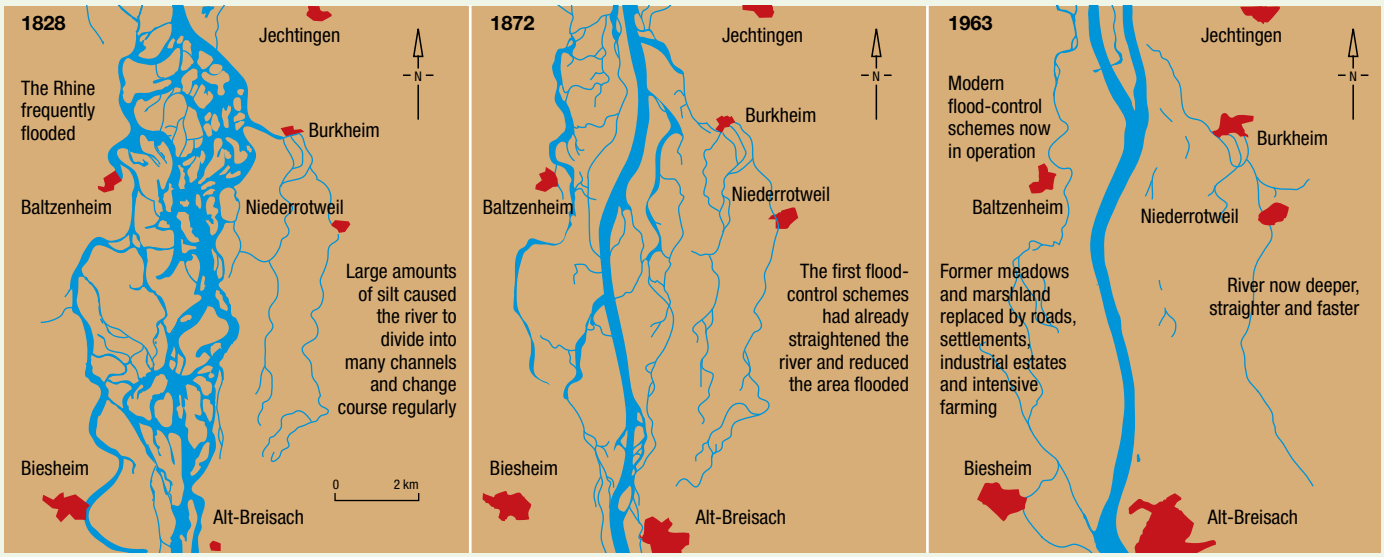
About one-third of all nitrogen discharged into the North Sea originates from the Rhine. Toxic chemicals in the river include cadmium, lead and mercury, which accumulate in the higher levels of the food chain. Warm water released from manufacturing plants and power stations disrupts the ecology of the river. Salt in the river comes mainly from the potash mines in Alsace.

Many of the toxic pollutants have settled into the mud on the floor of the Rotterdam harbour. Dredged material must be stored because it is too toxic to be dumped at sea.

3.3.9 River transport, Rhine River, Basel, Switzerland



3.3.10 Changes in flood control across the Rhine River



3.3.11 Changes in the hydrology of the Rhine River, 1828–1963

Activities

Working geographically

1. Write a factual report on the ways that human activities have impacted on the Rhine River in Europe.
2. Take on the role of a public relations officer for the local water authority. Your role is to prepare a presentation for local residents on why it is important that they manage their water use so as to avoid the need to build another dam in the area. Present a digital presentation to the class.

Exam-style questions

Extended responses

- Explain the operation of the water cycle and assess its importance to global ecosystem functioning.
- Account for the spatial distribution of the global water budget.
- Assess the impact of human activities on the hydrosphere.
- Analyse the effect of human activity on the operation of river systems.
- Explain the influences that the hydrosphere has on human activities around the world.

Glossary

aquifer a water-bearing layer of the earth's crust

catchment an area from which a river system or lake derives its water

condensation the process by which water changes from a gaseous state to a liquid state

drought a prolonged period of below-average rainfall that inhibits plant growth

evaporation the process by which water changes from a liquid to a gaseous state

flood the over-bank flow resulting from prolonged or heavy rainfall

groundwater water that has seeped into the ground and is contained within the soil or rock layer

hydrosphere the interconnected system of water in the atmosphere and lithosphere, including the oceans, ice caps, rivers and groundwater

impervious matter through which water cannot pass; also known as impermeable

infiltration the downward movement of water into the soil or rock

irrigation the supply of water to arable farming land by artificial means

precipitation the forms in which water passes from the atmosphere to the earth's surface, which include rain, sleet, snow, hail, dew and fog

run-off water that flows over the surface of the land

transpiration the discharge of water vapour from plants into the atmosphere

water budget the total amount of water available in an area; its inflows and outflows

water table the upper surface of the zone of saturation in permeable rock, sand or soil

CHAPTER

4 The lithosphere

The lithosphere is the solid, outer portion of the earth—its rigid upper mantle. The principal features of the lithosphere are the tectonic plates on which the ocean basins and continents are located.

This chapter will examine the processes that shape the surface of the land. It will also focus on the landforms shaped by water, wind and ice; the formation and characteristics of soils; and the ways people interact with the lithosphere. The study of landforms, their origin, evolution, type and distribution is called geomorphology.

The land surface is the most visible, and one of the most influential, aspects of the biophysical environment. The structural features of the earth's surface are subject to constant change. Some of these changes can easily be seen, as when a volcano erupts or when a landslide tears away a hillside. Others are too slow to be visible over a human lifetime. Valleys deepen and widen and ocean waves gradually reshape the margins of the land. Mountains may seem everlasting, but after every storm our rivers are heavy with sediment washed from their slopes.

> **There are no passengers on Spaceship Earth. We are all crew.**
>
> **Marshall McLuhan**

4.0.1 Mount Bromo, East Java, Indonesia

UNIT 4.1

Forces that shape the earth's surface

The presence of soaring mountains, deep gorges and rugged coastlines all tell of the ongoing battle between opposing forces: tectonic and gradational. The forces of gradation, which result from gravity and the radiant energy of the sun, wear down and smooth the earth's surface. Figure 4.1.1 shows how exposed rocks are subject to weathering. Tectonic forces, the result of the earth's internal energy, upheave the land surface. These forces deep within the earth have pushed up and created new landforms. If it were not for tectonic forces, the earth's surface would have been reduced long ago to a flat, featureless plain by the relentless gradational processes of weathering, mass movement and erosion. The Snowy Mountains of south-eastern Australia were, for example, once 5000 metres higher than they are today. Millions of years of gradation have lowered them to their current height and rounded form.

Catastrophic earthquakes and volcanic eruptions have been responsible for the formation of some of the earth's most spectacular scenery. Yet the majority of landform features associated with the earth's internal forces are the result of small, largely discrete movements that are constantly repeated over millions of years. Most of the rock masses seen at the earth's highest elevations were originally formed on ancient ocean floors. This is evidenced by the fossilised remains of marine organisms found on top of the lofty Himalayan Mountains.

Occupying a part of the Great Rift Valley (see Figure 4.1.2), the Red Sea was formed as Arabia split from Africa due to plate tectonics. A number of volcanic islands rise from the centre of the sea. Most are dormant, but in 2007, the volcano on Jabal al-Tair island erupted violently.

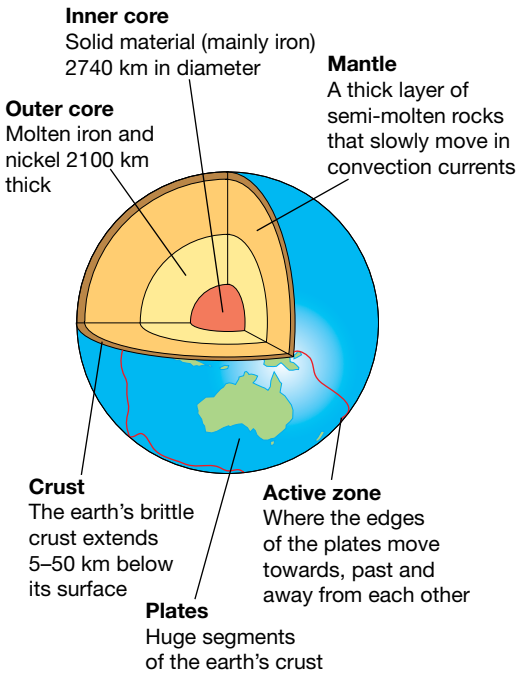
Looking inside the earth

Tectonic activity, whether it is sudden and violent or slow and imperceptible, occurs within the outer shell of the earth known as the lithosphere. The lithosphere is the solid portion of the earth (as opposed to the liquid hydrosphere and gaseous atmosphere). It encompasses all solid materials between the earth's surface and the overlying mantle of its core. As large amounts of these materials are inaccessible, their effects on the surface features of the earth are still not fully understood.

For many years, scientists have been aware that the earth's rumblings and joltings originated from movements deep within the earth. They have pondered not only the nature of the earth's interior, but ways of exploring below the surface.

4.1.1 The weathering of exposed rock

4.1.2 The Great Rift Valley in Kenya was formed by tectonic plates moving apart.



4.1.3 The earth in cross-section. The tectonic movements that shape the earth's surface features take place in the lithosphere.

Scientists developed techniques that enabled them to gain a greater understanding of the structure of the earth. For example, when an earthquake strikes, the earth reverberates with shock waves. These waves, called seismic waves, travel through the earth. The speed of seismic waves varies according to the properties of the material through which they pass. From a study of thousands of seismographs, the depth, density, physical state and type of rock in each layer below the surface can be inferred.

To understand the forces at work within the lithosphere it is necessary to know how this sphere relates to the internal structure of the earth. Figure 4.1.3 illustrates the internal structure of the earth.

The core

Extending about halfway to the surface from the earth's centre is the core, which has a radius of 3400 kilometres. Because of the intense heat at the centre of the earth, the core is thought to consist of molten rock. Scientists, however, are not certain of the physical state of this material, since the combination of high pressure and temperature at the centre of the earth cannot be duplicated in laboratories.

Surrounding the inner core is the mantle, believed to be about 2900 kilometres thick. Temperatures in the mantle are high enough to melt rock material, but pressures are so intense at these depths that most of the mantle is rigid. However, within the upper mantle, there is a soft layer of partially molten rock known as the asthenosphere. Movement of material in the asthenosphere plays an important role in shaping the earth's surface.

There is a distinct boundary between the mantle and the lithosphere. The surface of this separation is known as the Mohorovicic Discontinuity, or Moho, a simplification of the name of the seismologist who discovered it.

The crust

The outermost and thinnest of the earth's layers is its crust. This uppermost part of the lithosphere is the most accessible part of the earth's structure. The depth of the crust varies from 40 kilometres beneath the continents to 6 kilometres beneath the deep ocean floors. This variation is a result of differences in rock density in the two areas.

Rather than forming a single, continuous shell over the earth, the lithosphere is broken into a number of large units, called plates. These move over the partially molten material in the asthenosphere.

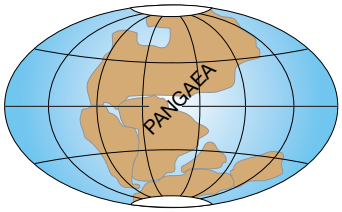
Activities

Understanding the text

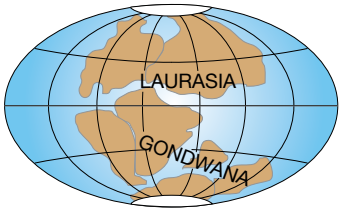
1. Describe the two sets of forces that shape the earth's surface.
2. State what the lithosphere is. How does it differ from the hydrosphere and the atmosphere?
3. Explain how scientists were able to establish what is below the earth's surface when it is so inaccessible.
4. Identify, with the aid of a diagram, the layers that make up the internal structure of the earth.
5. Explain why the depth of the crust varies.
6. State what the lithospheric plates are.

UNIT 4.2

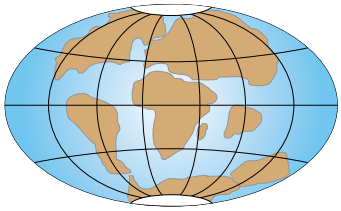
Continental drift and the origin of the continents



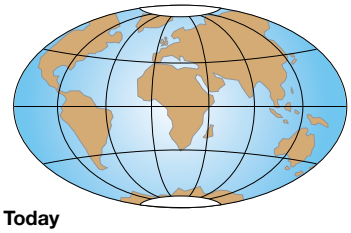
225 million years ago
One large supercontinent called Pangaea



180 million years ago
Pangaea begins to break up. Laurasia and Gondwana can now be easily distinguished



65 million years ago



Today

4.2.1 The movement of the continents

The publication of Alfred Wegener's theory of continental drift in 1915 provided an explanation for the striking similarity between the edges of the shoreline on the two sides of the Atlantic Ocean, especially between those of Africa and South America. Wegener's findings were based on the matching of fossils and rocks from the coastal regions of two continents. He suggested that the only reasonable conclusion to be drawn from this was that the currently isolated continents shifted laterally from a former 'supercontinent'.

Pangaea

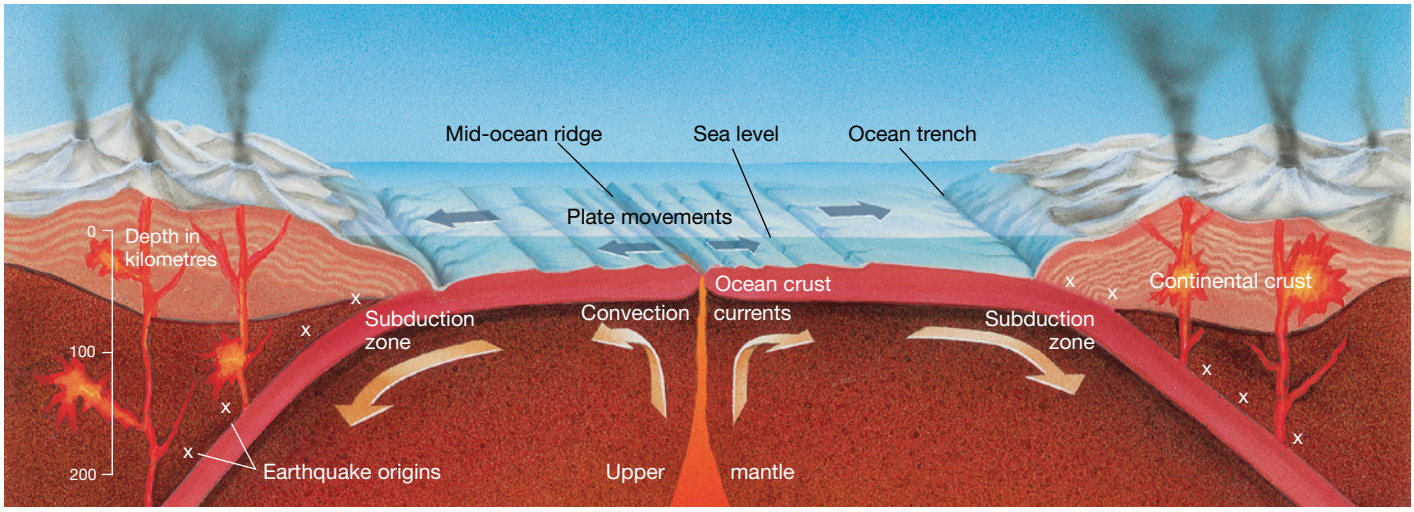
The supercontinent was named Pangaea and was believed to consist of two main parts: Laurasia (Asia, Europe, Greenland and North America) and Gondwana (Australia, Antarctica, Africa, India and South America). Laurasia and Gondwana began to move apart about 200 million years ago. Each part of the original land mass (today's continents) slowly drifted to its present location. The broken pieces of the supercontinent, it was argued, could all fit back together like the pieces of a giant jigsaw puzzle. Figure 4.2.1 shows the movement of continents over the aeons.

Wegener's theory was generally rejected at the time, because it lacked a plausible mechanism to explain the movement of the continents. Subsequent geological investigations of the mid-Atlantic Ocean have shown that the sediments near the mid-Atlantic ridge are thin and relatively young, while those progressively further away are broken and older. This indicates that new land is being created and is forcing the continents further apart as it emerges.

Plate tectonics

The essential points in formulating the theory of plate tectonics were:

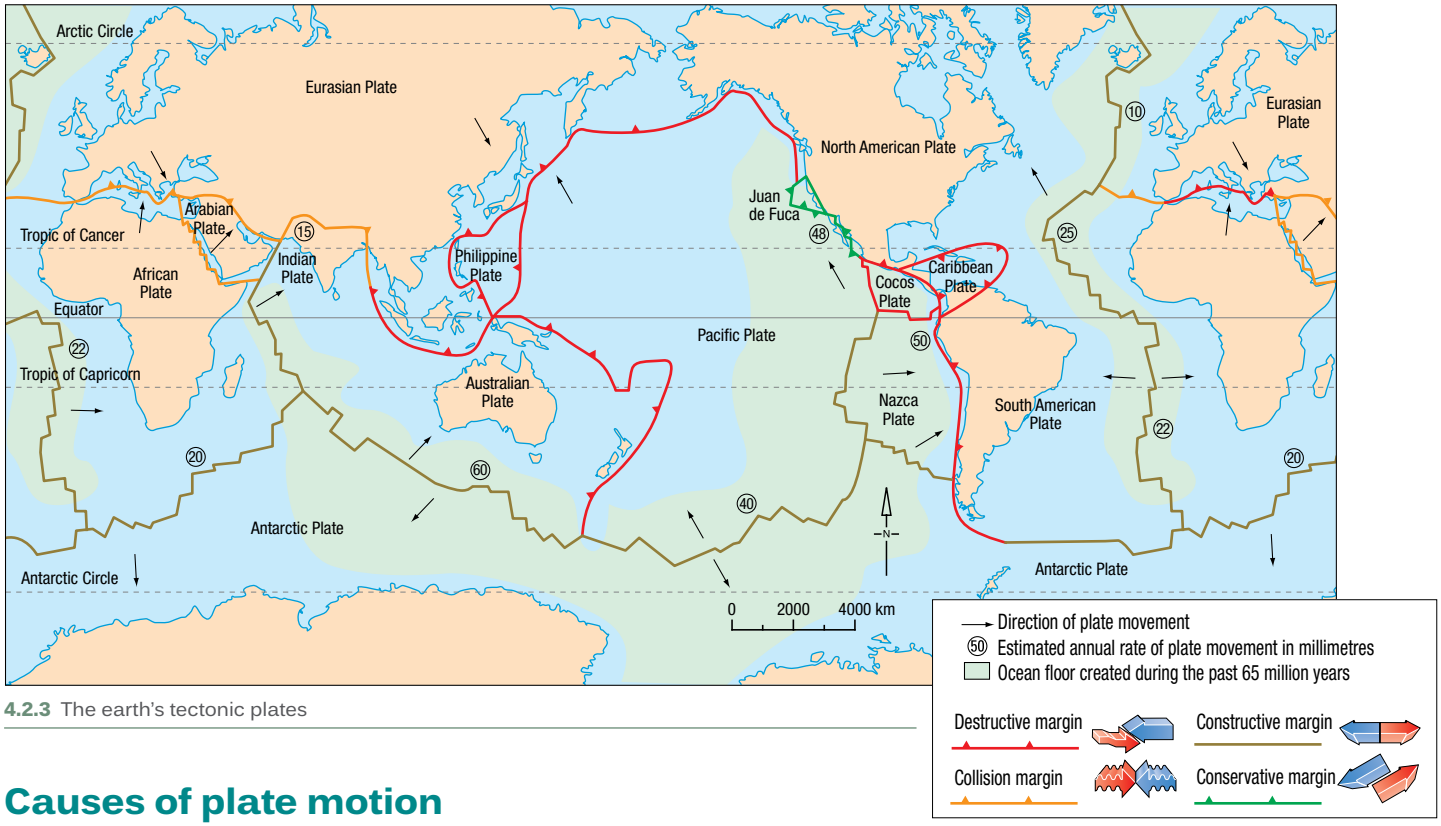
- identification of the asthenosphere as a layer of weak, plastic-like material that acts as a lubricating layer
- identification of the cold, rigid, lithospheric plates moving like great rafts over the fluid asthenosphere
- the idea that if new oceanic crust is being continuously created along the mid-ocean ridges, either the earth must be expanding and the oceans must be getting larger, or an equal amount of old crust must necessarily be destroyed in order to maintain an earth of constant size.



4.2.2 Tectonic processes

Figure 4.2.2 shows how a convection current in the asthenosphere rises, separates and forms a mid-ocean ridge. The convection current sinks again where the oceanic plate meets the continental plate. As it sinks, it carries the solid rocks of the crust downwards into the earth's interior where they melt back into the asthenosphere. The places where this downward movement occurs are known as subduction zones.

Figure 4.2.3 shows five major lithospheric plates, as well as a number of minor ones. Scientists working for NASA have now measured the velocities of plate movements using satellites and lasers. Their calculations have confirmed earlier suggestions that the earth's plates move at speeds of between 1.5 and 7 centimetres per year. Australia continues to drift north at a rate of 6.7 centimetres per year.



4.2.3 The earth's tectonic plates

Causes of plate motion

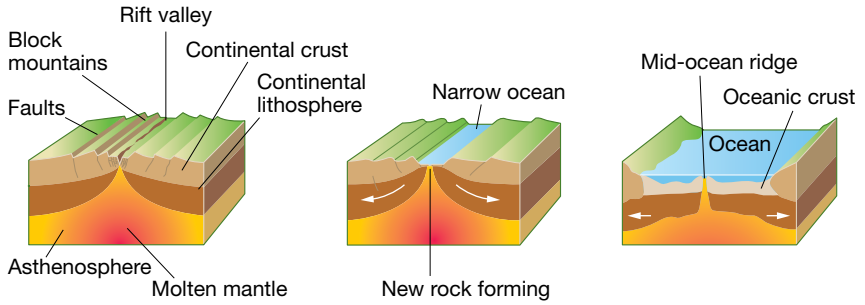
Convection currents within the earth's mantle have long been regarded as the cause of plate motion. The rising magma at the diverging mid-ocean ridges is believed to push the plates apart horizontally. The depth of mantle convection is still unknown. Some recent research suggests that it is shallow and largely confined to the asthenosphere, rather than extending further into the mantle.

Plate movements

The lithospheric plates are rigid slabs of rock that move individually. For this reason, as a unit, their inner parts are relatively inactive. Almost all tectonic and volcanic activity on the earth's surface takes place at the boundaries of the plates. At the boundaries they diverge, converge or slide past one another. Each type of boundary produces distinctive and recognisable landform features.

Diverging plate boundaries

Diverging plate boundaries are the points where plates separate and new crust is created. Figure 4.2.4 illustrates this process.



1 Plates break apart, forming a rift valley, faults and block mountains (e.g. African Rift Valley)

2 Plates move apart and new rocks are formed on the ocean floor (e.g. Red Sea)

3 With further movement the sea floor spreads to form major oceans (e.g. Atlantic Ocean)

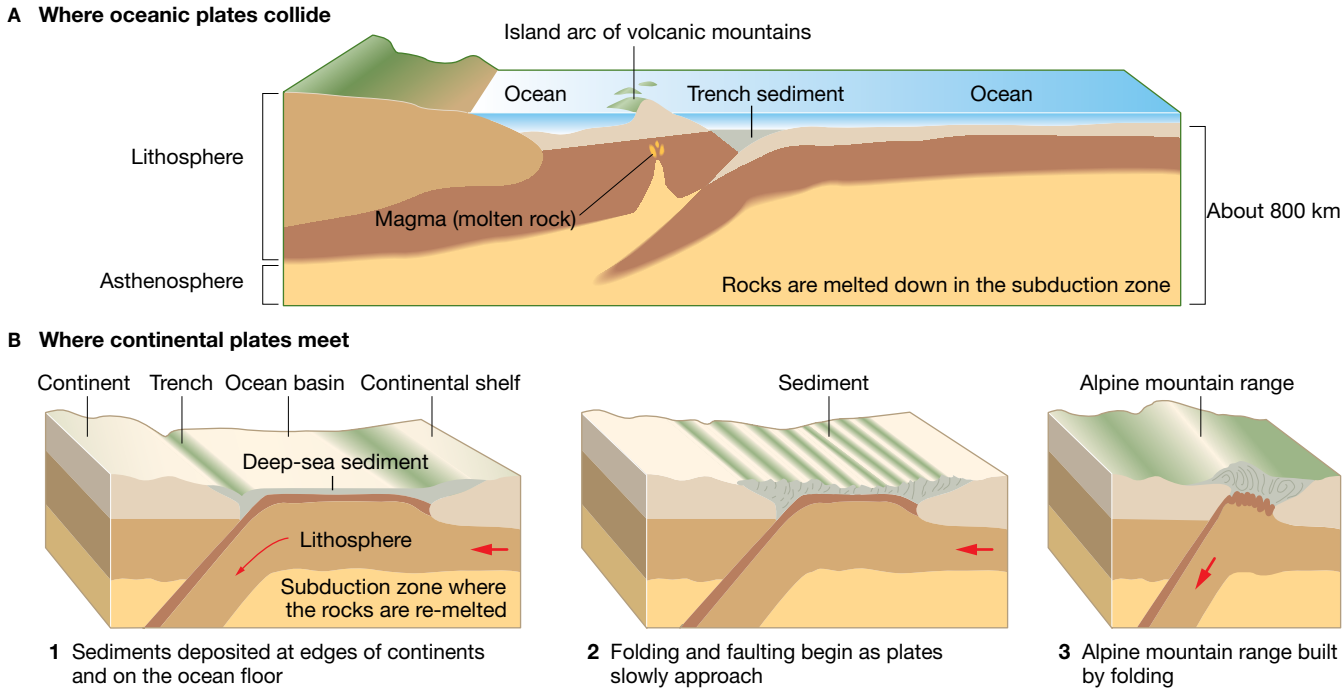
4.2.4 Divergence of tectonic plates

As the plates move apart, molten material fills the gap, forming a mid-ocean ridge. These ridges extend for some 65 000 kilometres throughout the earth's oceans. The islands of Hawaii in the mid-Pacific are, for example, the peaks of a mid-ocean ridge.

Converging plate boundaries

Converging plate boundaries are the points where plates collide. The process of sea-floor spreading increases the earth's land surface area. To balance this process, collisions between plates are necessary. The destruction of the old lithosphere takes place in the subduction zones. A subduction zone is an area where two tectonic plates come together, one riding over the other. The following are the types of collisions that occur:

- **Colliding oceanic and continental plates:** When an oceanic and a continental plate collide, the dense floor of the ocean is subducted (or forced down) beneath the less dense continental plate. This forms a deep trench. The descending slab of the sea floor melts and then erupts in a chain of volcanoes along the edge of the continental plate. Over hundreds of millions of years, the Andes Mountains of South America were formed in this way.
- **Colliding oceanic plates:** When oceanic plates collide, the plate that is older, colder and therefore denser, subducts under the other, forming a trench. This movement weakens the crust, and molten rock escapes to the surface, forming islands of volcanic mountains. Chains of active volcanoes form on the landward side, parallel to the deep sea trench. Examples of such island arcs in the Pacific basin include the Aleutians, the Philippines and Japan. Figure 4.2.5 A shows how such islands are formed.



4.2.5 Convergence of tectonic plates

4.2.6 The Himalayas are continuing to be pushed upwards as the Indian Plate rams into the Eurasian Plate.

- **Colliding continental plates:** When two continental plates meet as shown in Figure 4.2.5 B, neither will subduct because both are of the same density. Volcanism is not common in these areas, but folding of the crust, mountain-building and earthquakes occur over a broad area. The Himalayan Mountains (see Figure 4.2.6) were formed in such a way and are still moving. After the breakup of Gondwana, India moved as an island some 3000 kilometres from its original location in the Southern Hemisphere. The continents eventually collided, with India pushing deep into Asia.

Horizontal movements

Where plates move horizontally past each other along a single vertical fault line, the release of built-up pressure causes earthquakes. The San Andreas Fault in California is a major fault system arising from movement between the Pacific and North American plates.

Mountain building

The world's great mountain ranges coincide with the advancing edges of the earth's continental plates. They are a product of plate tectonics. As the continental plates collide, the earth's crust thickens in an effort to absorb the impact. As it does so, pressure is exerted and layers of rock are compressed and forced upwards, folding and faulting as they go. Mountains are landform features composed mostly of steep slopes and large amounts of local relief within a specified area.

As continental movements tend to be very slow, the mountain chains they produce are dominated by folded rock strata (layers of rock) and are therefore classified as Fold mountains. Folds are wave-like patterns in the earth's crust. Mountains can also be the result of faulting and volcanic activity. Faults are fractures in the rock structure. Rift valleys and block mountains are large-scale landforms associated with faulting.

Activities

Understanding the text

1. Outline Wegener's theory of continental drift. What is the evidence supporting this theory? Why was it generally rejected at the time?
2. Identify the discoveries that helped to revolutionise our understanding of movements within the lithosphere.
3. Explain why the discovery of the asthenosphere is so significant to the theory of plate tectonics.
4. State what is regarded as the cause of plate motion.
5. Identify where almost all the tectonic and volcanic activity on the earth's surface takes place.
6. Describe the distinctive features produced at the different types of plate boundaries.
7. Describe the relationship between the location of the world's great mountain ranges and continental plates.
8. Explain how mountain ranges are formed.
9. Distinguish between mountains formed by folding and those formed by faulting.

Earthquakes

Earthquakes are a series of rapid vibrations caused by sudden movements within the earth's crust. These movements are usually the result of the fracturing or faulting of rock strata that have been placed under great stress. The energy released by these sudden movements travels through the earth in a series of waves that spread out from the focus (the point where the earthquake begins) and epicentre (the point on the earth's surface directly above the focus) of the earthquake. When earthquakes occur in heavily populated areas they can cause widespread devastation (see Figure 4.2.7). Most loss of life is caused by collapsing buildings, fires and tsunamis.

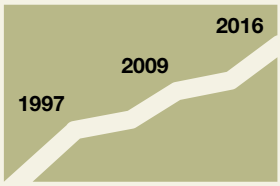
Worst earthquakes 1900–2015

Location	Year	Magnitude scale	Deaths
Sumatra–Andaman Islands	2004	9.3	295 000
Haiti	2010	7.0	222 000
Gansu, China	1920	8.6	200 000
Xining, China	1927	8.3	200 000
Japan	1923	8.3	143 000
Sichuan, China	2008	7.9	87 500
Kashmir, Pakistan	2005	7.6	86 000
Bam, Iran	2003	6.6	40 000
Iran	1990	7.7	35 000
Chillan, Chile	1939	8.3	28 000
Armenia	1988	6.9	25 500
Santiago, Chile	1906	8.6	20 000
Kangra, India	1905	8.6	19 000
Central Asia	1907	8.1	12 000
India/Nepal	1934	8.4	10 700
Mexico	1985	8.1	9 500
Nepal	2015	6.3	8 000
Java, Indonesia	2006	6.3	5 700
Chile	1960	9.5	4 485

4.2.7 Worst earthquakes 1900 to 2015

On 24 August 2016, a magnitude 6.2 earthquake hit the Apennine Mountains in central Italy, devastating the small towns of Amatrice, Accumoli and Pescara del Tronto. On October 26, two aftershocks of magnitude 5.5 and 6.1 hit Visso, north of Amatrice. On October 30, a magnitude 6.6 earthquake struck Norcia, situated between Amatrice and Visso. Overall, 299 lives were lost. The country is particularly exposed to earthquake risk as it is located where continental plates collide and building stock is vulnerable.

Human impact	**Economic loss**	**Impact on buildings**	**Historic footprint**	**Protection gap**
299 lives lost 390 injured over 10 000 homeless	The economic losses were US$6 billion. Insurance coverage paid out US$200 million.	The exact number is not known but over 10 000 people are now homeless. Satellite imagery shows whole quarters have been destroyed.	A large majority of the costliest and most frequent earthquakes in Europe have happened in Italy.	Just over 1% of residential buildings are insured against earthquakes, leaving reconstruction costs to society at large.



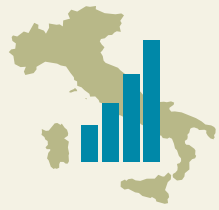
Earthquake in Italy 2016
The series is the third and fourth to hit the region since 1997. Assisi (1997) and L'Aquila (2009) were struck by earthquakes of similar magnitudes.

In 1703 and 1915, earthquakes of even higher magnitudes devastated the region with tens of thousands of fatalities. Italy has suffered eight major earthquakes since 1970.

The deadliest quake in Europe was the magnitude 7.2 earthquake in Messina, Sicily, in 1908. It was followed by a tsunami and claimed around 86 000 victims.

Italy's exposure to earthquakes
Since 1970, seven of the ten costliest earthquakes in Europe have hit Italy. The 1980 Irpinia earthquake was the sixth costliest worldwide since 1970.

The 1908 Messina earthquake was the eighth deadliest worldwide since 1900. In the 20th century, Italy had the highest number of earthquake-related fatalities in Europe.

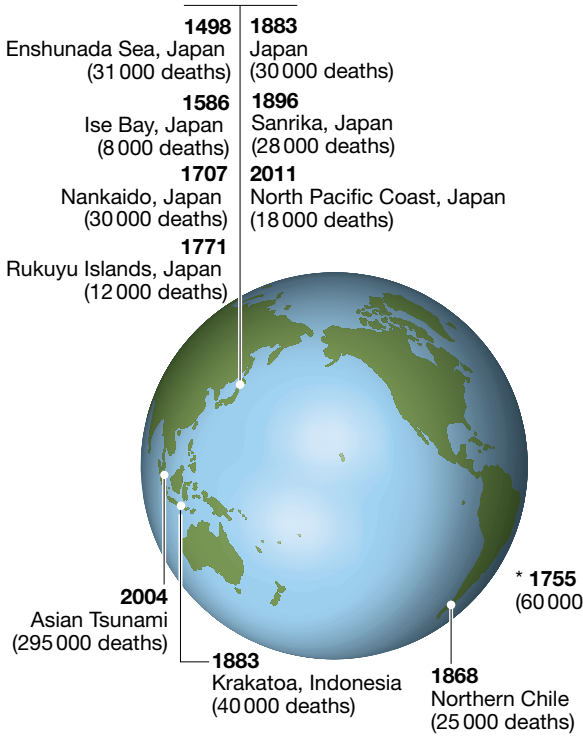


Key loss drivers from 2016 earthquakes
The final death toll from the string of earthquakes is 299.

In comparison, in April 2016, the magnitude 7.0 earthquake in Kumamoto, Japan, claimed 137 fatalities.

In the case of Italy, the shallow tremor combined with the vulnerability of old buildings increased the impact of the earthquake. The most stringent Italian building code zonation applies in the region. The many collapsed houses and fatalities we see are a consequence of the old vulnerable building stock still present in the area.

4.2.8 The Italian earthquake



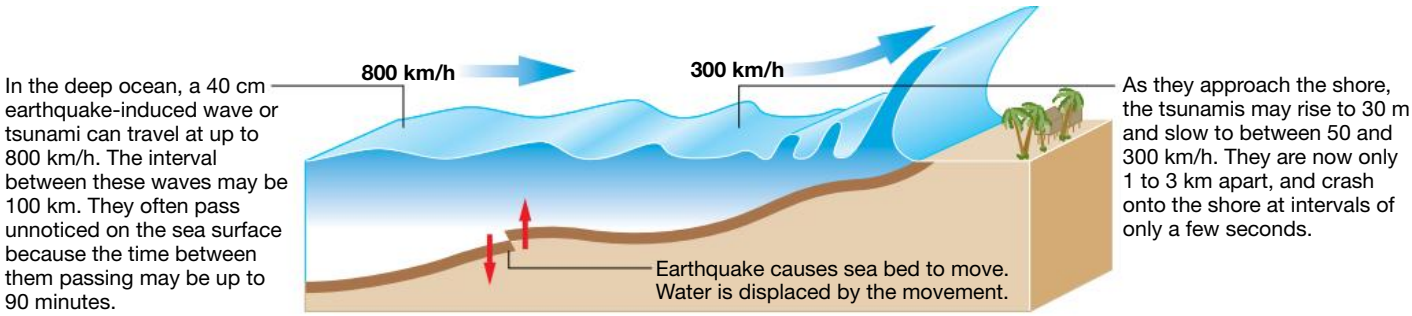
4.2.9 The deadliest tsunamis on record

Figure 4.2.8 outlines the damage from the 2016 earthquake in the Apennines, central Italy.

The world's most powerful earthquake struck southern Chile in 1960. It had a magnitude of 9.5 and left 4485 people dead or injured, and two million people homeless. The port of Puerto Saavedra was destroyed in the ensuing tsunami, which caused US$550 million worth of damage in Chile and killed a further 170 people as five-metre waves hit the coasts of Japan and the Philippines. A day later, Volcán Puyehue in Chile's lake district spewed ash 6000 metres into the air in an eruption that lasted for several weeks.

Tsunamis

Tsunamis are large ocean waves, usually associated with earthquakes, landslides, or volcanic eruptions in or adjacent to land. Tsunamis can devastate coastal communities, as shown in Figures 4.2.9 and 4.2.10.



4.2.10 The formation of a tsunami

Japanese tsunami of 2011

By Becky Oskin

A magnitude 9.1 earthquake shook north-eastern Japan on 11 March, 2011. It had been the largest earthquake to ever hit Japan and it unleashed a savage series of tsunami waves. The earthquake struck offshore of Japan along a subduction zone where the Pacific Plate dives under the overriding Eurasian plate. As the earthquake occurred at quite a shallow depth of only 24 km, most of its energy was released at the seafloor. About an hour after the quake, waves of over ten metres hit the east coast of Japan, sweeping away vehicles, severing roads and destroying buildings.

The tsunami waves reached run-up heights (how far the wave surges inland above sea level) of up to 39 metres at Miyako city and travelled inland as far as 10 km in Sendai. The tsunami flooded an estimated area of approximately 561 square kilometres in Japan. The waves even overtopped and destroyed protective tsunami seawalls at several locations.

At least 28 000 people died or went missing across swathes of the eastern coast of Japan and over 465 000 were displaced. The massive surge even caused three-story buildings where people had gathered for safety to collapse. More than 138 000 buildings were destroyed and economic cost of the disaster was US$360 billion. Figure 4.2.11 shows the extent of damage from the tsunami. The tsunami caused a cooling systems failure at the Fukushima Nuclear Power Plant which resulted in a nuclear meltdown and release of radioactive materials. The electrical power and backup generators were overwhelmed by the tsunami, and the plant lost its cooling capabilities.

The earthquake triggered tsunami warnings throughout the Pacific region as the waves raced outwards from the epicentre at speeds approaching 800 kilometres per hour.

The following facts illustrate the immensity of this event:

- The earthquake shifted earth on its axis of rotation by redistributing mass, like putting a dent in a spinning top. The temblor also shortened the length of a day by about a microsecond.

4.2.11 The aftermath of the tsunami, showing the level of destruction

- More than 5000 aftershocks hit Japan in the year after the earthquake, the largest a magnitude 7.9.
- About 250 miles (400 kilometres) of Japan's northern Honshu coastline dropped by 0.6 metres, according to the US Geological Survey.
- The jolt moved Japan's main island of Honshu eastward by 2.4 metres.
- The Pacific Plate slid westward near the epicentre by 24 metres.
- In Antarctica, the seismic waves from the earthquake sped up the Whillans Ice Stream, jolting it by about 0.5 metres.
- The tsunami broke icebergs off the Sulzberger Ice Shelf in Antarctica.
- As the tsunami crossed the Pacific Ocean, a 1.5-metre-high wave killed more than 110 000 nesting seabirds at the Midway Atoll National Wildlife Refuge.
- In Norway, water in fjords pointing toward Japan sloshed back and forth as seismic waves from the earthquake raced through.
- The earthquake produced a low-frequency rumble called infrasound, which travelled into space and was detected by the Goce satellite.
- Buildings destroyed by the tsunami released thousands of tons of ozone-destroying chemicals and greenhouse gases into the air.

Source: Live Science website, 'Japan Earthquake & Tsunami of 2011: Facts and Information', 2017

Volcanic activity

Volcanic eruptions occur when molten rock reaches the earth's surface, through cracks or faults in the underlying rock structures. Figure 4.2.12 shows the eruption of Alaid volcano. Once it reaches the earth's surface, the molten material (lava) cools and hardens. Over time, successive layers of lava and volcanic ash may build up a volcanic cone. A caldera, or crater, forms when a particularly violent eruption blasts away the top of an existing volcanic cone. The most active volcanoes lie in volcanic belts that coincide with zones where there is fracture of, and collision between, the earth's crustal plates.

4.2.12 Night view of the eruption of Alaid volcano in 1988. Alaid is 2339 metres high, and forms the bulk of Ostrova Atlasova, an island in the Kuril chain north of Japan. An explosive eruption is in progress at the cone, with volcanic bombs leaving trails of light in the sky. In the foreground is a lava river.

Land formation

Volcanic eruptions can produce landforms in a rapid and spectacular manner. Some of the world's largest mountains and many of the islands that dot the world's oceans are the result of past volcanic activity. It is estimated that more than 1500 volcanoes in the world could be active today with 500 million people living near them. Recent major eruptions have occurred at Mt St Helens in the United States (1980), Mt Pinatubo in the Philippines (1991) and Mount Merapi in Indonesia (2010).

Large-scale eruptions

The annual level of volcanic activity is surprisingly high. In 2007, for example, there were 19 ongoing major volcanic eruptions and 29 new eruptions. Large-scale eruptions may result in short-term climatic change as millions of tonnes of volcanic ash and smoke are released into the atmosphere, reducing the amount of sunlight reaching the earth's surface.

The Tambora eruption in Indonesia in 1815 is the largest in modern history. It killed 120 000 people. According to the Global Volcanism Program, it was the only eruption in at least 1000 years to rate 7 on the Volcanic Explosivity Index (VEI; each number on the scale represents an eruption 10 times more powerful than the previous). The eruption cast a pall of ash around the world, lowering global temperatures by more than 2.8°C. The result was the 'year without a summer' in 1816. About 300 centimetres of snow fell in Canada's Quebec City in the middle of summer. The eruption is also credited with the invention of the bicycle, as the cost of maintaining horses rose because of the rising cost of oats as well as the deaths of many horses.

Gradational processes

Whereas tectonic activity causes the earth's surface to be uneven, gradational processes work to smooth out the surface. Newly formed features of the lithosphere immediately come under attack when they are exposed to atmospheric processes and gravity. Exposed rock material is fragmented by weathering, detached by mass movement and agents of erosion and then deposited at lower elevations as debris. Gradational processes act upon the surface of the lithosphere, wearing down high places and filling in low places. Tectonic forces constantly disturb the surface of the land, creating new landscapes upon which gradational processes can work. Figure 4.2.13 shows the Horseshoe Bend at Colorado River, which is a landscape created by gradational forces.

4.2.13 Horseshoe Bend, Colorado River, is a distinctive landscape created by gradational forces.

SPOTLIGHT

Mount Merapi eruptions of 2010

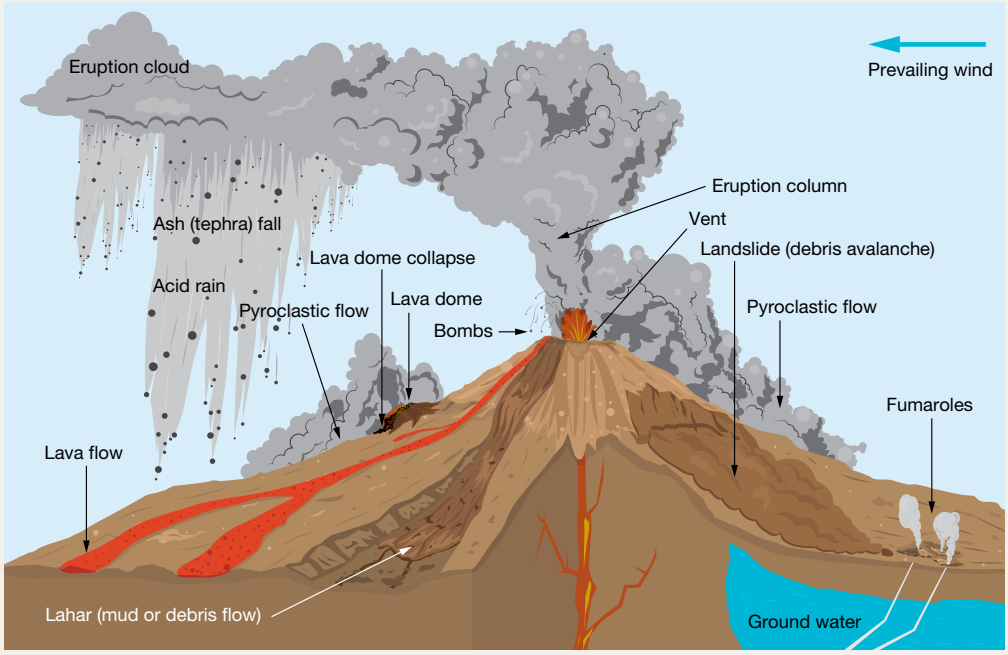
Sitting over a tectonic plate boundary, Indonesia has more active volcanoes than any other country. Mount Merapi—a steep stratovolcano in Central Java—is the youngest of a volcanic chain extending along the plate boundary. Mount Merapi is Indonesia's most active volcano and erupts on average every five to ten years. During eruptions, new lava domes grow in the summit crater and when they collapse and slide down the steep flanks of the mountain, pyroclastic flows are generated. These avalanches of hot rocks and gases are deadly. Figures 4.2.14 and 4.2.16 show the hazards created by the eruption of Mount Merapi.

Mount Merapi dominates the landscape in one of the most densely populated areas of the world. Rapid population growth and increased pressures on land use forces people to live in the danger zone on the slopes of the volcano where the rich, fertile volcanic soil is used to grow rice. When the eruptions began in 2010, over 350 000 people were evacuated but many remained behind. As the eruptions continued, others chose to return and in all 353 were killed, many scorched by the pyroclastic flows. Figure 4.2.15 shows rescue efforts after the 2010 Mount Merapi eruptions.

Mount Merapi presents as one of the most dangerous volcanoes in the world. With its persistent minor eruptions it is long-overdue for a large-scale eruption that could put at risk over 1.1 million people. There are 300 communities that live on the slopes of Mount Merapi. Thus far the deadliest eruption occurred in 1672, when 3000 people were killed.

4.2.14 Plumes of smoke rise over 10 000 metres into the air as Mount Merapi erupts in 2010.

4.2.15 Houses are in flames as volunteers rescue burned victims of the eruption of Mount Merapi in Argomulyo village early on 5 November, 2010.



4.2.16 The hazards created by the eruption of Mount Merapi which damaged the surrounding area

Physical weathering	
Type	**Description**
Unloading	Unloading occurs when rocks, once deeply buried, have the weight and pressure of overlying material removed. The rocks expand and may crack along joints parallel to the surface and peel off in sheets.
Frost action	When water held in the tiny fissures of rocks freezes, it expands by approximately 10% of its volume, forcing cracks to part. Recurrent freezing and thawing, especially on a daily basis, enlarges such cracks.
Organic action	The germination of seeds and the wedging of roots in the cracks of rocks exerts pressure, causing the cracks to widen. Burrowing animals, such as rabbits and earthworms, allow air to penetrate further. This may indirectly accelerate weathering.
Note: While some experts now disregard temperature change, or thermal expansion and contraction of rock, as being a significant weathering process, others argue that it is important in some contexts. In the Australian bush, for example, the extreme heat associated with bushfires can have a dramatic effect on the exterior of rocks. Experts now consider biological activity, for example the impact of plant roots (in relation to physical and chemical weathering) to be the most influential weathering process.	
Chemical weathering	
Type	**Description**
Oxidation	Minerals react with oxygen to form oxides and, as water is also usually involved, hydroxides. Iron is the most common element in the process. Rocks containing iron appear to be rusting as their surface decays.
Solution	This is the process by which weak acids dissolve minerals in rocks and distribute them in solution. Limestone is susceptible to attack from carbonic acid, formed when carbon dioxide is dissolved in rainwater. Limestone caves and karst landscapes (those shaped by the dissolving of soluble layers of bedrock, usually carbonate-based rocks, such as limestone or dolomite) are a result of this process.
Hydration	Rocks expand as their minerals chemically combine with water. Clay minerals have an enormous capacity for such water uptake. This results in what has been termed physio-chemical weathering.
Organic acids	Organic acids are produced when water combines with the decaying organic material in humus. The acids attack (and weather) rocks as they seep through the soil.

4.2.17 Types of weathering

Weathering

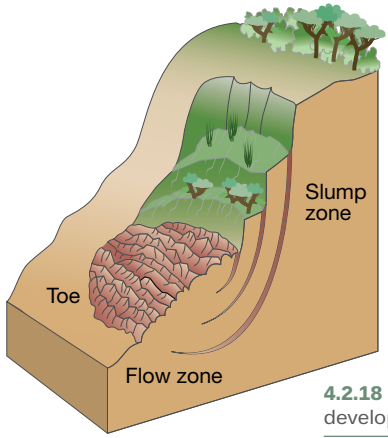
Weathering is the in situ physical disintegration and chemical decomposition of rocks and minerals at or near the earth's surface by atmospheric and biological agents. Weathering is an essential prerequisite for many types of erosion as it loosens surface material, making it more readily removed. The process of weathering is often unobtrusive. Physical weathering slowly breaks up the rocks of the land surface into smaller particles but does not change their chemical composition. Chemical weathering involves the actual decomposition of rocks, primarily by means of exposure to water, oxygen and carbon dioxide. Most of the original minerals formed deep in the earth's crust are changed by chemical weathering into new compounds. These compounds are usually stable in the atmosphere and the conditions (temperature and air pressure) that exist at the earth's surface. The substantial age and stability of the Australian continent have produced a great thickness of rock that has been modified by the process of weathering. In some areas the modified rock exists to a depth of 100 metres. Figure 4.2.17 distinguishes the types of weathering.

Mass movement

Once weathering has reduced the size of rock particles, it is easier for them to be loosened and removed from the site. When this occurs in response to gravity it is known as mass movement. In some such movements the fragments of weathered material tend to stay together and move as a unit in bulk. In other instances, such as soil creep and flow movements, different layers of material flow at different rates.

The nature of the moving material varies greatly and includes everything from great slabs of solid rock to loose, unconsolidated rock debris and soil. Sometimes this form of movement will be quite abrupt, as when a landslide releases millions of tonnes of material in a spectacular plunge. At other times it will be imperceptibly slow. For instance, it may only be leaning fence posts, trees and power poles that reveal the relentless downslope movement of soil, a process often referred to as soil creep.

Mass movements often leave visible scars on the land surface. Heavy rainfall saturating the land surface may trigger a slump or flow (the sudden downslope movements of earth and rock). These are particularly common in clay-rich soils, which become slippery when wet. Water acts as a lubricant that weakens the binding properties of the soil and rock material. See Figures 4.2.18 and 4.2.19.



4.2.18 An earthflow with slump features well developed in the upper part

Erosion and deposition

The shaping of the land's surface continues with the processes of erosion, and then the transportation and subsequent deposition of material. The ultimate resting place for eroded and transported material is the lowest place: the ocean floor. Eventually, most loose material will find its way to the sea. It will have been collected and carried there by the agents of erosion: wind, running water and glacial ice.

A vast range of erosion, transportation and deposition processes operate on the earth's surface. The most important of these are water, wind and ice. The action of running water (the fluvial process) is normally considered to be the dominant landscape-shaping process and the action of waves the most dominant process in shaping coastlines.

4.2.19 Aerial photograph from a survey showing the extent of the mudslide of 22 March 2014 that covered 2.5 square kilometres near the rural community of Oso, north-east of Seattle, Washington State, USA. A total of 43 people died here when heavy rain caused this unstable hillside to collapse. The area is prone to landslides, with previous collapses and mudslides dating back to at least 1937.

Activities

Understanding the text

1 Explain what an earthquake is.
2 Explain what a tsunami is.
3 Identify where most active volcanoes are found.
4 Explain how volcanic eruptions create short-term changes in climate.
5 Explain the role of gradational forces in shaping the earth's surface.
6 Define what is meant by the term weathering. Why is it such an important process?
7 Differentiate between physical and chemical weathering.
8 Outline the ways weathered material can be moved downslope.

Working geographically

9 Study Figure 4.2.1. What evidence can you see to support the theory of continental drift?
10 Study Figures 4.2.2 and 4.2.3.
   a Name the mountain ranges formed by the collision of the following crustal plates:
      i the Indian and Eurasian plates
      ii the South American and Nazca plates.
   b Refer to an atlas and identify islands in the Atlantic Ocean that are part of the mid-ocean ridge.
   c Identify two continents that have deep ocean trenches offshore because of subduction.
11 Collect media reports about recent earthquakes and volcanic eruptions. These may include video recordings, webpage snapshots and newspaper and magazine articles. Write a synopsis of the material gathered and present the information to the class.
12 Investigate one of the tsunamis shown in Figure 4.2.9. Outline the impact of the tsunami on the communities affected.
13 Investigate the spread of tsunami waves across the Pacific Ocean from the Japanese tsunami of 2011. Provide a map and account for the pattern observed.
14 Investigate the effects of mudslides and how this hazard has impacted on communities.

UNIT 4.3

Landforms shaped by water, wind and ice

Over time water, wind and ice can have a huge impact on the shape (morphology) and character of the land.

Landforms shaped by water

Water is a significant agent of weathering and mass movement, but it is as an agent of erosion that it has the largest impact.

Fluvial processes: rivers and streams

Even the impact of a single raindrop can dislodge particles of earth, feeding them as sediment load into running water or surface run-off. The running water becomes organised into rivulets and streams, collecting and carrying with it any loose material it encounters.

Running water is particularly effective in arid and semi-arid regions and where human activities have damaged the protective cover of vegetation that binds the soil together. Where rain falls on exposed earth, it quickly forms rivulets that erode deep channels, called gullies.

Once in the river, the water and its accompanying load erode the rocks and sediments over which the river flows. The processes involved are outlined below:

- **Hydraulic action:** This is the power of the flowing water itself. The surging water exerts a dragging action on the river bed and banks. This can excavate enormous quantities of poorly consolidated (that is, relatively loose) alluvial materials (sand, silt and gravel), especially during floods.
- **Abrasion:** This occurs when rock particles that are carried by the swift-flowing current strike channel walls. As they do so they grind off chips of rock and earth.
- **Corrosion:** This is due to the chemical solution of material from rocks being exposed to the stream by solvents carried in the river.

Material can be transported as bedload, suspension load and dissolved load. The bedload is moved by traction; that is, by rolling, sliding and bouncing along the channel bed. Once in the river, the sediment load may be temporarily deposited along the river's banks until it is brought back into motion and moved further downstream. This is usually associated with periods of high flow when the river's velocity increases. Most rivers have alluvial deposits; that is, they contain the sediment they themselves have transported and dropped.

Landform evolution

By observing the repeated cycles of river erosion and deposition it is apparent that these processes can occur quite quickly. This is especially the case when associated with periods of high river discharge or flow. In contrast, the process of landform evolution takes place slowly. Indeed, as we look around us the landscape looks static and enduring—frozen in time. This impression is misleading as landforms are continually evolving.

In the mountainous headwaters of river catchments, where gradients are often steep, rivers erode downwards, creating narrow V-shaped valleys. Interlocking spurs, river rapids and waterfalls are common landscape features, while floodplains and meanders are largely absent in this section of the river.

In the central reaches of a river system the mountains have given way to low hills. Here the land continues to undergo substantial downcutting, but the river valleys begin to broaden. Even further downstream, lateral erosion and valley widening become more prominent and floodplains with meanders start to develop.

Away from the mountains and hills, lateral erosion dominates. Valleys widen and the reduction in stream velocity results in the deposition of some of the river's load of sediment. These sediments are known as alluvial deposits. They often form extensive lowland or coastal floodplains across which the river will meander. The fine soils of those plains are called alluvium and are usually very productive.

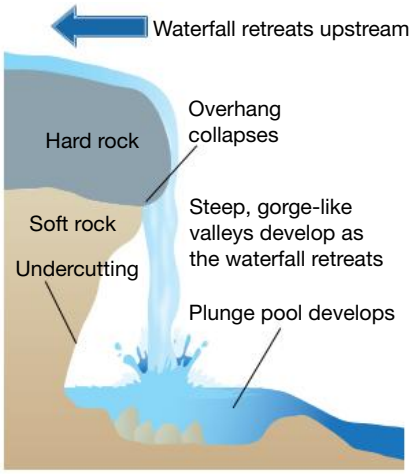
Migrating waterfalls

Waterfalls develop when a river flows from a hard rock layer onto a softer layer of rock. Pummelled by the water, the softer rock wears away, creating a drop-off. The cascading water may then erode the drop-off, causing the waterfall to migrate upstream. The rate of retreat is determined by the hardness of the rocks. Figure 4.3.1 illustrates the waterfall migration process. In glacial areas, waterfalls often flow from hanging valleys into larger glacial valleys. Figure 4.3.2 shows a hanging valley waterfall in Yosemite National Park.

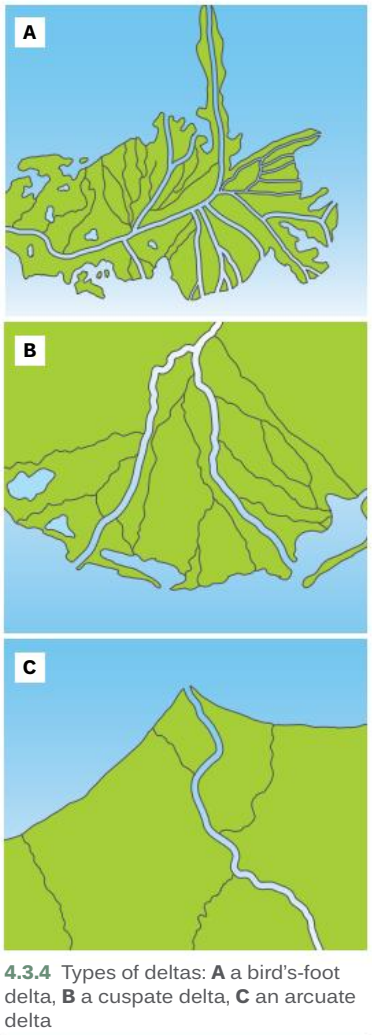
Deltas

When a river empties into a lake, an inland sea or an ocean, its velocity is reduced. Its sediments accumulate to form a depositional feature known as a delta. Blocked by this mass of sand, gravel and mud, the river splits into channels. Each channel builds up its own spit of land. In this way, a broad delta forms.

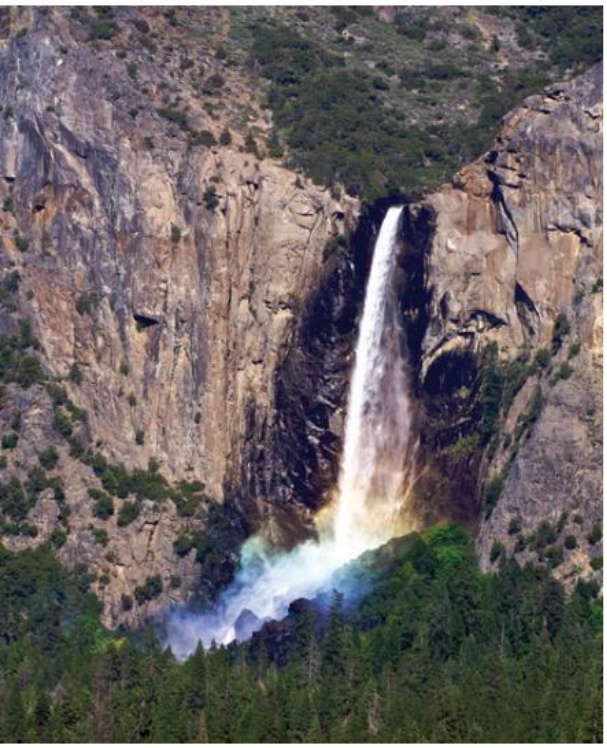
Although most deltas are layered in the same way, their shape varies according to the contours of the ocean floor, the amount of sediment that has been deposited and the action of the ocean waves. A bird's-foot delta occurs when a rapid river current penetrates calm waters, dumping its load of sediment as fingers of sand. Where a river encounters strong ocean tides or currents, its sediments are redistributed across a broad front, creating a cuspate delta. When the supply of sediment is significantly greater than that taken away by waves and currents, an arcuate delta forms. Figure 4.3.4 shows these three types of deltas. Deltas are quite unstable landform features. Their shape and form changes, especially during major storm events. Figure 4.3.3 shows the Mississippi River delta which is a bird's-foot delta.



4.3.1 Waterfall migration



4.3.4 Types of deltas: **A** a bird's-foot delta, **B** a cuspate delta, **C** an arcuate delta



4.3.2 The landforms of Yosemite National Park have been carved out by glacial ice. The waterfall in the middle distance is cascading down a hanging valley cut by a tributary glacier. This valley it created is much shallower than the main glacial trough that dominates the landscape.

4.3.3 The Mississippi River delta is an example of a bird's foot delta.

Coastal landscapes shaped by waves

The ocean works relentlessly to transform the edges of the land. As a result, our coastlines represent the most varied and rapidly changing part of the lithosphere. Waves, tides and currents from the sea; rivers and glaciers from the land; and daily weather conditions all play their part in shaping coastal environments; that is, the terrains where land and sea overlap. Coastal terrains extend as far inland as the salt water, sea spray and windblown sands reach, and into the ocean as far as the waves are able to move the material on the sea bed.

Desert landscapes shaped by water

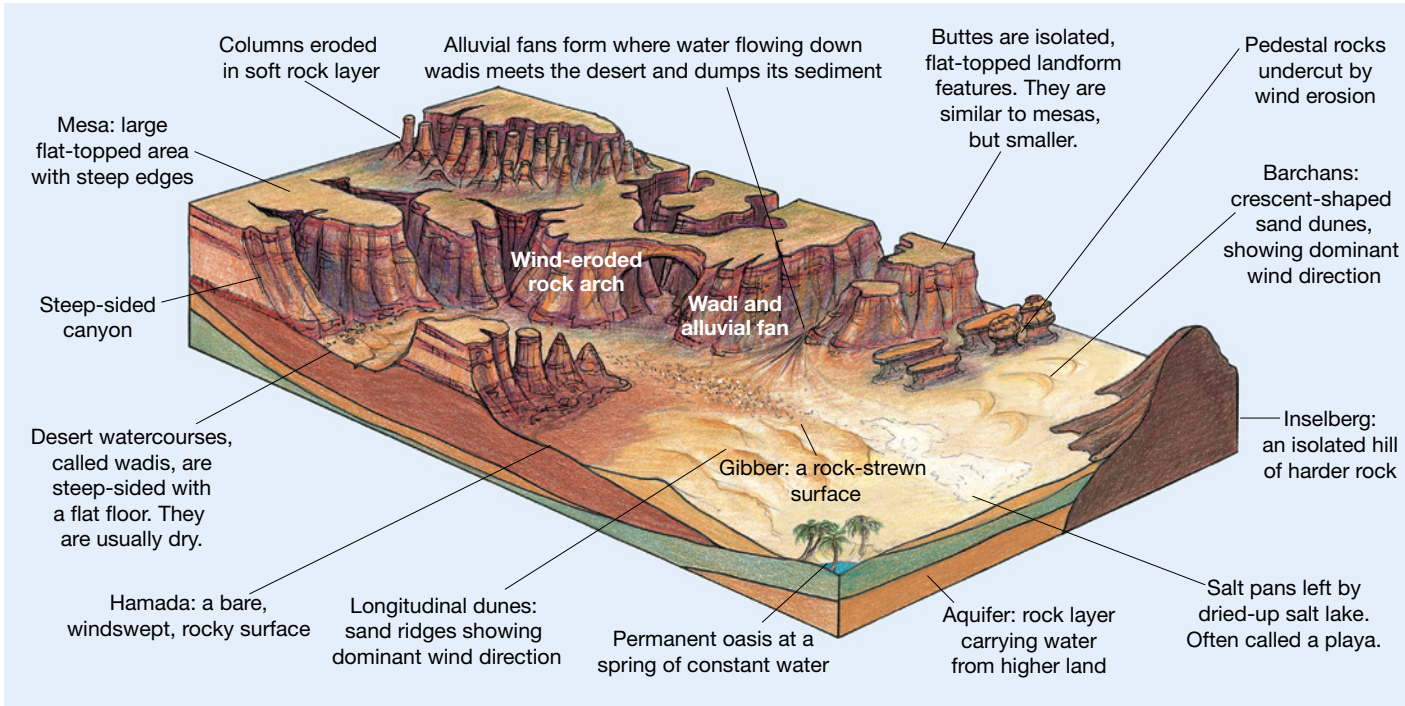
While it does not rain often in deserts, when it does, the rain is often very heavy and results in flash flooding. Because there is no vegetation, run-off is extremely rapid and can erode large amounts of material.

Surface run-off is channelled into dry riverbeds (wadis) that cut through plateaus, forming canyons. As plateaus are eroded, mesas and buttes are left isolated from the retreating escarpment, or steep cliff. Mesas are wider than they are high, while buttes are higher than they are wide.

The eroded material is carried by the water through the wadis. It is eventually deposited on the lowlands, forming alluvial fans. These spread out across the desert basin, or bolson, where the fine particles can be shaped into dunes by the wind.

Where water flows into a desert depression, playa lakes form. When the water eventually evaporates, salt pans or clay pans are formed.

Inselbergs are large masses of resistant rock that rise abruptly from the surrounding plain. They are exposed when the softer surrounding rock material is eroded. Uluru, in central Australia, is probably the world's best known inselberg. The landforms of the desert are shown in Figure 4.3.5.



4.3.5 Landforms of the desert

SPOTLIGHT

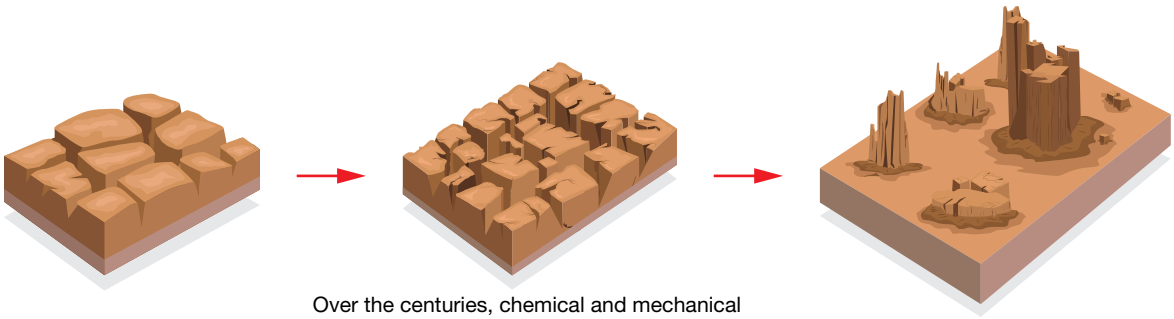
Differential erosion

The spectacular landscape of Monument Valley in North America is a result of differential erosion. Figures 4.3.6 and 4.3.7 illustrate the formation of this landscape.

Sixty-five million years ago, mountain-building processes began uplifting the Colorado Plateau. As the plateau rose, rivers cut deep canyons into the layers of sedimentary rock.

Over the centuries, chemical and mechanical weathering took their toll on what remained. The layers of rock were eaten away by acids in rainwater and shattered by ice that expanded as it froze in the crevices.

Winds laden with sand and dust, the by-products of erosion, constantly blasted the exposed rock layers, gradually wearing them away. Erosion-resistant columns of red sandstone (together with large mesas and buttes) remained isolated above the weathered plateau.



4.3.6 The floor of Monument Valley is hundreds of metres lower than the plateau that once occupied the area.

4.3.7 The spectacular landscape of Monument Valley. The columns of rocks, which are the remnants of an ancient plateau, rise up 300 metres. The softer rock has been gradually eroded away, leaving these monuments to the power of nature. This process is known as differential erosion.

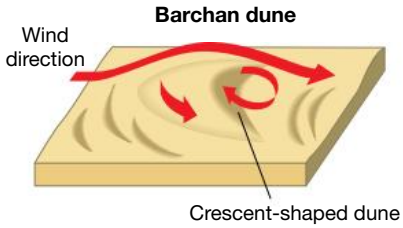
Activities

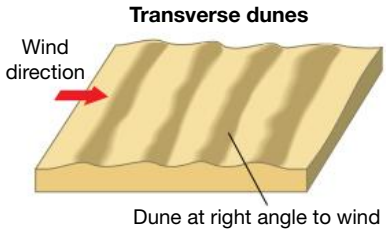
Understanding the text

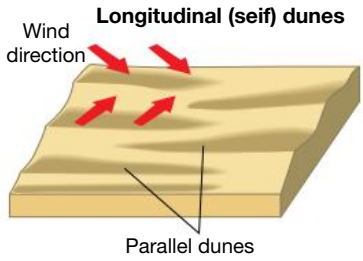
1. Identify the circumstances under which water erosion is most effective.
2. Define each of the following erosional processes: hydraulic action, abrasion and corrosion.
3. Explain how material in streams is transported.
4. Describe how fluvial landforms change as you travel from the headwaters of the river to its mouth.
5. Identify how far and in which directions coastal terrains extend.
6. Explain why rainfall is such an effective agent of erosion in desert environments.

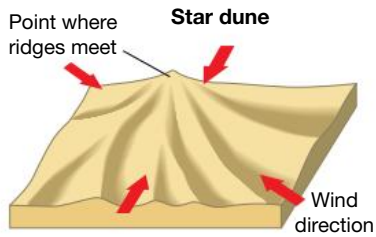
Working geographically

7. Study Figures 4.3.6 and 4.3.7. Use them to write a report outlining the process of differential erosion. Undertake research to investigate whether the Arnhem Land Plateau and outliers of Kakadu are the result of a similar process.
8. Write a report outlining how waterfalls form and migrate towards a river's headwater.
9. Study Figure 4.3.5. Select one of the landform features depicted in the diagram and investigate the processes responsible for its formation.









4.3.8 Different types of sand dunes

Landforms shaped by wind

Winds are particularly effective in shaping landforms in areas where there is little or no vegetation. These include the world's arid and semi-arid regions and those areas in which human activity has degraded the land and destroyed the vegetation.

In the zone closest to the ground, the wind picks up weathered rock materials and uses them to 'sand-blast' larger rock structures. This process is known as abrasion and it often contributes to the formation of distinctive sculptured rock formations.

On a larger scale the formation of rock-strewn surfaces (known as reg or desert pavement) has been, in part, attributed to the removal of finer material by wind. This process is known as deflation.

The wind also plays an important role in moving and reshaping dunes.

Sand dunes

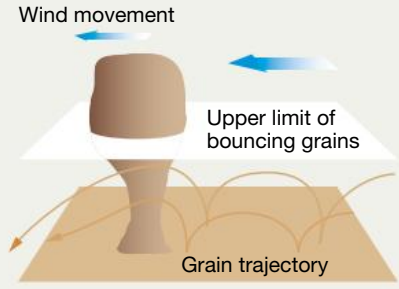
The erosion of fine surface sand by wind is known as deflation. Once airborne, sand can act as an abrasive tool, wearing down and shaping exposed rock. Pedestal rocks, for example, are formed when windblown sand cuts away the base of rock structures but leaves their tops intact.

When the windblown material is deposited it accumulates and forms sand dunes. The shape of these dunes varies according to the strength and direction of the wind, the amount of sand available and the type and extent of vegetation cover in the area. Dunes are named according to their shape and direction. Some of the more common types are shown in Figure 4.3.8.

SPOTLIGHT

Pedestal rocks

Windborne sand grains follow bouncing trajectories that carry them as high as 1 metre above the ground. The abrasive action of these grains cuts away the base of rock structures but leaves their tops intact. The result is a distinctive landform feature known as a pedestal rock. See Figures 4.3.9 and 4.3.10.



4.3.9 Formation of a pedestal rock

4.3.10 Wind-shaped pedestal rock

Activities

Understanding the text

1. State the conditions under which winds are particularly effective.
2. Explain the process of abrasion.
3. State what a reg surface is. What role does deflation play in their formation?

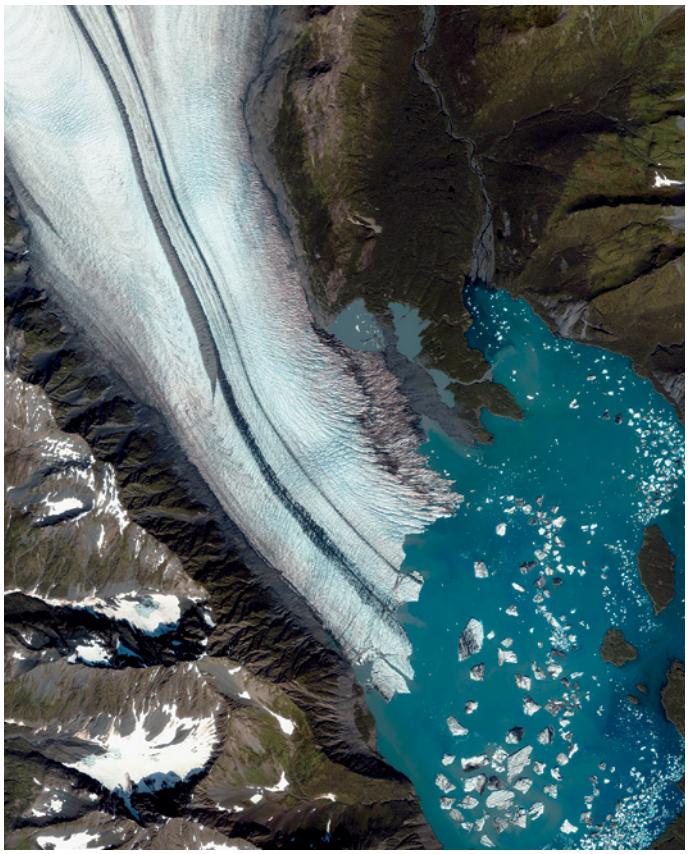
Working geographically

4. Write a short explanation outlining the processes responsible for the formation of the various types of sand dunes.
5. Write a short explanation outlining the formation of pedestal rocks.

Landforms shaped by ice

Glaciers

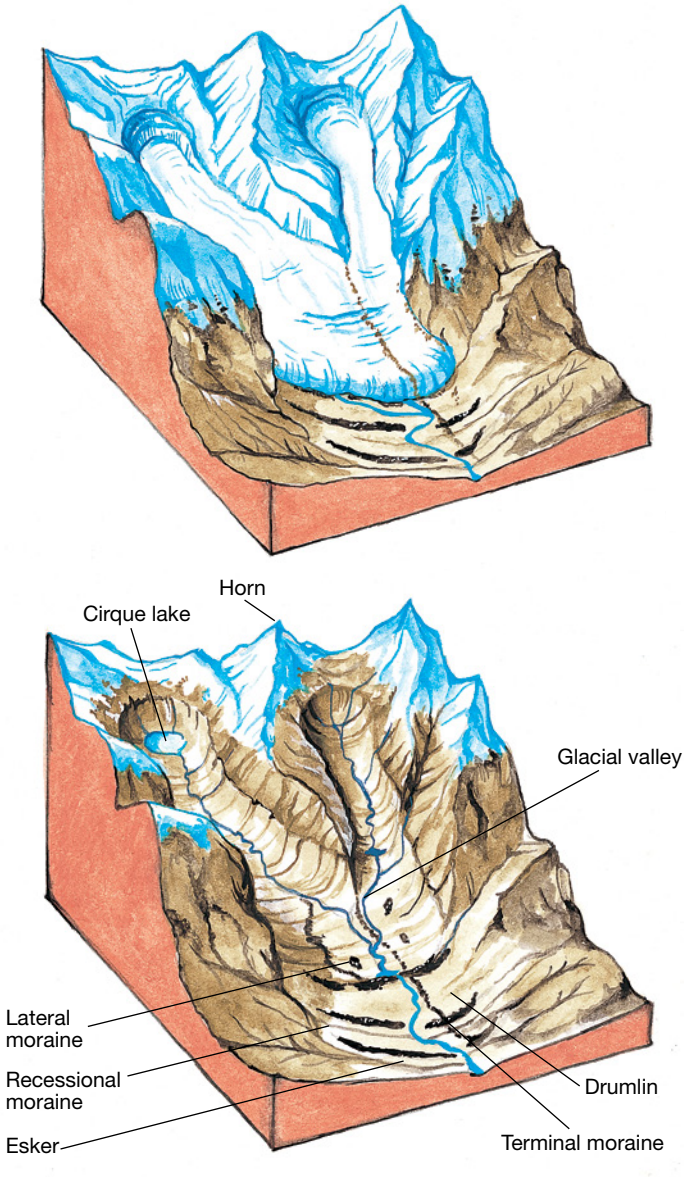
Glaciers are huge masses of ice. They form when snow that has accumulated over many years is compacted to form glacial ice. Gradually, the quantity of snow becomes greater and due to its increasing weight, the compacted glacial ice is forced to move outwards and downwards under the force of gravity. See Figures 4.3.11 to 4.3.13.



4.3.11 Bear Glacier, Alaska

Figure 4.3.11 shows the ablation zone where Bear Glacier is losing ice. Pieces of the glacier that have broken off look like shards of white glass in the blue water. Upslope from the lake, the foot of the glacier is riddled with crevasses. These are cracks in the ice caused by the glacier's movement over a rough surface. As a glacier moves, it picks up dirt and debris from the rocks it passes. When two glaciers merge, as they have in Bear Glacier, the dirt and debris they carry form parallel stripes, or medial moraines, on the surface of the ice.

4.3.12 The Aletsch in the Swiss Alps



4.3.13 The development of glacial landform features

SPOTLIGHT

Lithosphere facts

- The land under your home is the product of 4.6 billion years of evolution.
- In Iceland you can actually walk on the mid-Atlantic ridge, peer into an active rift valley and later take a hot shower with water heated by underground molten magma.
- The Red Sea and the Gulf of Aden are active divergent zones.
- Areas of ancient rift valleys include Lake Baikal in Russia (the earth's deepest lake), the Rhine Valley of Europe and the Rio Grande Valley of Mexico.
- The great earthquakes and the volcanic eruptions of the Philippines, Japan and the Aleutians, as well as the disastrous eruption of Krakatoa (between Java and Sumatra in the Indian Ocean), are all consequences of active ocean–ocean convergent boundaries.
- An archipelago is a sea studded with islands. The world's largest archipelago extends for 5000 kilometres from the Malay Peninsula down through Indonesia to New Guinea. It includes more than 13 000 individual islands.
- Greenland is the earth's largest island. It covers an area of 2 175 600 square kilometres. Australia, at 785 000 square kilometres, is the world's second largest island.
- The world's saltiest sea is the Dead Sea. Ten times saltier than the Pacific Ocean, its concentration of salt gives it a very high buoyancy.

Erosion and deposition

Ice sheets are layers of ice covering relatively flat landscapes. Both ice sheets and glaciers have great erosional and depositional power. The surface of the land is scratched and worn down by the constant grinding action of rock fragments that have been 'plucked' from the ground and embedded in the base of the ice. This process is known as abrasion. The rock-laden glacial ice grinds away the irregular surfaces over which it moves, leaving very distinctive landform features.

The most distinctive erosional features of glacial landscapes are U-shaped valleys. These form during periods of glacial activity when glaciers deepen and widen the former river valleys. Hanging valleys mark the entry point of smaller tributary glaciers. Other erosional features found in areas subject to glacial processes include cirques (amphitheatre-like valley), arêtes (ridge of rock separating two valleys) and pyramidal peaks (horns). Fiords are formed when rising sea levels flood the valleys once occupied by glaciers.

The rocks transported by the ice can be carried for long distances before they are eventually deposited to form moraines. These are deposits of soil and rock once embedded in the glacial ice. Lateral moraines consist of rock debris that has accumulated along the side of the glacier. Where two glaciers meet, the inside lateral moraines may merge to form a medial moraine. The remaining rock debris, deposited at the end of a glacier forms a terminal moraine.

Valley glaciers are found in the Himalayas, Andes, Alps, Rockies and New Zealand's Southern Alps. Ice sheets occur in Antarctica and Greenland.

Activities

Understanding the text

1 Explain what glaciers are. How do they develop?

2 Explain what abrasion is. How do glaciers 'abrade' the surface of the land?

3 List the erosional and depositional features that are characteristic of glacial landscapes. Illustrate the features you have listed.

4 Explain how fiords are formed.

Working geographically

5 Draw a block diagram of a glacial landscape and label the landform features you have studied.

6 Undertake library and internet research for more detail on the processes and landform features mentioned in this unit.

UNIT 4.4

Soils

The development of soils is the result of the interaction of the lithosphere with the other components of the biophysical environment. As shown in Figures 4.4.1 and 4.4.2, soils are a complex mix of inorganic minerals (usually in the form of clay, sand and silt), air, water and organic matter.

Soils teem with hidden life: billions of microorganisms, bacteria and fungi are vital for the conversion of inorganic and organic material into the simple nutrients that are readily available to plants in the water within soil. Soils provide a foundation for plant and animal life on land. The depth of soil varies from place to place and depends largely on the steepness of the land.

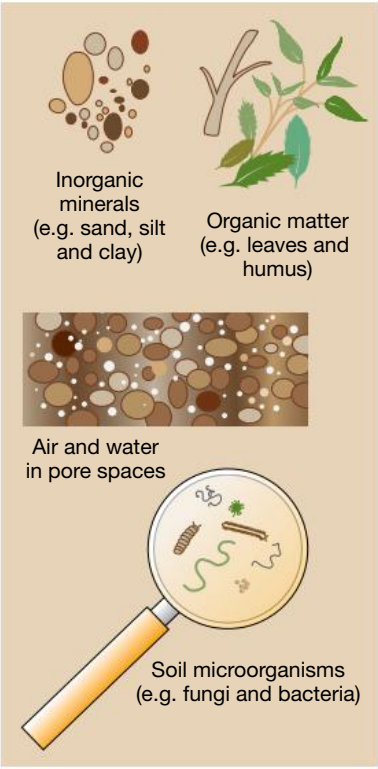
The profile of a soil

Soils are developed by physical, chemical and biological processes, including the weathering of rock and the decay of vegetation. For soils to develop, two processes must take place. First, water moving down through cracks in the rock strata must cause physical and chemical changes in the original material. Second, the activities of living organisms must bring about further modifications. Where the presence of water and organisms is limited, soil development will be poor.

In well-developed soils, the action of water and organisms changes the original rock material to the extent that different layers, or horizons, develop. Each layer has identifiable physical and chemical characteristics. The presence of these layers constitutes a true soil. It can differ markedly from its original parent material in properties and characteristics.

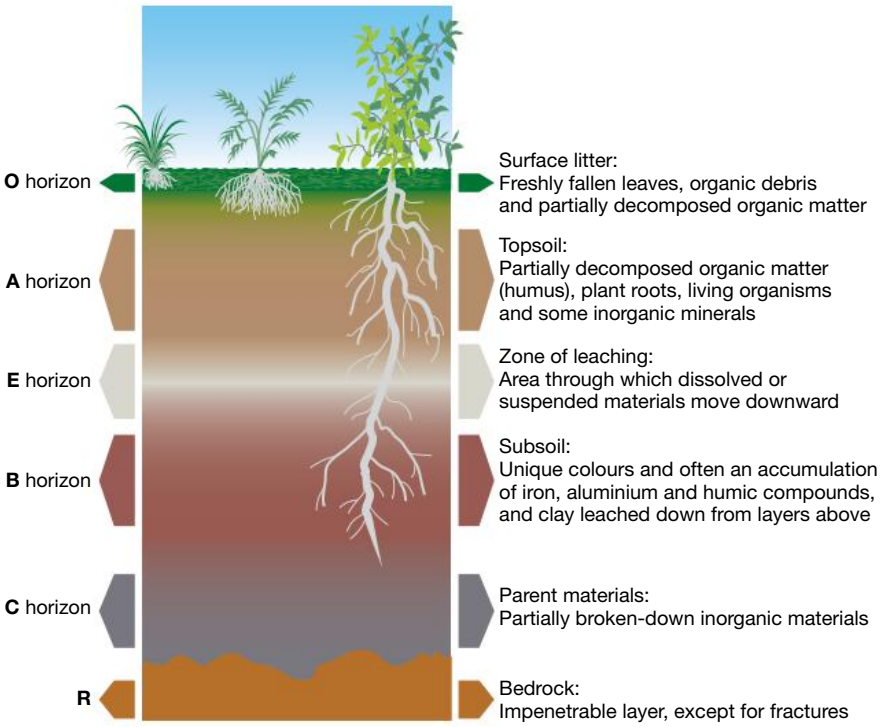
Soils typically comprise several horizons, roughly parallel to the surface, which together form the soil profile. Each horizon has a distinct colour, thickness, texture and composition. The horizons vary in number, depending on the type of soil. A generalised soil profile is illustrated in Figure 4.4.3.

The action of climate and organisms on the parent rock material over long periods of time, and the influence of topography, produce the particular soil profile.

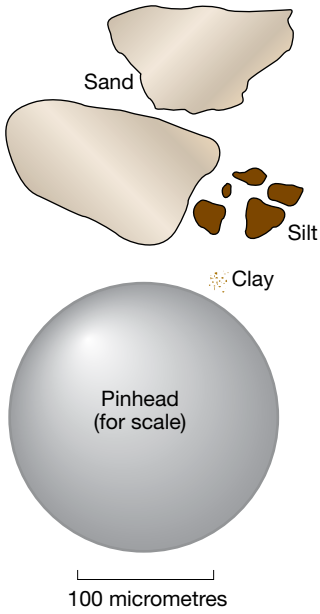


4.4.1 The constituents of soil

4.4.2 Soil texture refers to the size of the soil particles.



4.4.3 A generalised soil profile



4.4.4 The particles that constitute the inorganic component of soil are classified according to size.

Soil characteristics

The four principal characteristics of soil are texture, structure, colour and acidity/alkalinity composition.

Texture refers to the size of the soil particles, which range from tiny clay particles to sand and fine gravel. Figure 4.4.4 gives an indication of the relative sizes of particles.

Structure refers to how the particles clump together in characteristic small masses called aggregates or peds. Sand falls through your fingers because it has no structure; soil particles with a high clay content cling together, creating structure. Structure is vital for plant growth as it affects the rate of water absorption. Soils are classed according to the shape of the peds: whether they are platy, prismatic, blocky or granular. Individual structures may range from tiny granules (about the size of a fingernail) to fist-size blocks. An aggregate caused by ploughing is called a clod.

Colour reflects the presence of identifiable substances in the soil. Dark colours occur where the humus content is high; when it is lacking, soils are light. Some soils take on a red and yellow appearance in response to the oxidation of iron.

Acidity and alkalinity are important characteristics affecting plant growth. Acidity/alkalinity composition is expressed in terms of a pH value: 7 is neutral; 8.5 is alkaline; 5.5 is acidic.

Soil formation

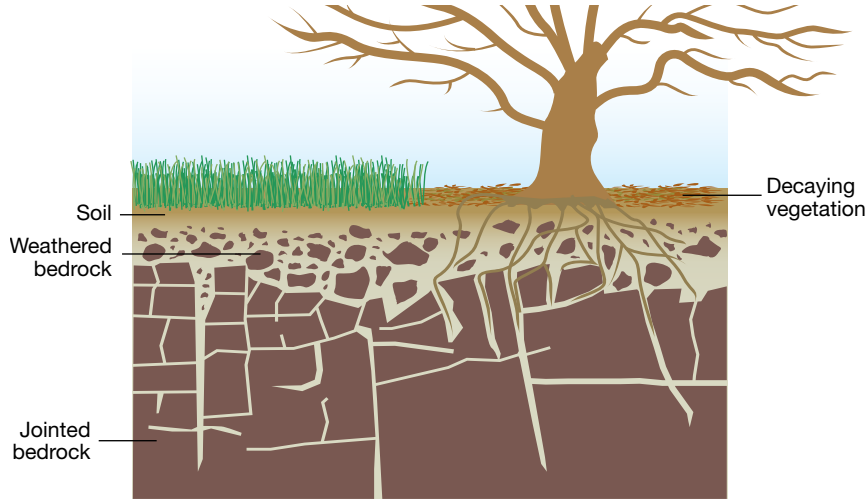
Soil formation should be considered in terms of soil-forming processes as well as soil-forming factors. The soil-forming factors control the processes, which in turn lead to the development of the soil.

Soil-forming factors

Soil formation is traditionally considered to be dependent on five soil-forming factors: parent material, climate, relief (topography), organisms (including human activity) and time.

Parent material

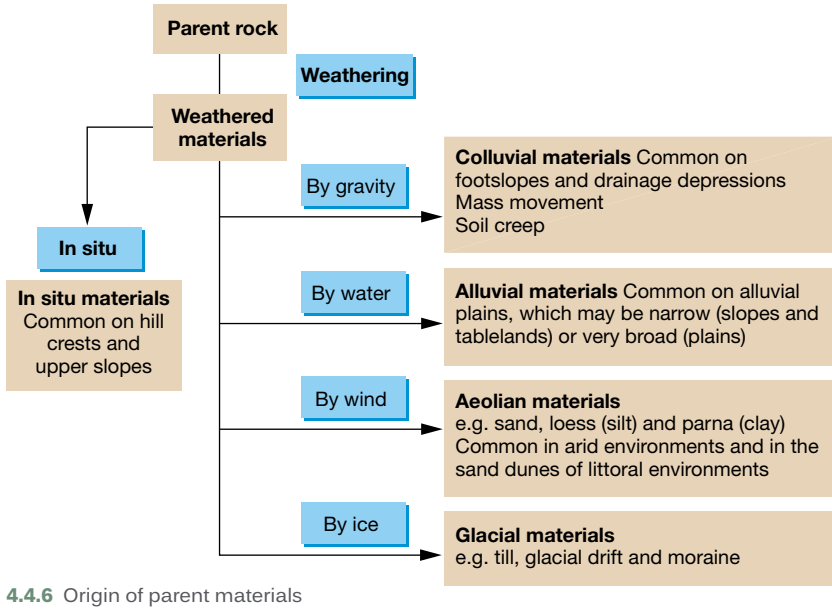
Some soils form directly from weathering bedrock in situ, but most are formed from materials that have been transported and deposited. In either case, the parent material provides a starting point for soil formation. Figure 4.4.5 shows how solid bedrock is broken down to form the inorganic component of the soil. The mineral composition and grain size of the bedrock strongly influences the type of soil formed. Siliceous parent materials, such as granite and sandstone, are relatively high in silica and quartz. As they are low in clay-forming minerals, the soils derived from them tend to be low in clay and of low fertility.



4.4.5 Chemical and physical weathering processes break down massive rock into small particles that form the inorganic component of soil.

Non-acidic parent materials, such as basalt, are high in ferromagnesian minerals. These minerals are important for clay formation and so the soils derived from them are usually clayey and often fertile.

Where a soil's parent material is not the underlying bedrock, it can be geological material that has been transported and deposited; for example, alluvial soil. The agents and the materials transported about the earth's surface are summarised in Figure 4.4.6. The agents include gravity, water, wind and ice. Of special interest are soils that develop in alpine areas. Here the parent material for the soils in bogs is the characteristic vegetation of the site: sphagnum moss.



4.4.6 Origin of parent materials

Climate

Climate strongly influences soil-forming processes. The ratio of precipitation to evaporation influences the amount of water available for weathering, new mineral formation, leaching and the translocation of materials, especially clay. Where rainfall exceeds evaporation, there is a net downward movement of water. This results in eluviation (the removal of material from the uppermost horizon of a soil to a lower horizon) or leaching. The drier the climate, the less water is available for these processes. Low temperatures also reduce weathering rates, but generally increase the rate of organic matter accumulation.

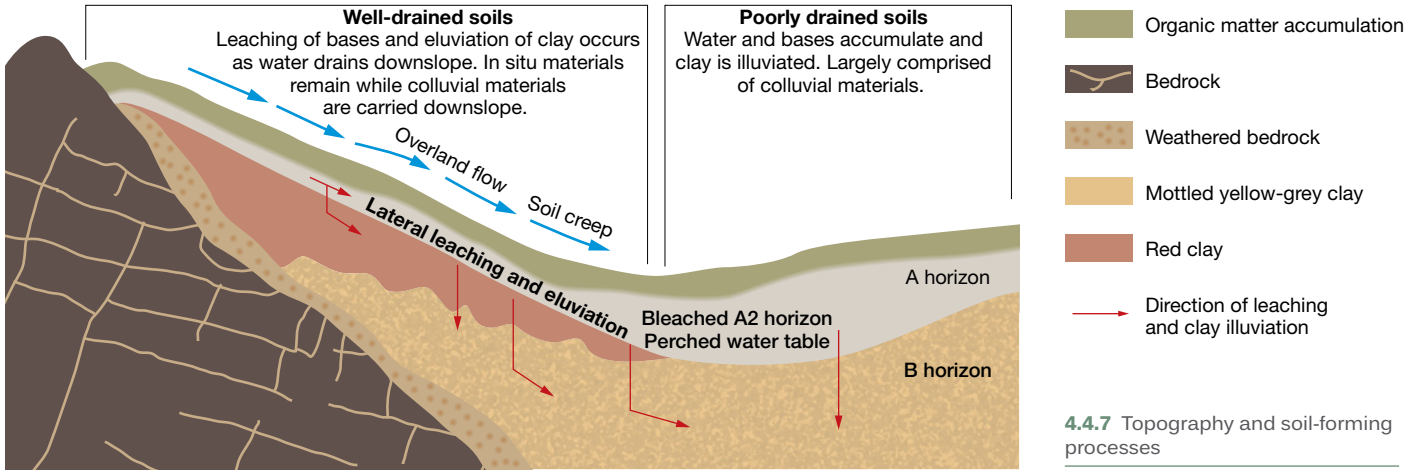
Water availability can also influence the rate of plant growth and hence the rate of organic matter accumulation and the activity of soil organisms.

DID YOU KNOW?

In a moist tropical climate, soil development on volcanic ash can increase in thickness at a rate of about 1 centimetre a year. In drier areas in Central America it takes 1000 years to produce a soil 30 centimetres thick. The rate of soil formation under most Australian conditions is close to zero.

Topography

The shape of the land influences the amount of water available for weathering, new mineral formation, leaching, the translocation of colloids, and the downward movement of clay particles. Figure 4.4.7 shows how well-drained soils occur upslope and that water-transported material accumulates on the lower slopes and in depressions. The amount of water, minerals and clay that accumulates depends on the volume of water moving into and out of the soil profile.



4.4.7 Topography and soil-forming processes

Organisms

Biotic activity (including human activity) can affect the type of soil occurring at a particular location, most notably in surface soil layers. It also affects the different types of global vegetation that are supported by the soil.

Plants provide a protective cover on the soil surface, which reduces erosion. Plant roots add organic matter and form miniature channels in the soil, which greatly improve soil structure and the soil's general condition for plant growth.

Earthworms can also assist by ingesting soil and mixing it with organic matter, and by constructing channels, which aerate the soil. Microorganisms play an important role in breaking down organic matter and in the cycling of nitrogen between the atmosphere, plants and the soil.

Human impact on the soil can be dramatic:

- Clearing of vegetation and subsequent cultivation can cause erosion of the soil.
- Overcultivation can lead to a loss of organic matter and the breakdown of soil structure.
- Irrigation and clearing trees can cause water tables to rise and bring salty water to the surface, producing saline soils.

Human impact on the soil is not always detrimental. Drainage of poorly drained land, use of conservation farming techniques, addition of nutrients and organic matter, and use of controlled irrigation often increase soil productivity and stability.

DID YOU KNOW?

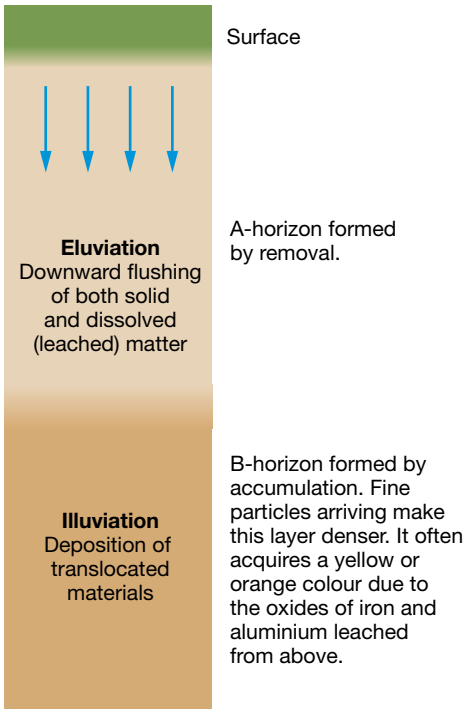
There may be one million earthworms and 25 million insects in 1 hectare of pastureland. As many as one million bacteria can inhabit 1 cubed centimetre of soil.

Time

Soil type is influenced by the amount of time that soil-forming processes have been occurring. Theoretically, at least, if a sufficient period of intense weathering has occurred, all soils should approach a similar state, regardless of parent material. In practice, this never occurs because there are too many variables impacting upon weathering.

DID YOU KNOW?

It takes up to 400 years for 10 millimetres of soil to form, and between 3000 and 6000 years to produce mature soil of sufficient depth for farming.



4.4.8 The simultaneous processes of eluviation and illuviation produce distinctive A and B horizons.

Soil-forming processes

The layer of fine particles produced by weathering does not constitute a real soil until it undergoes additional changes from the interaction of various processes. These processes are described below.

Movement of water through the soil profile

Water sinking into the ground takes with it both solid and dissolved matter from the upper part of the soil and deposits it in the lower part. This contributes to the differentiation of soil into horizons, each with its own characteristics.

This process is associated with:

- the leaching of soluble minerals, including calcium, magnesium, sodium, nitrate, chloride, sulfate and carbonate
- the movement and accumulation of organic matter, silicon compounds and iron or aluminium oxides
- clay translocation, which is the movement (eluviation) and deposition (illuviation) of suspended clay particles. This process leads to the formation of the A and B horizons, as shown in Figure 4.4.8.

The speed of the above processes depends on the ratio of precipitation to evaporation and on soil permeability. For example, highly permeable soils, such as sands, will be more readily leached than impermeable soils.

Soil drainage

Soil drainage, particularly the amount of time a soil is wet or saturated, has very significant effects on the soil. In well-drained soils, which remain wet for only short periods of time, red and reddish-brown colours dominate. Generally, the red colour is likely to be attributed to oxidised iron.

Poorly drained soils remain wet for at least several weeks and often all winter. Dull yellow and grey colours are found in these soils, which are frequently mottled with patches of red, orange, white and grey.

Continual weathering and new mineral formation

Weathering of primary minerals (those derived from the original rock) is a continual process in soils and leads to the formation of secondary minerals (clays and oxides). The secondary materials may, in turn, also be altered. Some primary minerals, such as quartz, resist weathering and remain in the soil profile for a considerable time.

Solution, precipitation and accumulation of soil components

Many compounds, such as iron and manganese, accumulate in soils. Calcium carbonate can accumulate in soils derived from parent material that is rich in calcium carbonate, such as limestone. It can also accumulate in dry regions where there is little leaching so these soluble constituents are not removed from the profile.

Wetting and drying

Wetting and drying out is important in soils that shrink and expand substantially with changes in moisture content. These are known as expansive soils.

Biological activity

Biological activity includes the accumulation of organic matter and the development of soil structure by plant roots, fungi, animal activity and decomposing organic matter. Numerous other biologically controlled reactions affect nutrient cycling in the soil, particularly that of nitrogen.

Human activities can also act as a biological agent. For example, cultivation and excessive grazing can lead to erosion and reductions in organic matter and degradation of soil structure.

Activities

Understanding the text

1. Explain why soil is such an important part of the lithosphere.
2. Outline what soil consists of. How does it differ from its parent material?
3. Describe soil structure and why this characteristic is especially important in agriculture.
4. Explain what different colours in the soil indicate.
5. List the five factors of soil formation.
6. Describe the ways different parent material can affect soils.
7. Outline the influences that climate exerts over soil-forming processes.
8. Outline the ways in which the position on a slope accounts for different soil patterns.
9. Explain, with special reference to earthworms, the importance of biotic activity in the soil.
10. Describe the process of translocation. Is it important to horizon development within soil profiles? What types of materials are involved in this process?

SKILLS BUILDER

Investigating soils

Investigate your local environment to see if there is a site where you can examine a soil profile. It may be exposed at a road or railway cutting, or in a safely constructed soil pit especially dug for such a purpose. The latter is better as it is less likely to have been affected by weather.

'Reading' the soil correctly will give you an indication of the relative importance of each of the factors of soil formation.

Study the site

Before examining the profile itself, it is important to study the site to identify how various aspects of the biophysical environment may have affected soil formation. Where appropriate, consider the following:

- parent rock (refer to a local geological map)
- altitude (may be read from a local topographic map)
- angle of the slope
- aspect (bearing or compass point)
- relief (nature of the slope: uniform, convex or concave)
- exposure
- drainage (for example, is it well-drained or boggy?)
- natural vegetation or type of farming (consider the tree species, ground cover, crops and livestock)
- previous few days' weather (for example, has it been wet, dry, hot or cold?).

Examine the soil profile

Examine the soil profile itself. Where appropriate, draw up a table or make a detailed, labelled field sketch.

Identify the different horizons. Indicate the depth of each horizon and describe the lower boundary. (Is it sharp, gradual, indistinct or irregular?)

Describe the characteristics of each horizon, noting any differences in:

- colour: this can simply be described as it appears to the eye; for example, reddish-brown.
- texture: examine the size of the particles: clay, silt or sand.
- structure: is it without structure or do the particles cling together?
- soil pH: this may be measured by an indicator.
- presence of any carbonates: add dilute hydrochloric acid. If it effervesces it is more than 1 per cent carbonate.
- soil organisms: note the number and type visible.

Look for any evidence of translocation of material from water moving through the soil. Examples include leaching and clay translocation.

Write a report

Write a report on the soil-forming factors and the soil-forming processes that are responsible for the development of soil at this site.

UNIT 4.5

Human interactions with the lithosphere

The lithosphere is vital to life on earth. It supports the food webs that sustain life; it provides a vast array of natural resources, and it plays an important role in the purification of the water. We also depend on it to dispose of some wastes. The rapid growth in world population and the accelerated rate and extent of our impact on the lithosphere has led to the deterioration of this vital component of the biophysical environment.

In a relatively short period of time on the geological time scale, humans have had a profound effect on the physical world around them. Nature is very unforgiving. Entire civilisations have collapsed as a result of the mismanagement of their resource base. Archaeological evidence shows that a number of agriculture-based urban societies in the Middle East once prospered between 3500 BCE and 500 CE, but at the expense of their soils. Productive farmland was degraded into barren desert and then abandoned.

Some experts argue that unless we use our knowledge and technology to work within the limits of the biophysical environment we could suffer a similar fate. This time, it could be on a global scale.

Land degradation

One of the primary concerns arising from human interaction with the lithosphere is land degradation: the decline in the quality of natural land resources.

Land degradation encompasses soil degradation and the deterioration of natural landscapes and vegetation. It includes the adverse effects of overgrazing, excessive tillage (mechanical cultivation of agricultural soils by a plough), erosion, sediment deposition, mining, urbanisation, disposal of industrial wastes, road construction, decline of plant communities, and the effects of noxious (poisonous) plants and animals.

The lithosphere is at risk wherever the natural balance is altered by development for agriculture, mining, forestry, industry, urban settlement and tourism or for infrastructure (such as roads, railways, dams, power stations, pipelines and transmission lines). Land degradation has an impact on each sphere of the biophysical environment. It affects soil, flora, fauna, water (both quality and quantity), aesthetic appeal and, inevitably, production levels.

Desertification: land degradation in a changing climate

Desertification is the persistent degradation of dryland ecosystems, rendering the land unproductive and devoid of vegetation. It is primarily caused by climatic variations and human activities. Dryland ecosystems are often in marginal areas and are extremely vulnerable to inappropriate land use practices and outright over exploitation. This results in the removal of vegetation which is accompanied by a loss of nutrients in the soil. This makes the land infertile and unusable for farming or pastureland.

Desertification results in desert-like conditions spreading in arid and semi-arid land. Apart from Antarctica, no continent is immune from desertification. Desertification is particularly acute in both Africa and Asia, which hold 37 per cent and 33 per cent of the world's arid zones respectively. One-third of the earth's land surface (48 million square kilometres) is now threatened by the process of desertification.

Over 250 million people are directly affected by desertification; about one billion in over one hundred countries are at risk. These people include many of the poorest, most marginalised and politically weak citizens.

Causes of desertification

Desertification occurs where land use practices in marginal areas leave the soil vulnerable to erosion by wind and water. The practices contributing to desertification include:

- removal of natural vegetation cover by taking too much fuelwood
- cultivation of land with unsuitable terrain or soils
- overgrazing—too many livestock on too little land area
- improper soil and water resource management, which leads to increased erosion, salinisation and waterlogging of soil.

Central to the problem is the increased intensity of land use associated with rapid population growth and high population densities. Poverty is a related issue. The poor are often forced by their desperate circumstances to exploit the land beyond what would normally be regarded as a sustainable level of use. When combined with prolonged periods of below-average rainfall, famines are often the tragic outcome. Land degradation and incidence of famine are two of the major factors contributing to the increasing problem of environmental refugees.

As the climate changes, many areas will begin to experience a new climate regime, such as warmer temperatures. In many dryland areas aridity is increasing which translates into scarcer rains and as a result, rivers, lakes and groundwater sources are drying up. More intense and much longer droughts are being experienced over much wider areas.

Desertification in the Sahel, Africa

In the African Sahel region, more than 65 million hectares of productive land has been turned into desert in the last 50 years. With population growth rates exceeding 3 per cent a year, the region's population is set to double in less than 25 years. This growth will place an intolerable strain on the region's fragile environment. The increased intensity of land use will inevitably result in overgrazing and overcultivation. The enlarged herds of cattle, goats, sheep and camels will strip the vegetation, exposing the soil to erosion. Fuelwood is the main source of energy for cooking and heating, and deforestation associated with the collection of fuelwood makes the situation worse.

The Sahel is particularly vulnerable to this form of land degradation. In a harsh climate, marginally productive land easily becomes sterile. Prolonged droughts, lasting for two to three years, are common over two-thirds of the continent. Even in 'normal' years, rainfall is very unreliable and in some seasons does not occur at all. Throughout much of the region, rainfall has been below average for the last 15 to 20 years. Some experts argue that this prolonged drought reflects a change in the region's climate, brought about by the large-scale removal of the natural vegetation.

In the past, people coped with poor soils and unreliable rainfall by rotating crops and allowing the most fragile land to lie fallow for up to 20 years. This form of shifting cultivation, together with the land use practices of the nomadic herders, was perfectly sustainable while human and animal numbers did not exceed the 'carrying capacity' of the land.

Larger population numbers and lower rainfall have upset this balance. It has forced farmers to bring more marginal land into production and to reduce periods of fallow. The environmental impact and the effects on humans of these actions have often been devastating, as is evident in Figures 4.5.1 and 4.5.2.

4.5.1 Global warming and deforestation mean that once-fertile land in River Nile state in Sudan is turning to dust and desert.

4.5.2 Desertification claims productive land on the outskirts of Bandiagara, a town in the semi-arid and central plateau of Mali, inhabited by the mainly agricultural Dogon people.

SPOTLIGHT

Land misuse and erosion

The Ethiopian highlands is a region that has supported an agriculture-based society for thousands of years. Here the soil and vegetation have been severely degraded over the course of just two decades. A rapidly increasing population and inappropriate farming practices aimed at securing a quick financial return have eroded land and deforested slopes, which in turn has reduced the people to a subsistence existence, as shown in Figure 4.5.3.

4.5.3 Deforestation and erosion, Bale Mountains, Ethiopian Highlands

4.5.4 Bhola, Bangladesh, is located in the Bay of Bengal delta, where the accumulation of sediment is evident.

In tropical Ecuador and Peru, the deforestation and cultivation of valley slopes have exposed 50 per cent of the land to rates of erosion that exceed 1500 tonnes per square kilometre each year.

The Ganges river drains an area of just over 1 million square kilometres of intensively worked farmland and heavily harvested forestland in India, Nepal and Bangladesh. The river transports 1.46 billion tonnes of sediment to the Bay of Bengal every year (see Figure 4.5.4). The Amazon, which drains a much larger area, delivers just 363 million tonnes into the Atlantic annually.

War and civil unrest have also played a major role in the degradation of the land. Conflicts in Somalia, Ethiopia and Sudan have led to economic collapse and political chaos. In addition to the direct environmental damage caused by the conflict, the allocation of scarce resources to support military activities has detracted from efforts to address the region's environmental problems. Conflict and civil disorder also impact on the people themselves and their willingness and ability to deal with desertification.

Tackling desertification must be a global priority, especially in line with the 2030 Agenda for Sustainable Development. Goal 15 is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat diversification and halt and reverse land degradation and halt biodiversity loss.

Activities

Understanding the text

1 Define land degradation. Outline a range of human activities that are responsible for it.

2 Explain how desertification occurs in marginal areas of the world.

Working geographically

3 Investigate the impact of desertification throughout the world. Write a report identifying where it is of greatest concern and what efforts are being undertaken to tackle it.

Exam-style questions

Extended responses

- Outline the tectonic and gradational forces shaping the earth's surface.
- Explain the difference between physical and chemical weathering. Give examples of each.
- Outline the factors that influence the development of soils.
- Outline the ways in which people interact with the lithosphere.
- What is desertification? Explain how the activities of people have contributed to desertification.

Glossary

asthenosphere a layer of partially molten material within the upper part of the mantle, upon which the lithospheric plates move

bog a type of wetland that accumulates acidic peat, which is a deposit of dead plant material

colloids small particles with very high surface-to-volume ratios formed by the combination of organic and mineral materials

colluvial material that has been transported downhill and accumulated on the lower slopes

continental drift a theory that proposes that all the continents were once joined together in a giant supercontinent, which subsequently split apart, with the continents drifting away from one another until they reached their present locations

desertification the spread of desert-like conditions in arid and semi-arid regions resulting from a combination of climatic changes and increasing human pressures, such as overgrazing, removal of vegetation and the cultivation of marginal land

earthquakes vibrations and shock waves caused by the sudden movement of tectonic plates along fracture zones, or faults, in the earth's crust

eluviation the removal of material from soil by percolating water

erosion the wearing away of land by running water, rainfall, wind, ice or other geological agents

ferromagnesian minerals minerals rich in iron and magnesium

geomorphology the study of landforms, including their origin, evolution, form and distribution

gradational processes those processes that result from gravity and the sun's radiant energy and which act upon the surface of the lithosphere and bring it to a common level; they include the fragmentation of rocks by weathering, their mass movement downslope, and the detachment and removal of these materials by the agents of erosion and the deposition of debris at a lower elevation

illuviation the introduction of material by percolating water, alluvial, fine silt and clay

land degradation a decline in the quality of natural land resources, commonly caused by improper use by humans

landform a specific physical feature of the earth's surface; for example, a plain, escarpment, valley, plateau, hill or mountain

land use the range of uses that humans make of the earth's surface

leaching the process by which soluble materials are dissolved and filtered down through the soil profile by percolating water

lithosphere the outer shell of the earth, consisting of solid rock (100–150 kilometres thick), soil and geological formations

mass movement the downslope movement of weathered rock material under the influence of gravity

soil the loose material composed of both mineral and organic matter that covers the earth's land surface; its thickness varies from place to place

tectonic forces disturbances in the earth's crust that result from the earth's internal energy and create physical features, such as mountains, on the earth's surface

tectonic plates sections of the earth's crust that move about as distinct units on the asthenosphere on which they rest

translocation the movement of soil-forming materials through the developing soil profile; translocation occurs by water running through the soil transferring materials from upper to lower portions of the profile

volcanism a process resulting in the upward movement and expulsion of molten material from within the earth to the surface, where it cools and hardens

weathering the in situ physical disintegration and chemical decomposition of rocks and minerals at or near the earth's surface by atmospheric and biological agents

CHAPTER

5 The biosphere

Humanity is confronted by a major dilemma. The energy sources on which our standard of living depends are carbon-based. Burning these resources to produce electricity releases carbon dioxide into the atmosphere and this is altering the earth's climate. The warming of the planet is starting to impact on earth's animal and plant species and entire habitats. From bleached coral reefs to melting glaciers, from thawing permafrost to vanishing rainforests, the impacts of climate change are increasingly apparent. No part of nature is an island, and changes in one place can trigger profound shocks in regions thousands of kilometres away.

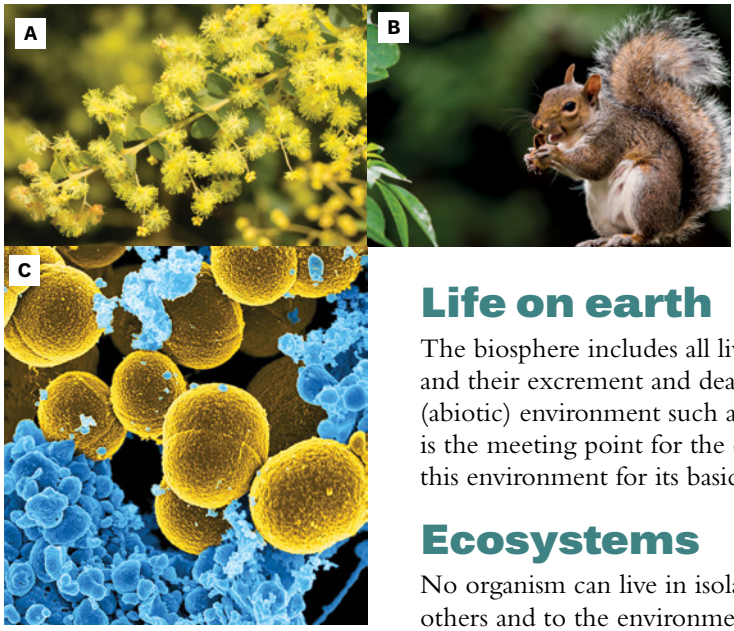
This chapter focuses on the biosphere: that part of the earth where all living organisms exist and interact. It examines the variety and distribution of plants and animals, the earth's terrestrial ecosystems, the factors affecting the global pattern of vegetation, and the development of local vegetation regimes.

> **Destroying rainforest for economic gain is like burning a Renaissance painting to cook a meal.**
>
> **E.O. Wilson, US biologist**

5.0.1 Wild animals at a waterhole in Etosha National Park, M'bari

UNIT 5.1

Ecosystems and life on earth



5.1.1 Elements of the biosphere: **A** plants, **B** animals, and **C** microorganisms

Life can only be created and sustained in the presence of moisture, sunlight and nutrients. These elements only occur together on or near the surface of the land and in the sea. The biosphere is the global realm that encompasses all living things: from the creatures on the ocean floor and the insects burrowing beneath the soil to the animals and plants on the earth's surface and the spores floating high in the atmosphere.

Life on earth

The biosphere includes all living (biotic) organisms (plants, animals and microorganisms) and their excrement and dead remains (see Figure 5.1.1). It also consists of the non-living (abiotic) environment such as rocks, water and air. Thus, the biosphere incorporates and is the meeting point for the other three spheres. Every living thing is dependent upon this environment for its basic requirements.

Ecosystems

No organism can live in isolation. An individual of a species is intimately related to others and to the environment in which it lives. Each is a member of a population, which in turn forms a part of a larger community. A community, together with its non-living environment, forms an ecosystem, as illustrated in Figures 5.1.3 and 5.1.4.

SPOTLIGHT

The humble spud

Will there be enough food to support the billions to be added to the world's population this century?

The bewildering variety of potatoes (see Figure 5.1.2) may well hold the answer to this dilemma, especially in developing nations. Protecting such genetic diversity, which forms nature's capital, or the basis for future productivity, is more important than ever before.

The International Potato Centre's research facility in Peru holds the largest potato gene bank in the world with over 2400 wild and 4700 native varieties found in Andean South America (Colombia, Venezuela, Ecuador, Peru, Bolivia, Argentina and Chile). Live tissue cultures of this tuber plant are kept in test tubes and research is conducted to develop climate and disease resistant species. Living samples and seeds are distributed completely free of charge to farmers in poorer countries.

The potato was first brought to Europe by Columbus in the eighteenth century. Initially it was somewhat of a novelty. Marie Antoinette, the Queen of France, wore the flowers of the potato plant in her hair. Her husband, King Louis XVI, wore them in his buttonhole.

5.1.2 The many colours, sizes and shapes of potatoes reflect their high species diversity.

By doing so, they tried to encourage the French people to grow and eat this strange new food. Eventually, it was adopted in both Europe and North America and many historians maintain that it played an important role in ending famine there.

Compared with grains, tubers are much more productive. If the head of a wheat or rice plant grows too big, the plant will fall over, and the plant's food potential is lost. Growing underground, tubers are not limited by the rest of the plant. In 2008, a Lebanese farmer dug up a potato that weighed over 11 kilograms. It was bigger than his head.

Source: Smithsonian.com, 'How the Potato Changed the World', 2011

Though on different scales, a tidal pool on a rock platform and a huge expanse of tropical rainforest both represent an ecosystem. The term 'ecosystem' comes from the Greek work *oikos*, meaning 'house', with the implication being that a household interacts within a functional physical structure. An ecosystem is a group of organisms living together in the environment that immediately surrounds them.

Life has a variety of functions within the different levels of the biosphere. Individuals of a species must come together and usually touch in order to mate and nurture their young. Feeding territories are established, with different species occupying their own niche, and all sharing the resources (such as nutrients) available within the ecosystem. An ever-changing network of interactions sustains an ecosystem of species living in many curious and interdependent ways.

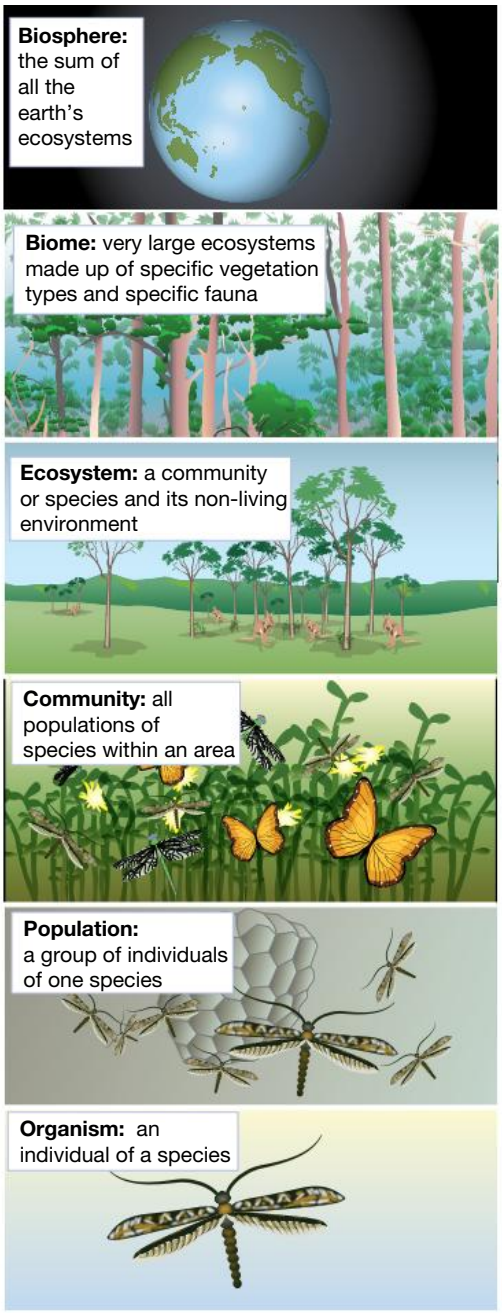
Dynamic ecosystems

The world's ecosystems are dynamic. They respond to change, whether brought about by natural or human forces. There are, however, limits to how rapidly the biological communities within ecosystems can adapt to the stress of change without being degraded or destroyed.

The amazing array of plants and animals on earth reflects how these organisms have adapted, through evolution, to different environments, or to a different range or set of physical conditions. The many ecosystems that exist can be broadly divided into two groups: aquatic and terrestrial.

Aquatic ecosystems

Major ecosystems in the hydrosphere are called aquatic ecosystems and include life forms of marine environments (for example, the open sea, ocean inlets and coral reefs) and freshwater environments (for example, rivers, lakes, dams and wetlands).

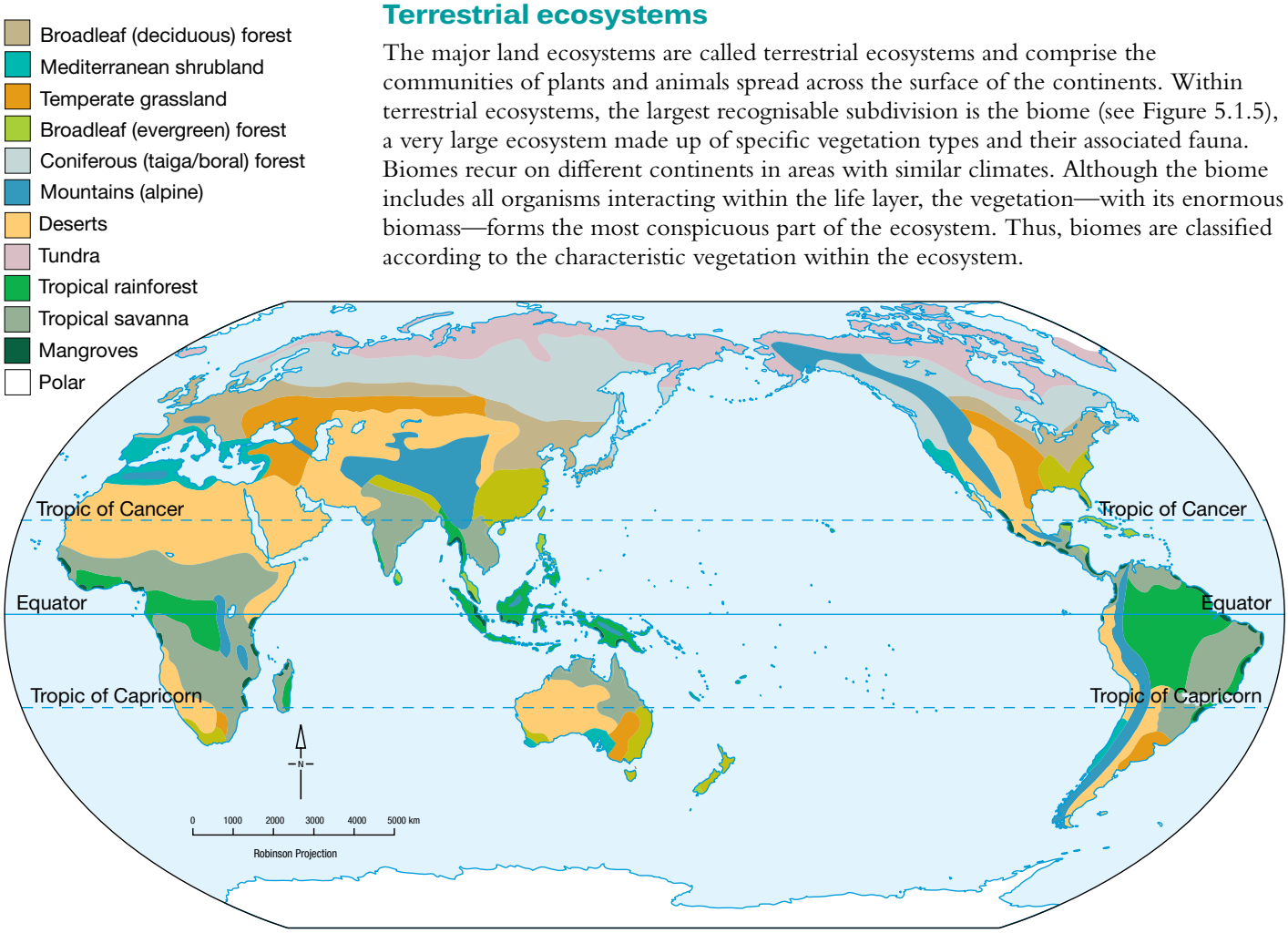


5.1.3 Levels within the biosphere

5.1.4 Each ecosystem has its own characteristic community of plants, animals and decomposers.

Terrestrial ecosystems

The major land ecosystems are called terrestrial ecosystems and comprise the communities of plants and animals spread across the surface of the continents. Within terrestrial ecosystems, the largest recognisable subdivision is the biome (see Figure 5.1.5), a very large ecosystem made up of specific vegetation types and their associated fauna. Biomes recur on different continents in areas with similar climates. Although the biome includes all organisms interacting within the life layer, the vegetation—with its enormous biomass—forms the most conspicuous part of the ecosystem. Thus, biomes are classified according to the characteristic vegetation within the ecosystem.



5.1.5 The earth's major terrestrial ecosystems or biomes

Activities

Understanding the text

1. Outline the conditions that make it possible for life to exist on earth.
2. Explain what a biosphere is.
3. Define the term ecosystem.
4. Explain why the world's ecosystems are described as 'dynamic'.
5. Distinguish between terrestrial and aquatic ecosystems.
6. What is a biome?
7. Explain why the earth's major biomes are identified by their characteristic vegetation type.

Working geographically

8. Study Figure 5.1.3 and the text and then define each of the following terms: organism, population, community and ecosystem.
9. Study Figure 5.1.5 and describe the distribution of the earth's main terrestrial ecosystems.

Listed below are the principal biomes. They appear in order of availability of soil, water and heat:

- **forest**—ample soil water and heat
- **savanna**—transitional between forest and grassland
- **grassland**—moderate shortage of soil water; adequate heat
- **desert**—extreme shortage of soil water; adequate heat
- **tundra**—insufficient heat to sustain vegetation growth throughout the whole year.

The actual number and names of biomes vary between authorities, and there are no absolute distinctions between them; just as climates grade into each other, so do vegetation types. Nevertheless, it is undeniable that similar climates in different places bring about similar types of vegetation. The concept of biomes is an attempt to describe this process on a worldwide scale.

One of the most well-known examples of a biome is the equatorial or tropical rainforest, which grows in wet, hot climates, such as Brazil, Zaire, Malaysia and parts of coastal Queensland. At the other end of the climatic gradient are the Arctic areas of Canada, Greenland and Russia's Siberia, where tundra vegetation occurs. A similar type of vegetation can also be found on the high mountains of Tibet, in the Andes and even on the mountains of New Guinea, where similarly cold conditions exist.

UNIT 5.2

Factors affecting the global pattern of vegetation

Plants are immobile and unable to generate their own heat, which means they are completely controlled by their environment. As the environment changes from region to region, so does the vegetation. Four main factors interact to produce each distinctive biome:

- climatic (such as water supplies, temperatures, light and wind)
- topographic (such as altitude, angle of slope and aspect)
- edaphic (related to soils)
- biotic (related to the living environment).

5.2.1 Desert plants survive in the dry environment by reducing water loss.

Climatic factors

There is an obvious relationship between vegetation and climate as all plants need certain moisture and temperature conditions to grow.

Precipitation

The availability of water is the most important controlling factor in the distribution of vegetation. Precipitation is considered to be the limiting factor that determines whether the biomes of the world's land surface are forest, grassland or desert. Water is very important for plant growth and development because it is vital to processes such as photosynthesis, germination and the transport of nutrients. Plants continually lose moisture from their leaves by transpiration, and this must be balanced by a comparable uptake of soil water.

Precipitation usually determines the amount of water available. However, rainfall effectiveness (whether the moisture is available to plants at the right time) is more important than rainfall totals. Moisture effectiveness through precipitation can be influenced by timing and availability:

- **Timing:** Does it coincide with the growing season? Is it concentrated in summer when moisture loss through evapotranspiration is high?
- **Availability:** Does it fall as steady, soaking rain allowing beneficial soil infiltration to occur? When major storm events occur, how much water is lost as surface run-off?

Timing

Heavy rainfall throughout the year supports forests of various types. Tropical rainforests flourish where there is ample water; as the supply of water diminishes, the vegetation responds accordingly. This is readily observable when moving inland from the east coast of Australia. Pockets of tropical rainforest survive along the coast. These give way to wet sclerophyll forests, which in turn give way to dry sclerophyll forests further inland.

If most of the rain falls in summer, when evaporation rates are especially high, there may be inadequate soil moisture to support trees, and grasslands thus predominate. Savanna grasslands are characteristic of tropical latitudes, while prairies are typical in the temperate, mid-latitude areas.

Availability

In deserts, water availability is limited and transpiration rates are potentially high. This produces smaller plants specially adapted to reduce water loss and survive the effects of extreme aridity. The little rain that falls triggers a profuse growth of ephemerals (plants with very short life cycles). Plants adapted to low water availability include mulga, cacti (see Figure 5.2.1) and saltbush. These are classified as xerophytes.

Alpine and tundra vegetation is usually characterised by dwarf plant forms. These are better able to handle the low availability of moisture and low rates of transpiration.

Temperature

For each plant species there is an optimum temperature range and a maximum and a minimum beyond which irreparable damage occurs. Most plants prefer temperatures between 10° and 35°C for effective photosynthesis.

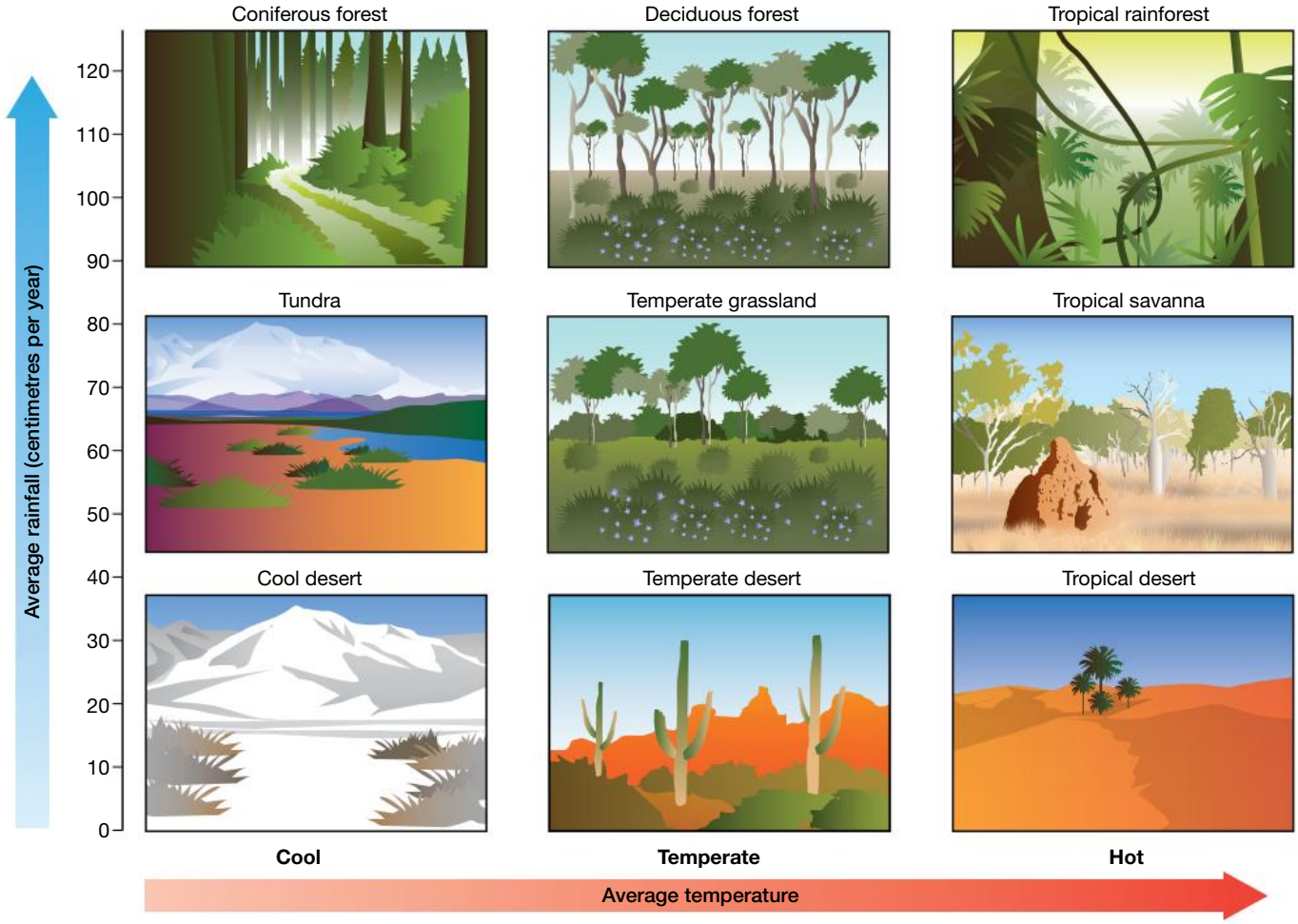
Global differences in temperature are reflected in the different forest types:

- Constant mean monthly temperatures above 16°C, accompanied by adequate precipitation, produce optimum conditions for plant growth. Broadleaf evergreen trees predominate in tropical rainforests.
- Seasonal variations in temperature and precipitation with five months below 6°C, or a dry season, produce broadleaf deciduous forests.
- A period of more than six months below 6°C provides only a short growing season and coniferous, or boreal, forests dominate.

The importance of differences in average temperature and average precipitation on a continental scale is evident when examining the gradual transition from one biome to another. When it is realised that similar climates on different continents support similar vegetation, the overall distribution of biomes by latitude bears a strong resemblance to the latitude-based differences in climate. Figure 5.2.2 shows the relationship between biomes and the main climatic parameters (rainfall and temperature).

Light

All green plants require light: their leaves act like miniature solar panels, collecting the sun's energy and using it to combine carbon dioxide with water to produce organic nutrients through the process of photosynthesis. This stored chemical energy provides the food for most other organisms.



5.2.2 The relationship between biomes and climate

As intensity of light determines the amount of energy available for photosynthesis, ecosystems near the Equator have a much higher energy input than polar ecosystems. The biomass of a tropical rainforest far exceeds the meagre biomass of a desert ecosystem: 45 kilograms of dry carbon per square metre compared with 0.7 kilograms of dry carbon per square metre.

Within a tropical rainforest ecosystem, individual species of plants have adapted to survive the low light intensity on the shaded forest floor. Ferns have numerous fronds, which are capable of individually turning to capture any shaft of sunlight briefly available, as seen in Figure 5.2.3.

5.2.3 Ferns thrive in low-light areas as their fronds and leaves can move independently to capture any sunlight that may reach them (often on the floor of a forest).

Winds

Moving air is common in all ecosystems and normally has little effect on vegetation, apart from occasional storm damage. However, if winds are strong and continuous (for example, on coastal headlands, ridge tops and mountain slopes) only vegetation that is wind resistant can survive. Winds can cause physical damage and asymmetrical shapes in plants, as shown in Figure 5.2.4.

Persistent winds can also reduce moisture availability by evaporating more water from the soil and even increasing the rate of transpiration from the plants themselves. Winds, however, are not entirely destructive. They can assist in the transportation of pollen, spores and seeds and thus are important for plant dispersal.

5.2.4 A gnarled Juniper tree shaped by the wind on the island of El Hierro in El Sabinar, Spain

Topographic factors

Vegetation patterns are affected indirectly by altitude, aspect and the degree of slope. These topographic features modify the climate and also have an impact on soils.

Slope

The steepness of the slope is important because it influences the stability of the surface material and the amount of water retained in the soil. Steeper slopes assist erosion and are more susceptible to mass movement. The end result is skeletal, rocky soils with a low moisture content. This makes a poor medium for plant growth. By contrast, soils on valley floors are rich in mineral particles, nutrients and organic matter, making them more fertile and productive. This is because these soils are the recipients of material transported from adjacent slopes.

Aspect

The orientation of a slope alters sunlight and temperature conditions. North-facing slopes in the Southern Hemisphere are more favourable for plant growth than those facing south (especially in winter). This is because these slopes receive the most direct solar radiation.

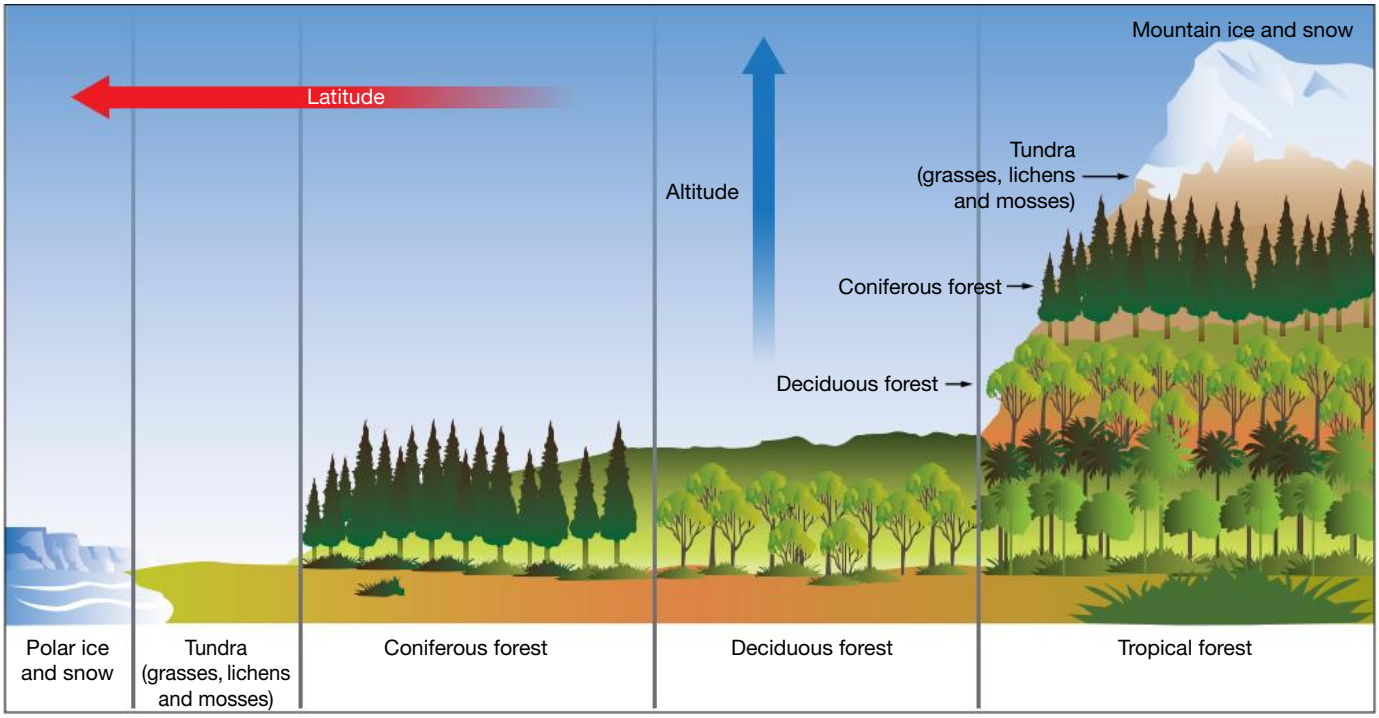
Altitude

With increasing elevation, there is a decrease in both soil depth and air temperature and increased exposure to wind. These combine to limit the conditions for plant growth. As altitude increases there is a noticeable decrease in the:

- number of plant species
- height of plants
- density of plants
- growth rate of plants
- length of the growing season.

As one moves up very high mountains, a distinct vertical zoning of vegetation is revealed. This zoning is similar to the changes observed when travelling from the Equator to the poles.

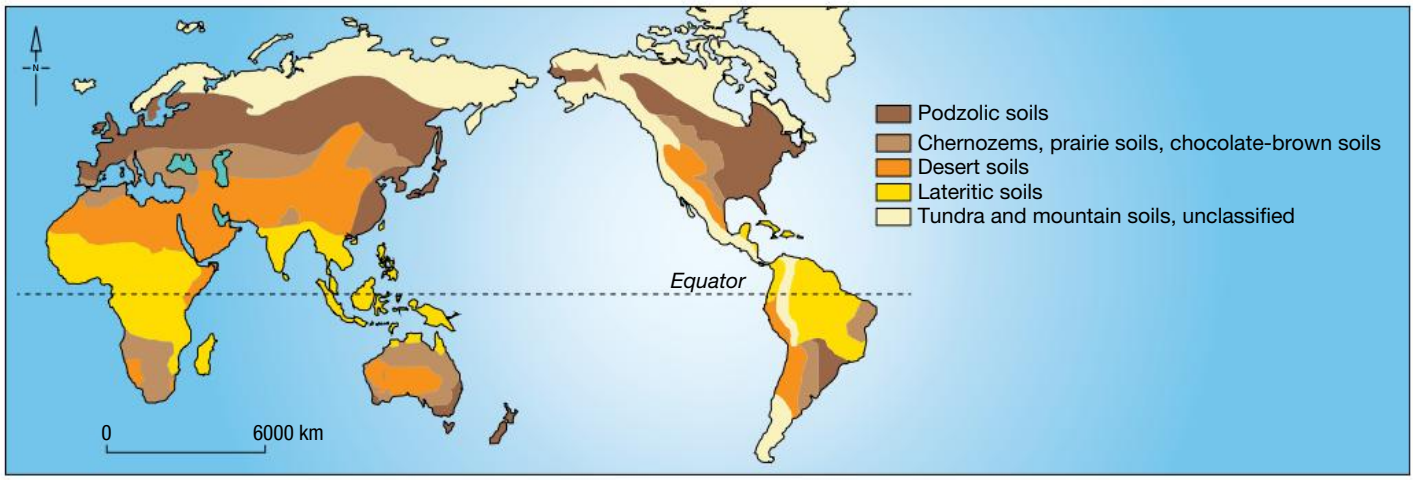
Both increasing latitude and elevation result in a shift to cooler vegetation types with a decrease in community diversity, as shown in Figure 5.2.5. The Andes rise to glacier-clad summits from the rainforests on the east and the deserts on the west. In the Andes, nearly all the world's latitudinal temperature and vegetation zones can be observed in vertical succession.



5.2.5 The relationship between latitude, elevation, vegetation type and biodiversity

Edaphic (soil-related) factors

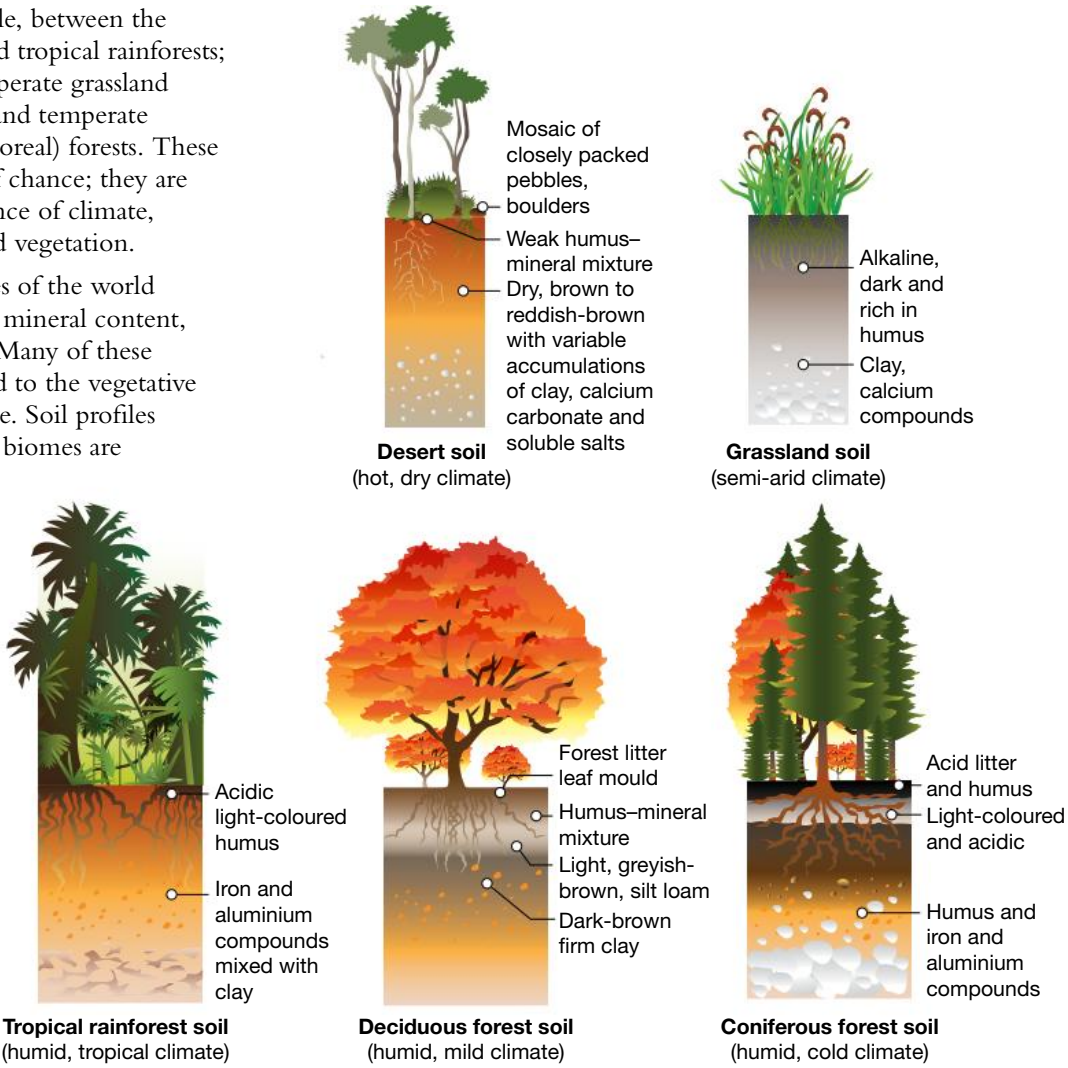
Most plants are dependent on soils as a medium in which to grow because soils provide the water, air and nutrients necessary for growth. Vegetation, in turn, also has an impact on a soil's characteristics. Soils and vegetation, therefore, have an intimate mutual relationship. On a global scale, the distribution of vegetation and soil types present similar patterns. This is evident when comparing Figures 5.1.5 (page 90) and 5.2.6.



5.2.6 The generalised pattern of world soil types

Similarities emerge, for example, between the distribution of lateritic soils and tropical rainforests; desert soils and desert and temperate grassland vegetation; and podzolic soils and temperate forests, including coniferous (boreal) forests. These similarities are not the result of chance; they are due to the overriding importance of climate, which influences both soils and vegetation.

Mature soils in different biomes of the world vary widely in colour, texture, mineral content, pore space, acidity and depth. Many of these characteristics can be attributed to the vegetative cover and the associated climate. Soil profiles typically found in five types of biomes are illustrated in Figure 5.2.7.



5.2.7 The soil profiles typical of five selected biomes

Biotic factors

Biotic factors result from the multitude of relationships that exist between plant and animal species within an ecosystem. A biome is not merely a random collection of plants and animals but a highly complex, interactive community. Human activities are the most significant biotic factor influencing vegetation and its companion fauna.

Plant competition

Plants grow by forming organic compounds from sunlight, atmospheric carbon dioxide and water. In doing so, they compete with each other for these vital ingredients. Nowhere is this battle more apparent than in a tropical rainforest, which teems with diverse life forms engaged in a relentless struggle.

An example of a remarkable mutually beneficial relationship between plants is the one that has developed between the largest and one of the smallest organisms: trees and fungi. Mycorrhizal fungi weave their threads into a mat around the roots of trees. This acts like a sponge, mopping up soil water that is rich in nutrients. The nutrients are fed to the tree, which, in turn, provides the fungi with simple sugars.

Relationships between plants and animals

Among the intriguing features of biomes are the extensive networks of relationships that have developed between plants and animals. Over time, species adapt to one another: animals to plants, animals to animals and, as shown with strangler figs and epiphytes, plants to plants. Each successive generation refines its ecological niche. Plants and animals tend to become more specialised and particular species develop mutually beneficial (symbiotic) relationships with others. In many cases, plants and their pollinators and seed-dispersal agents have evolved together; one ultimately dependent on the other.

5.2.8 The green and blue hummingbird in the Ecuador tropical montane forest

Hummingbirds are highly specialised pollinators. They feed on concentrated nectar, which fuels their high metabolism rate and their ceaseless hovering and darting. Their long bills often exactly match the length of the flowers on which they feed. This is a remarkable example of co-evolution, which ensures that only a pollinator can reach the nectar, as shown in Figure 5.2.8.

Many plants rely on insects or animals for pollination. They also rely on highly mobile animals (such as birds, bats and monkeys) to ensure a wide dispersal of their seed.

Conflict between plants and animals

Not all relationships between plants and animals are beneficial. An ongoing conflict exists between plants and a marauding army of herbivores that rely on plants for their basic food source. Plants have evolved many ingenious defences, including thorns and spikes and various types of defensive chemical compounds. Usually, little serious damage is done in this continual war unless excessive numbers are involved and natural balances are upset. The latter are often triggered by human activity. The introduction of rabbits into Australia resulted in plague proportions of rabbits, which stripped the land bare, making it vulnerable to erosion.

Human activities

Human activities are the most significant of all the biotic factors operating today. As the human population and its domination in the biosphere increase, so does the threat to other life forms.

When human populations remained relatively small, the environmental impacts of human activity on the biosphere was limited. Today, many environments have been brought under direct human control through agriculture, industrial development and, in recent times, the unprecedented increase in human numbers.

The extent of human control of ecosystems is illustrated in Figure 5.2.10. Humans possess one quality that sets them apart from all other species: the ability to manipulate their environment to suit themselves. Technological developments continue to enhance this ability and have enabled humans to acquire an unprecedented level of control over nature.

SPOTLIGHT

Strangler figs and epiphytes

Strangler figs (*Ficus spp*.) are one of the great exploiters of the plant community, and use ingenious ways to secure space, sunlight and nutrients. There are many different species of strangler fig in the rainforest. Each has its own specific wasp pollinator and all fruit prolifically. (As many as 100 000 fruits have been found on a single tree.) Birds and monkeys feed on the fruits and are largely responsible for the dispersal of its seeds.

Occasionally one of these countless seeds lodges in the branch of a tree and germinates. The seedling initially sends out a long aerial root to the ground. Then, once it has locked into the soil, the young fig starts to grow, sending more roots down to the ground from its perch. As these roots cross over one another, they fuse together. The fig also sends out its own foliage above that of the host tree. Starved of sunlight, the host tree dies, its trunk encased in the fig's roots, shown in Figure 5.2.9. In this way, the fig avoids competition on the ground, seizing the place of the original tree. The fig has successfully established itself in the canopy where sunlight is at a premium.

Another way in which plants gain access to light without investing in lengthy stems or roots is for them to live on other (host) plants. Epiphytes (such as mosses, lichens, ferns, orchids and bromeliads) anchor themselves to a host tree. Unlike the fig, they do not live at their host's expense. Epiphytes are not parasitic, because they use their own root system to trap debris and moisture. Some trees actually send out roots from their trunk into the epiphyte to trap this resource.

5.2.9 The roots of the strangler fig have wrapped themselves around the trunk of the original host tree, which has subsequently died and rotted away.

The extent of human control of ecosystems

Type of control	Examples
Direct physical control	■ Confinement of animals or plants by enclosures of any kind ■ Exclusion of animals or plants by devices of any kind ■ Physical support given to organisms (mainly plants), such as stakes and trellising ■ Pruning, trimming and mowing ■ Weeding ■ Persecution of organisms by physical means, such as shooting ■ Performance of minor operations on a routine basis, such as shearing, dehorning, docking, castration and hoof care ■ Cropping/harvesting: removal of all or part of certain plants or animals and their transfer from the system to the point of consumption
Chemical control	■ Poisoning unwanted organisms, whether plant, animal, insect, fungus or bacteria ■ Stimulating growth by adding nutrients ■ Chemically inducing changes in organism behaviour or characteristics, such as through the use of defoliants, colourants, hormones, attractants and repellents
Habitat control	■ Ploughing or other modifications to soil, earth or rock ■ Provision of special environments, such as glasshouses, greenhouses and beehives ■ Provision of shelters, such as windbreaks ■ Microclimatic modification to deter unwanted organisms ■ Introduction or exclusion of fire ■ Habitat destruction (such as deforestation, swamp draining and filling) leading to local or global extinctions
Biological control	■ Spread of disease to unwanted species, such as myxomatosis in Australian rabbits ■ Introduction of predator or parasite specific to unwanted species, such as cactoblastis on Australian prickly pear ■ Introduction of species to niche, such as marram grass for sand dune stabilisation in south-eastern Australia
Genetic control	■ Regular importing of strains of organisms with special characteristics (usually high yield) ■ Importing genetic material, such as use of artificial insemination ■ Control of plant or animal breeding within the system, such as use of selective breeding, selective hybridisation ■ Scientific interventions to bring about genetic changes that act as a means of controlling and perhaps eliminating unwanted species
Behaviour control	■ Subjugation, such as 'breaking' of horses ■ Training of animals to respond to stimuli, such as to attack unknown humans and to feed at sound of buzzer to facilitate harvest ■ Stimulating inherent responses of organisms to light/dark, heat/cold, high/low humidity etc., such as by extending day length with lamps and by refrigeration to simulate winter and induce 'spring' behaviour on removal from refrigeration
Water-cycle control	■ Supply or removal of water by any means ■ Weather modification

Source: P. Chapman & S. Codrington, *Understanding Our Earth*, Pitman, Carlton, 1985

5.2.10 The extent of human control of ecosystems

Biomes and human impact

The dominance of ecosystems by humans has diminished the space available for other species. Most obvious has been the loss of natural vegetation. In fact, many biomes have been significantly altered by human activities, as is evident in Figure 5.2.11.

How people have influenced biomes

Ecosystem	Percentage of the world's land	Vegetation	Effect of people on the ecosystem
Equatorial and tropical rainforest	8%	Many different types of trees; dense layers of plants; adapted to high rainfall throughout the year	The effect depends on the type of use: ■ hunters and gatherers: very little effect ■ shifting cultivators: large short-term effect, when forest is cleared; after fields are abandoned, forest regrows; that is, medium-term effect ■ timber-cutting: large effect as large areas of trees are cut down ■ clearing for farming: large effect as forest is totally removed.
Temperate forest	7%	Forests of different trees, many of which are deciduous; trees adapted to moderate rainfall and cool winters, warm summers	Many of the world's temperate forests have been cleared and the land is used for crop growing. People have had a major effect on this ecosystem.
Coniferous (boreal) forest	14%	Forests of evergreen trees, mainly conifers; trees adapted to cold winters and low rainfall	People have changed some areas more than others. In Canada and the eastern part of Russia, some forests have not been used. In the USA and Norway, they are used for grazing and herding. In western areas of Russia, the effect of people is higher as the forests have been cleared for crop growing.
Savanna (grassland)	24%	Areas near Equator have trees and grasses; closer to deserts, grasses dominate; grasses adapted to a wet and a dry season	Major effect of people: ■ herding and ranching: fires have been used to clear trees and encourage grasses ■ areas of overgrazing where stock numbers are too high: erosion results ■ grasslands ploughed for crops: danger of erosion.
Temperate grassland	7%	Tall grasses in wetter areas, and scattered trees; shorter grasses where drier	Most of these grasslands have been cleared and ploughed for crop growing. Areas of grassland have been improved, or replanted with better grasses, for livestock grazing.
Mediterranean	1%	Shrubs and trees adapted to summer drought and winter rains.	Most vegetation has been cleared and soil ploughed for tree crops and other crops; some grazing.
Hot desert	21%	Sparse cover of shrubs and grasses; plants adapted to low rainfall and long periods without rain	Areas in Africa and Asia are used for nomadic herding. In the USA, Australia and South America, they are used for ranching (cattle/sheep). Very fragile ecosystem: although stock numbers are low, many areas are overgrazed and erosion is a problem.
Tundra	5%	Mosses, lichens and plants; adapted to cold temperature and low rainfall	Very little effect, although tourism can destroy the vegetation.
Polar	11%	Ice caps: no vegetation	People have had little direct impact on ice caps, but human activities such as fishing of krill and other marine life, pollution and climate change is starting to affect marine life.
Cities and industrial areas	2%	Natural vegetation cleared and people build a new environment (houses, roads and factories)	Major impact, as people change the nature of the ecosystem. Pollution of air and water is having a major impact on all the world's ecosystems.

Source: P. Chapman & S. Codrington, *Understanding Our Earth*, Pitman, Carlton, 1985

5.2.11 How people have influenced biomes

Activities

Understanding the text

1 List the four factors that determine the global pattern of vegetation.

2 Explain why water is vital to the growth and development of plants.

3 Outline the factors that affect rainfall effectiveness.

4 Give one example of how the seasonal distribution of rainfall affects the pattern of vegetation.

5 Outline how some plants have adapted to low water availability.

6 Explain how global differences in temperatures are reflected in vegetation types.

7 Explain why plants need light.

8 Outline the nature of the relationship between biomass and the intensity of light.

9 List five ways in which vegetation is influenced by wind.

10 Explain the impact that altitude, slope and aspect have on vegetation.

11 Describe the relationship that exists between vegetation and soil.

12 Describe the vegetation changes you would expect to encounter when moving downslope from skeletal soils on a ridge top to the deep alluvial soils of a valley floor.

13 Explain, with reference to an example, what is meant by a 'mutually beneficial relationship' between species within an ecosystem.

14 Explain why the impact of humans on the biosphere has increased.

Working geographically

15 Vegetational response can be matched to changes in temperature, which are determined by energy input. Investigate why this energy input is different at the Equator and the higher latitudes near the poles.

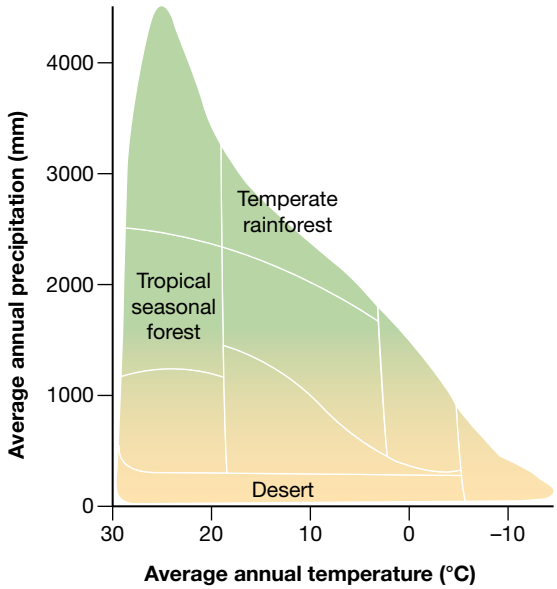
16 Study Figure 5.2.2. Write an explanation outlining how distinctive biomes are the outcome of the interaction between average temperature and average precipitation.

17 Study Figure 5.2.5. Write a report describing the impact of latitude and altitude on the pattern of vegetation.

18 Undertake library or internet research into:

- **a** plant adaptation to different light intensities
- **b** special adaptations made by plants and animals in two contrasting types of biomes.

19 Using the information in Figures 5.2.2 and 5.2.5, complete the following graph by locating each of the earth's major ecosystems: tundra, boreal (or coniferous) forests, temperate grasslands, temperate deciduous forest, savanna and tropical rainforest.



20 Study the map of soil distribution on a global scale (Figure 5.2.6) and compare it with the generalised map of global vegetation (Figure 5.2.5).

21 Examine the soil profiles in Figure 5.2.7 and then complete the following tasks.

- **a** Account for the differences in colour and fertility between grassland and desert soil.
- **b** Describe the characteristics of the soil profile in areas of coniferous forest. Suggest reasons why these soils are light coloured and acidic.
- **c** Identify which soil type offers the greatest potential for agriculture. Justify your answer.

22 With reference to Figure 5.2.10, write a report outlining the extent of human control of the world's major ecosystems.

23 With reference to Figure 5.2.11, undertake internet or library research into examples of how people have influenced biomes. Present your findings on an annotated visual display using a world map as a basis for the display.

UNIT 5.3

Biodiversity

5.3.1 All species, including the Indian elephant, have an inherent right to exist.

SPOTLIGHT

Biodiversity Convention

The Biodiversity Convention is an international agreement signed by 157 countries at the International Environment Summit in Rio de Janeiro in June 1992. Initially, the United States did not sign the convention at Rio. This was on the grounds that to do so would unduly interfere with its biotechnology industry. The United States has since signed. The Convention has now been ratified by more than 30 countries, including Australia, and came into force on 29 December 1993.

The convention is the first all-encompassing international instrument for the protection of wildlife. Parties to the convention must agree to undertake measures relating to:

- in situ and ex situ conservation
- sustainable use of biodiversity
- incentives to encourage conservation and sustainable use
- improved public understanding of biodiversity and the need for its conservation
- access to and transfer of relevant technologies
- the provision of financial resources to encourage developing countries to implement the provisions of the convention.

Many ecologists believe that the world is about to experience an episode of major species extinction, rivalling other periods when a significant portion of global fauna and flora was lost. The most recent of these was the disappearance of the dinosaurs some 65 million years ago. Whereas earlier extinctions were related to natural phenomena, such as climatic or geological dislocations, experts claim that the current episode is human-driven. The rapid conversion and degradation of habitat for human use; the accidental and deliberate introduction of exotic species; overharvesting of animals, fish and plants; pollution; human-induced global climatic change; and industry, agriculture and forestry are all activities that destroy or impair natural ecosystems and the species within them.

Biodiversity and why it is important

Biological diversity (or biodiversity) refers to the variety of life on earth and encompasses the different plants, animals and microorganisms, their genes and the ecosystems of which they form a part. Scientists define biodiversity at three levels: genetic, species and ecosystem:

- **Genetic diversity:** This is the inherited variation that occurs within populations of species as a result of different genes or biochemical combinations. This has an important practical use, especially in agriculture where resistance to pests arises and new traits may be sought. It is increasingly relevant for all forms of life, because genetically diverse populations will be more likely to adapt to, and thus survive, changes to their environment.
- **Species diversity:** This refers to the number of different species, or species richness. Species diversity among plants, for example, provides us with a host of useful products that could well determine the health and living standards of growing human populations. As well as providing new food sources, products extracted from wild species are valuable to the pharmaceutical industry.
- **Ecosystem diversity:** This is the variety of habitats, communities and ecological processes in the biosphere that play a vital role in protecting catchments, purifying water, regulating temperature, regenerating soil, recycling wastes, and maintaining the quality of the air we breathe. Plants and animals also supply us with many of the medicines that are used to cure human diseases.

Debates about the threats to biological diversity have tended to over-look microorganisms. They facilitate the addition of nitrogen to soils and the decomposition of animal and plant proteins in the soil.

All species and communities have an inherent right to exist (see Figure 5.3.1). They form part of a world that is an independent whole. The world belongs to the future as well as the present, and no species can claim it as its own. Ultimately, the actions of any species, including humans, will be guided by ecological limits.

Threats to biodiversity

As Figure 5.3.2 shows, a World Conservation Union analysis of animal extinctions that have occurred since 1600 found that, where the cause was known, 39 per cent resulted from species introductions, 36 per cent from habitat destruction and 23 per cent from deliberate extermination.

Species introductions can be deliberate or accidental. Exotic species can wipe out local flora and fauna either by preying on them or outcompeting them for food and space.

Habitat destruction is considered to be the biggest current threat to biodiversity. Habitat loss takes several forms. Among them are the outright loss of areas used by wild species when they are converted to human use. Habitat loss can also be degradation and fragmentation, where native species are squeezed into smaller and smaller areas of undisturbed land.

Hunting can lead to the uncontrolled exploitation of, and trade in, wildlife. It has decimated some species. Large mammals, such as elephants, are still targeted by poachers despite the global ban imposed on ivory trading in 1989. Wild birds are among the animals threatened by illegal trade in exotic species.

Pollution is a major threat in aquatic (and land) ecosystems. Acid rain, for example, has been held responsible for a serious decline in amphibian species.

The eventual extinction of a species generally results from a culmination of these related causes. Habitat destruction pushes species into small, isolated areas. Here they fall victim to the intrusion of other species, including humans, from adjacent, cleared areas.

Protecting biodiversity

Unprecedented concern about gene, species and ecosystem loss has prompted two approaches to biodiversity conservation: protecting habitats and protecting individual species and populations.

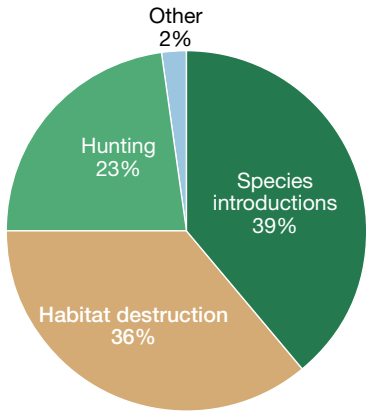
Protecting habitats

Parks and reserves, where human activity is limited, have been at the heart of strategies to protect threatened habitats and maintain biodiversity. There are deficiencies in the current network of protected areas. To adequately safeguard biodiversity, protected areas must:

- be large enough to effectively protect and conserve land in intact ecosystems and allow evolutionary processes to continue into the future
- have boundaries that reflect environmental rather than political needs
- be well-managed and adequately funded
- take into account the interests of local people—when people who once depended on the resources of an area are excluded from that area, they sometimes resort to destructive activities, such as poaching; they do so because they have no other way to support their families
- be surrounded by a 'buffer zone' where human activity is carefully managed—changes in areas surrounding the protected zone may interrupt breeding and migration patterns and affect air and water quality.

Protecting individual species and populations

While strategies to protect individual species and populations are important, they can only support a small percentage of threatened species. Measures include offering legal protection to individual species and developing management plans designed to protect them. Another measure is ex situ (outside natural habitats) conservation, using zoos and seed banks. Ex situ methods provide an insurance against the loss of genetic and species diversity in the wild and offer opportunities to reintroduce or bolster wild populations.



5.3.2 Known causes of animal extinction since 1600

Activities

Understanding the text

1 Explain what biodiversity means and outline why it is important.

2 To which other events in the past has the loss of biodiversity been compared? How does the current wave of extinctions differ?

3 Define the three levels of biodiversity.

4 Outline the threats to biodiversity.

5 Name the two approaches to biodiversity conservation.

6 List the conditions that protected areas must meet if they are to be effective.

7 Explain what ex situ conservation is.

8 Outline the measures the signatories to the Biodiversity Convention have agreed to undertake.

Working geographically

9 Write a paragraph outlining the known causes of animal extinction since 1600.

10 Investigate, through library and internet research, some of the causes of animal extinctions.

11 Write an exposition on the topic: 'The earth's biodiversity is under threat. Why does that matter?'

CASE STUDY

Australia: flora, fauna and change

More than 80 per cent of Australia's plant and animal species only occur in (are endemic to) this country. This percentage of endemic species is higher than for any other country: 92 per cent of vascular plants, 83 per cent of mammals, 45 per cent of birds, 89 per cent of reptiles and 93 per cent of frogs are endemic.

Australia's flora

The evolution of Australia's flora can be traced back to the continent's very beginning when it was part of the supercontinent Gondwana. When Australia and Antarctica were connected as part of a single land mass, the predominant vegetation was rainforest. Despite the high latitude, the climate was warm and moist. When Australia broke free and began to drift northward, it carried with it a sample of Gondwana's flora; the rainforests of Queensland support one of the greatest concentrations of primitive flowering plants in the world.

For most of its 50-million-year existence as an isolated continent, Australia was covered with extensive, diverse tropical or subtropical rainforest. By the time the Europeans arrived in 1788, Australia's rainforests survived only in isolated pockets along the east coast: just 1 per cent of the continent's land surface. This dramatic transformation of the Australian landscape was the response to a changing climate, changing soils and the use of fire on a continental scale. Of all the continents, Australia has vegetation that burns the most readily and over the largest area.

CLIMATE

The northward drift of the Australian continent carried it into the latitudinal belt characterised by subsiding air. Between 20° and 30° south, this sinking air suppresses cloud formation and rain. It also spreads out across the surface, which results in air flowing predominantly off the continent. The drying of the climate resulted in rainforest retreat, the development of vegetation types adapted to aridity and the continent's relatively infertile soils, as shown in Figure 5.3.3.

SOIL

Australian soils are among the oldest and poorest in the world. This is due to the lack of nutrient renewal, which is normally associated with the formation of new lithospheric material. The poor quality of Australia's soils is also a result of the loss of nutrients over a very long time through wind and running water.

Over millions of years, plants evolved to cope with the infertile soils. Many developed sclerophyll characteristics; for example, small, thick leathery leaves, which need to be replaced less often than leaves on deciduous trees. Sclerophyll is a Greek word meaning 'hard-leaved'. The hardness of the leaves comes from lignin, which prevents the leaves from wilting in the dry conditions. This enables sclerophyll plants to grow in the phosphorus-deficient soils of Australia (see Figure 5.3.4).

Sclerophyll leaves have aromatic oils and waxes to inhibit insect attack. The presence of these compounds and a lower water content result in high levels of combustibility, which explain why many of these plants burn so explosively.

FIRE

Bushfires have always been part of the Australian biophysical environment. Fires were relatively infrequent when Indigenous Australians first arrived, more than 65 000 years ago. By the time Europeans arrived, fire had transformed the landscape and smoke haze could be seen regularly on the horizon.

Aboriginal and Torres Strait Islander people had adapted their lifestyles to the conditions they found and had learnt to manage the land to meet their needs. Their main tool in doing this was fire. They made frequent use of fire to keep the country more open and easy to traverse; to restore biodiversity, promote the growth of fresh green grass, which would attract animals; to signal and hunt; and for the more obvious purposes of warmth and cooking.

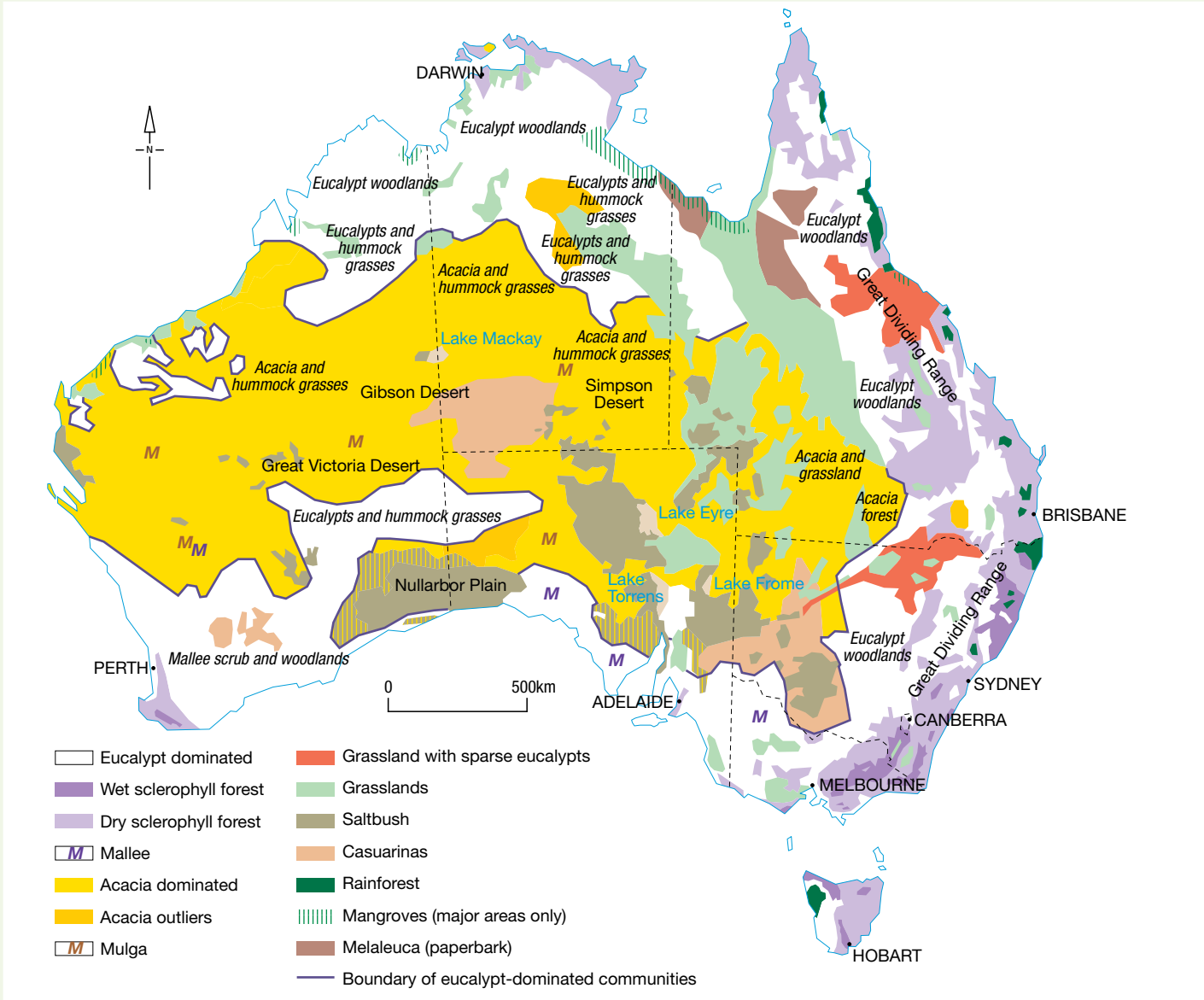
There is considerable evidence from fossil pollen and charcoal records to suggest that the purposeful use of fire extended from the earliest days of Indigenous Australian settlement. While fires had always occurred, it was only after the arrival of Indigenous Australians that they became more frequent and intense.

The main impact of the increased frequency of bushfires was to further restrict the extent of rainforests and to favour those plants best adapted to fire or to regeneration in its wake. Such adaptations include the following:

- **Epicormic buds:** Many eucalypts, especially those that burn frequently, have deep-set epicormic buds, which are protected by thick, insulating bark. With the crown of the tree destroyed by fire, hormones trigger these buds to produce new shoots. This new growth produces a halo, or fuzzy effect, around the branches of the trees as seen in Figure 5.3.5.
- **Lignotubers:** Other plants survive underground as lignotubers, which sprout from the base of the tree after all the above-ground parts have been consumed by the flames.
- **Stimulus for reproduction:** While others are killed outright, the fire's heat triggers the opening of woody fruits and seeds. These are released onto the ash-fertilised ground from which competing plants and seed-eating animals have been temporarily removed.

Australia's fauna

The main geological and climatic events that shaped the flora of Australia also influenced, in comparable ways, its fauna. Although little of the fossil evidence of Gondwana's wildlife is available, the supercontinent's fauna is thought to have included species largely adapted to living in



5.3.3 Australia's pattern of vegetation

5.3.4 Over millions of years, plants evolved to cope with Australia's infertile soils and arid climate. Many developed sclerophyll characteristics: for example, small, thick leathery leaves.

5.3.5 Epicormic buds produce new shoots on the trunks and branches of trees burnt in a bushfire.

rainforests. Evidence suggests that there were monotremes (egg-laying mammals like the platypus), marsupials, birds, reptiles and amphibians.

As the Australian continent experienced climatic fluctuations and eventually an increase in aridity, the vegetation responded accordingly. Forests and woodlands became increasingly fragmented and the areas of grassland extended. These provided bountiful resources for diverse communities of herbivorous animals.

Megafauna extinction

Megafauna were large land mammals and birds living in Australia (see Figure 5.3.6). There were over 60 species of megafauna including 450 kilogram kangaroos, 7 metre-long goanna-like creatures, 180 kilogram flightless birds, 130 kilogram marsupial lions and Volkswagen-sized tortoises. Megafauna became extinct 16 000 to 50 000 years ago.

The events leading to the extinction of Australia's megafauna are the source of considerable debate. The debate includes the following main theories: climatic change and human activity.

CLIMATE CHANGE EXTINCTION THEORY

Australia's climate changed at the end of the last ice age. It changed from cold-dry to warm-dry, which resulted in surface water becoming scarcer. Many of the inland lakes became dry (see Figure 5.3.7) or there was only water in the wetter seasons. In response, many of the browsing animals were forced to find new habitats where there was a more reliable source of water and vegetation. The new habitats were found on the narrow eastern band of Australia.

The disappearance of the megafauna due to climatic change has been rejected by some scientists. They argue that there were no climatic changes dramatic enough to account for the animals' extinction because the last ice age occurred some time later.

HUMAN ACTIVITY EXTINCTION THEORY

Hunted to extinction

This theory argues that Indigenous Australian people hunted megafauna into extinction. When people arrived on the Australian continent, the proposal argues that what then followed mirrored the common pattern of what happens after the arrival of people on previously uninhabited land masses: the bigger wildlife was hunted to extinction. In addition, larger animals reproduce slowly and they also find it difficult to hide and, for the most part, are slow moving. Humans armed with spears proved a very dangerous predator. By removing megafauna the debate concludes that the landscape was transformed.

Use of fire

The impact of Indigenous Australians, especially their use of fire over long periods, altered pattern vegetation patterns, and as a result the whole food chain was affected.

The extinction of the megafauna is also said to have greatly impacted upon the Australian environment. The loss of so many herbivores meant there was a great deal more vegetation to provide fuel for fires. This, in turn, caused dramatic changes in Australian flora and, ultimately, soil composition and rainfall.

The alternate theory about the impact of humans is that it appears that Indigenous Australian populations were not that large in prehistory. Recent studies indicate that demographic changes or an increase in population numbers began around 10 000 years ago. Hence, Indigenous Australian populations were not large enough to have such an impact to cause the extinction.

5.3.6 On an ancient Willandra lake shore a thylacine and a giant Procoptodon goliah are in the foreground. Behind them are people and a herd of Zygomaturus.

THE DEBATE CONTINUES

In 2017, archaeological research at Madjedbebe in Kakadu, Northern Territory (see Figure 5.3.8) showed that modern humans had been occupying Australia as far as 65 000 years ago. The new evidence suggests megafauna and humans coexisted for 20 000 years before megafauna became extinct. The coexistence for a longer period of time than previously thought has added another dimension to the ongoing debate about the causes of the megafauna extinction.

Two assaults on the ecosystem

Professor Tim Flannery, the Australian mammalogist, palaeontologist, environmentalist and global warming activist, argues that the Australian ecosystem has sustained two tremendous assaults. The first was by Indigenous Australians perhaps 16 000 to 50 000 years ago. This assault resulted in the extinction of most of the large predators and herbivores and the introduction of fire as a key environmental factor. The second assault was by European settlers. By forcing Indigenous Australians off their land, the settlers removed the one stabilising influence on the Australian environment. They also introduced many exotic (or foreign) species and new technology. As a result, an additional 20–30 species have disappeared.

5.3.7 Willandra Lakes system, Lake Mungo. The vast expanse of the now dry lake bed was a thriving habitat prior to the last ice age.

5.3.8 View to Nourlangie from Anbangbang Billabong, Kakadu National Park

Activities

Understanding the text

1. What factors have played a part in the dramatic transformation of Australia's pattern of vegetation?
2. Why did Indigenous Australians make frequent and purposeful use of fire?
3. What scientific evidence links the increased incidence of fire with the presence of Indigenous Australians?
4. What adaptations have many Australian native plants developed in response to frequent burning?
5. Write a report outlining the factors responsible for Australia's unique pattern of vegetation.
6. What name is given to the large land mammals and birds that only became extinct some 16 000 to 50 000 years ago?
7. Why were large animals vulnerable?
8. Outline the different factors that may have been responsible for their extinction.
9. Explain why there are different theories and why some might be more contentious than others.
10. How did the demise of the large marsupials affect the environment as a whole?
11. What was the second major assault on the Australian ecosystem?

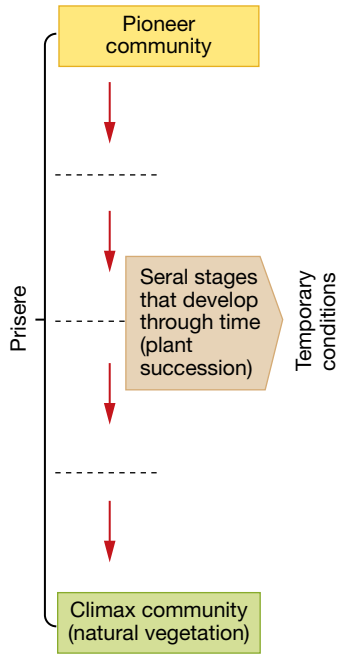
UNIT 5.4

Development of local vegetation

When viewed on the global scale, vegetation patterns are largely a product of climate. On more local scales other factors become relevant:

- **Topographic situation:** Altitude has a considerable influence on local site conditions. This is because it directly affects temperature and other phenomena through its influence on lapse rates (the change in temperature with altitude in the atmosphere) and cold air drainage (the downslope movement of air). Actual position on a slope also has a direct bearing on rates of soil accumulation, which vary along the slope. Rates of infiltration of water and movement of water through the soil vary with slope angle and position. Aspect affects temperature and rates of evapotranspiration.
- **Geology:** This provides the parent material from which soils are formed. Soils, in turn, provide the rooting environment for plants.
- **Animals:** These influence local vegetation patterns through the extent of their herbivorous behaviour and the dispersal of seeds and pollen.
- **Fire:** This is mainly the result of human interventions (deliberate or accidental).

Vegetation is an integral part of the biophysical environment in which all factors are interconnected. Vegetation is dynamic; always changing in large or small ways as it responds immediately or over time to a wide range of environmental influences, both natural and human-induced. For example, a wetland ecosystem that has been drained leads to the disappearance of those species of the community that are adapted to living in waterlogged habitats. These are replaced by species that are more characteristic of drier conditions. Such drained land may be used for agriculture, but if it is eventually abandoned, it will be quickly invaded by other species and turn into grassland, scrub or, given sufficient time, woodland.



5.4.1 A prisere, showing seral progression

Plant succession

Succession is a natural change in the structure and species composition of a plant community. Given the controlling factors of the biophysical environment, succession generally leads to the formation of the most complex community of organisms possible in an area.

A sere (plural: seres) is the name given to each stage in a sequence of events in which the vegetation of an area develops over a period of time. A prisere is the complete chain of successive seres, outlined in Figure 5.4.1. The first plants to colonise an area are called the pioneer species. Each succeeding community alters the local microclimate and surface conditions. This makes possible the appearance of a community that is more demanding in terms of soil moisture and nutrient levels. As time advances, the vegetation becomes taller, more diverse and more permanent. Eventually a stable community is attained. The plant community that is the end product of succession (that is, one that is in equilibrium with its environment) is known as the climax community. It may take hundreds or even thousands of years for climax vegetation to become established. Providing that it is not destroyed or severely damaged by humans or natural disasters, this community is stable and self-perpetuating; that is, able to sustain itself into the future.

No part of earth's surface supports a climax community indefinitely. In most areas there is a mosaic of communities at various stages of succession. There are two types of succession: primary and secondary.

Primary succession

Primary succession is the sequential development of more complex plant communities that may start on bare, uncolonised ground that has never had any vegetation growing on it before. Bare areas are rare, but they do occur where there are newly constructed deposits of mineral sediment, such as on sand dunes, lava flows from volcanoes, landslips and glacial debris left by melting ice. Most bare areas today are left exposed because the existing vegetation has been destroyed by fire or covered with volcanic ash. Often this devastation is caused by natural disasters.

Secondary succession

Secondary succession occurs when a community is removed or destroyed by human activities (such as forest clearance) or natural events (such as fire or cyclones). When the climax community becomes modified or displaced, the resultant plant community is known as a disclimax or plagioclimax. In many settled areas the natural process of plant regeneration is disrupted by activities such as farming, grazing and burning.

Tropical rainforests

A tropical rainforest represents a 'biological library' that, in some instances, dates back 100 million years. The tragedy is that rainforests are being destroyed by fire and the chainsaw before we have had a chance to unlock their treasures.

Rainforests are the most complex ecosystem on earth, unmatched for their biomass and diversity of species. A greater variety of life is packed into one square kilometre of rainforest than in any other square kilometre on earth. They are the home of more than half of all known species, and destruction of even small areas of forest often results in species loss or extinction.

Location

Rainforests once formed a continuous band of green around the equatorial and tropical regions of the plant. This band was broken only by the sea and pockets of land where the climate was unsuitable for rainforests to grow. Now these forests form a broken mosaic. The ever-dwindling areas of virgin forest are interspersed with areas that have been disturbed; some only slightly, others irrevocably. It has been estimated that half the world's tropical rainforest has been lost; down from 16 per cent of the earth's surface to just 7 per cent. This makes what is left even more valuable.

Rainforest ecosystems are found where conditions for plant growth are optimal: intense heat and light energy and abundant, well-distributed precipitation. The largest areas of rainforest are found in Central and South America (which have nearly three-fifths of the world's total), South-East Asia and Central and West Africa.

Characteristics

A tropical rainforest is a multilayered, tree-dominated community with a closed canopy where light penetration is substantially reduced through each stratum and most of the growing tissue is in the above-ground biomass. The tallest trees may be as high as 60 metres and their trunks 5 metres in diameter. Trees of this size, which tower over their neighbours, are known as emergents. Below them, the forest canopy becomes more continuous, the crowns of the adult trees interlock and cast shade over everything below. An amazing profusion of plants, including lichens and mosses, ferns and orchids, can be found clinging to trunks, branches and even each other. All these plants are adapted to very specific levels of illumination. Draped across the canopy are the woody stems and foliage of climbing plants and lianas, which help interlock the structure of the rainforest.

Rainforest ecosystems are very difficult to re-establish or regenerate. Once the cycle of nutrient replacement is disrupted by clearing, the nutrient level of the soil declines rapidly. If the forest's canopy is removed, the harsh tropical sun penetrates into the lower stories, or levels, of the forest. This alters the forest's microclimate and kills off the shade-loving vegetation. In such conditions it is unlikely that the forest will ever regenerate.

DID YOU KNOW?

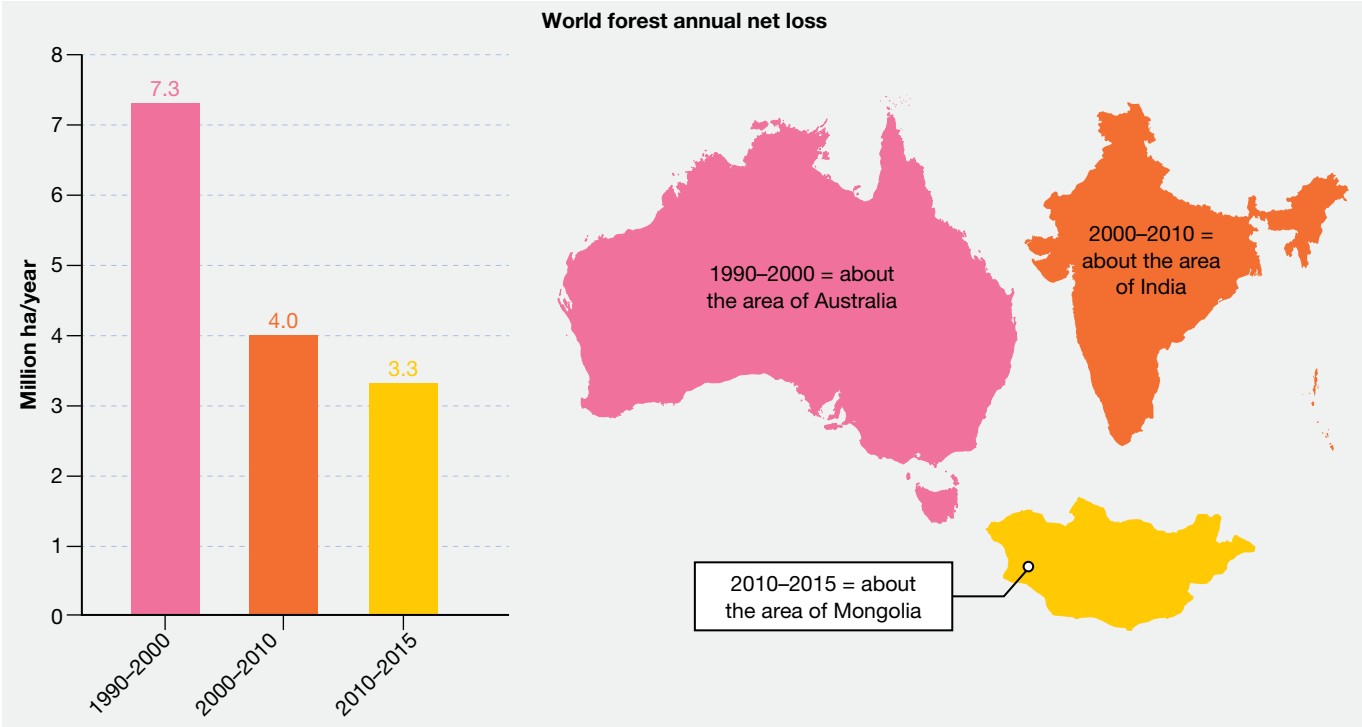
- Estimates of the number of the world's species vary significantly. A conservative estimate is 8.7 million species, but scientists believe 80% of the species on earth are still undiscovered.
- While most birds, mammals and plants have been scientifically recorded, little is known about other orders, such as insects, which make up an overwhelming majority of the species described to date. Similarly, not much is known about microorganisms, which recent work reveals to be more diverse than scientists had previously thought.

Deforestation

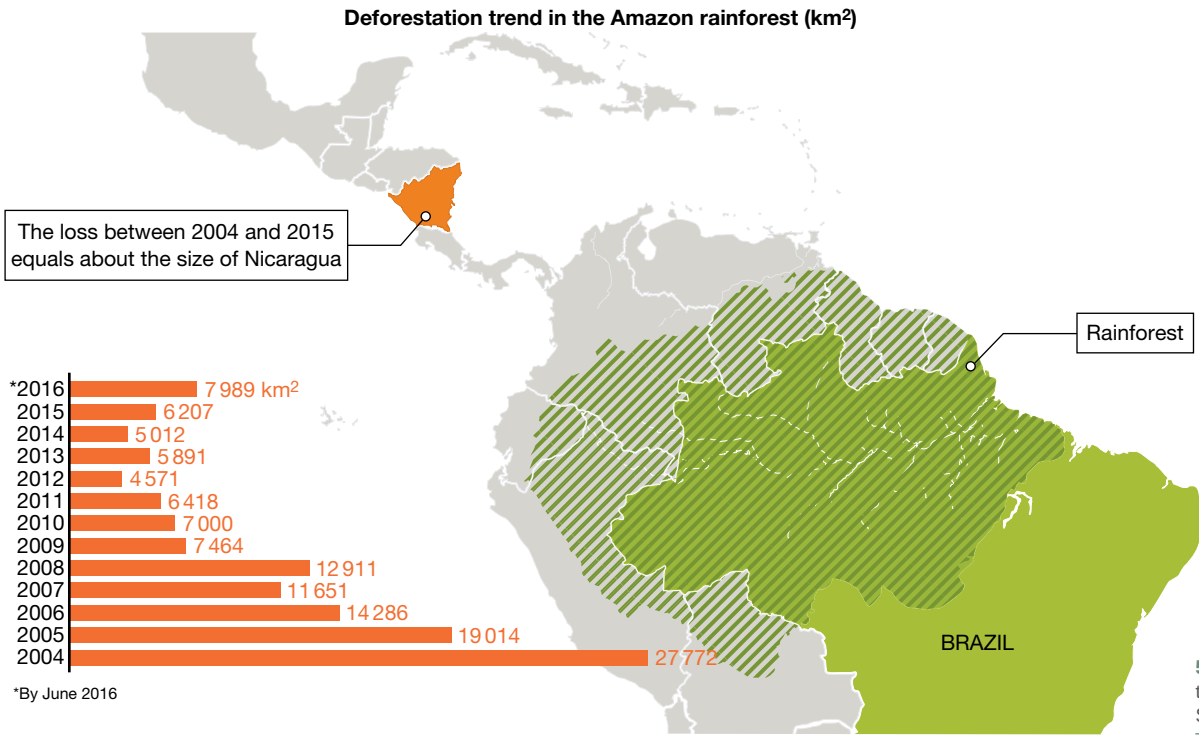
Since 1990, around 129 million hectares of the world's forests have been lost. The biggest loss of forests since 1990 occurred in the tropics, particularly in South America and Africa. As is evident in Figure 5.4.2, the annual rate of deforestation appears to have eased since the 1990s but, alarmingly, it appears to be on the rise again. Since 2012, deforestation in Brazil has been trending upwards (see Figure 5.4.3), with a very sharp increase in the rate of clearing in 2016, up 29 per cent from the previous year. Since 1990, the highest net loss in forest area has happened in Brazil and Indonesia, as illustrated in Figure 5.4.4.

DID YOU KNOW?

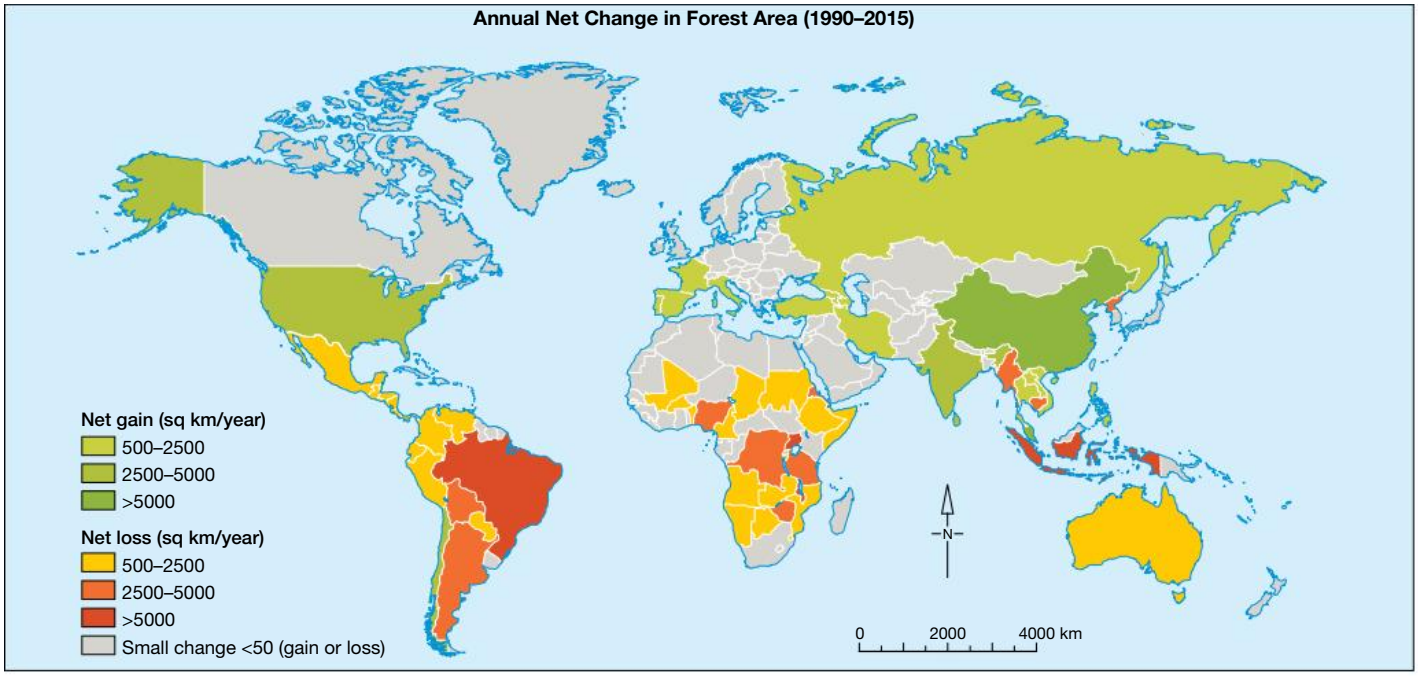
Every 30 seconds, somewhere on earth, a species becomes extinct.



5.4.2 Annual net decrease in forest area worldwide (1990–2015). Source: FAO



5.4.3 Deforestation in the Amazon rainforest. Source: FAO



5.4.4 Annual net change in forest area (1990–2015). Source: FAO

Beyond the loss of habitat for countless plant and animal species, the destruction of these forests results in the loss of untold numbers of potential new resources: tropical plants are used to produce medicines and industrial products. The forests are also home to some 100 million people who stand to have their traditional way of life destroyed.

The main causes of tropical forest deforestation are the conversion of forest to agricultural land and logging, as seen in Figure 5.4.5. As the world's population grows, more land must be devoted to production of food. Large areas of the Amazon, for example, have been burnt to create grasslands for cattle ranching. The impact of logging depends on the type of logging carried out. If forests are logged selectively and then left to regenerate, the use of these forests can go on indefinitely. Unfortunately, most logging is done by clear-felling, a method that involves the total clearing of the land. Huge swathes of tropical forests are also being cleared in both Indonesia and Malaysia to make way for palm oil plantations.

5.4.5 Deforestation in the Amazon

Importance to science

In the debates about conservation versus the exploitation of rainforest, the importance of forests to science has not always been fully appreciated. Even today we lack a detailed understanding of rainforest ecosystems, especially the immensity of their biotic diversity. We still don't know exactly how they interact, why they have persisted over millions of years and how they are driven by change.

A multitude of intimate relationships exists between the myriad specialist organisms that inhabit a rainforest. We have little or no knowledge of the ecological niches of these organisms. Studies of the ecological relationships between species have only just begun. The sad reality is that we are rapidly losing the chance of furthering our knowledge.

Effects of forest deforestation

There are five main effects of deforestation:

1. The areas cleared of tropical forest generally make poor farming land. The soils are naturally low in nutrients and once exposed to heavy rainfall they are leached and easily eroded.
2. Water quality within catchments declines as the turbidity (the amount of suspended silt) of water increases.
3. Increased run-off and river channel siltation results in an increase in the frequency and severity of flooding.
4. The people who live in the forest are displaced as their traditional habitat is destroyed.
5. It is feared that the large-scale destruction of the earth's tropical forests will alter the earth's climate.

Vast amounts of carbon are stored as wood fibre and leaf matter. Deforestation often results in the release of this stored carbon into the atmosphere. The burning of forests is thought to account for as much as one-quarter of all the carbon dioxide released into the atmosphere each year. The onset of the accelerated greenhouse effect could be lowered dramatically if the rate of deforestation was reduced. Scientists have estimated that deforestation accounts for more than 10 per cent of global warming.

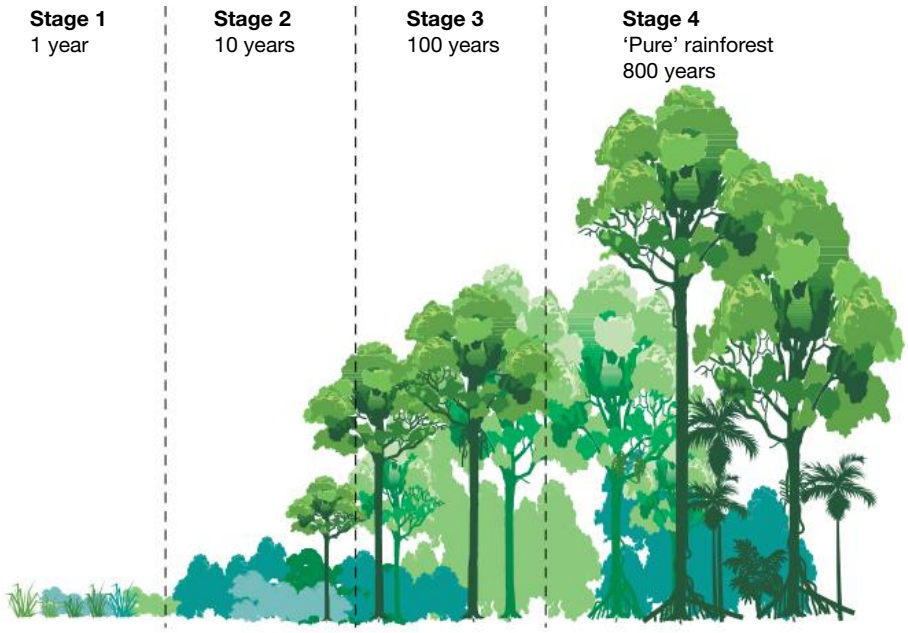
Human impact on tropical rainforests

For thousands of years, people have impacted on these forests in minor ways. Small patches of forest were cleared by groups who practised a 'slash and burn' style of agriculture. This involves clearing and utilising a plot of land and subsequently abandoning it when the soil loses its fertility. This involved only small areas, which soon regenerated when the cultivators moved on. Small human populations, poor hand tools, and the vigorous growth of vegetation combined to ensure that the rainforest regenerated effectively.

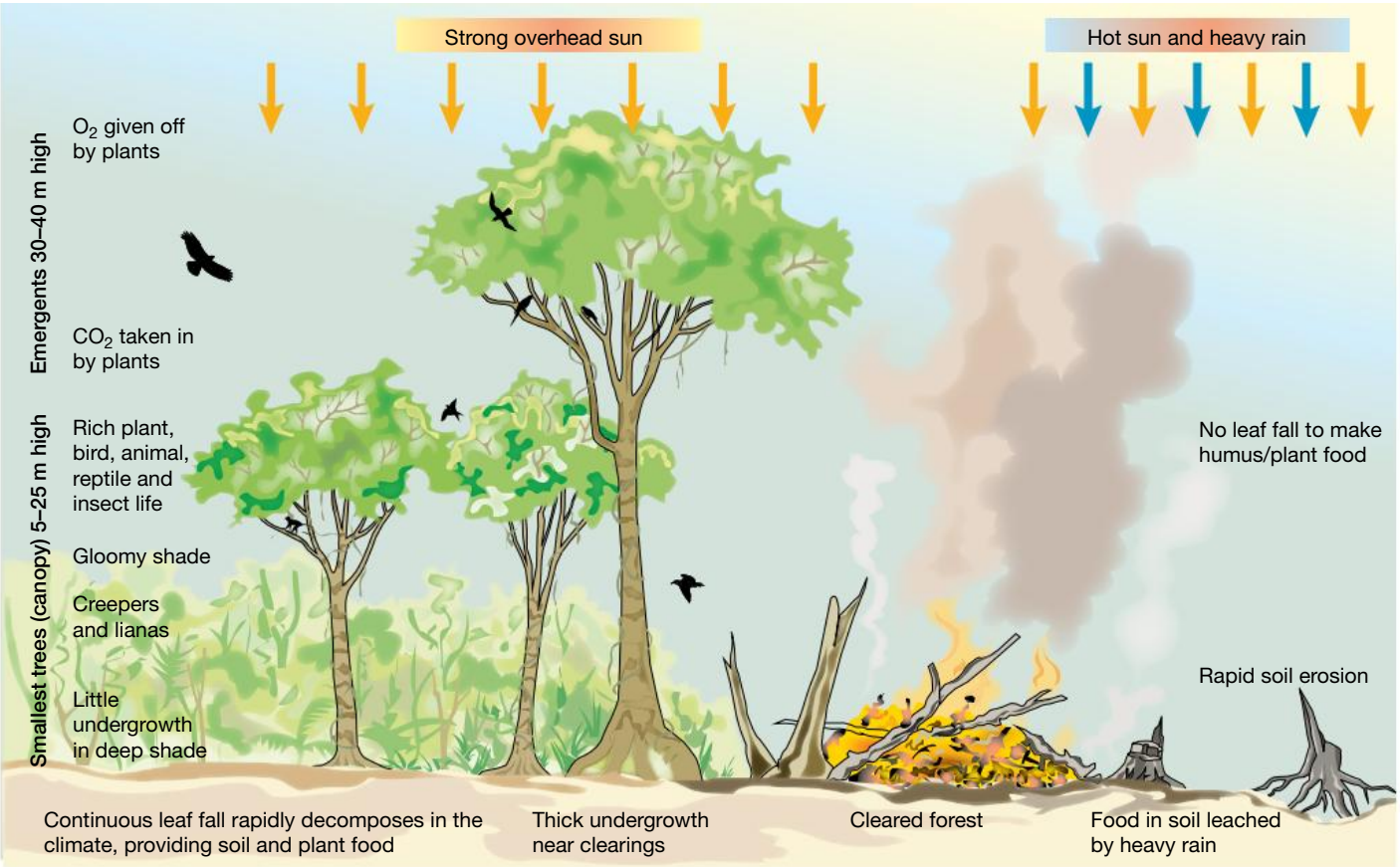
Once a clearing is abandoned it soon becomes covered by weeds, grasses and shrubs. As seeds are dispersed from the adjacent forest, trees begin to colonise the area. Given time, the trees will dominate and will shade out the earlier opportunistic species and develop the characteristic microclimate under the 'new' or 'restored' canopy. These stages in natural regeneration are illustrated in Figure 5.4.6.

The time required for the natural regeneration of a tropical rainforest is widely debated. Conservative estimates suggest that it takes at least 800 years on flat, relatively fertile ground for a rainforest to develop to the mature stage. If human impacts alter the factors that govern seral progression, this time scale can increase dramatically. In many instances, human interventions are so extensive that they disrupt the progression completely and a disclimax community results. In the Amazon Basin, for example, the large-scale burning of the forest to create grazing land for cattle has had a disastrous impact on the ability of the forest to regenerate.

The naturally poor soils quickly become infertile. Exposed soils on sloping land are rapidly leached of their nutrients and removed by the increased run-off. Such soils are incapable of supporting profitable agriculture or the regeneration of the original forest ecosystem. The impact of such human disturbance is shown in Figure 5.4.7.



5.4.6 Stages in the natural regeneration of a tropical rainforest



5.4.7 The impact of burning on a rainforest

Activities

Understanding the text

1 Identify the important factors that determine vegetation at a local scale.

2 Outline the process of plant succession and identify its stages.

3 Differentiate between primary and secondary succession.

4 Explain what is meant by a disclimax.

Working geographically

5 Why are rainforests considered to be among the world's most complex ecosystems?

6 Evaluate the extent of our understanding of rainforest ecosystems.

7 Briefly describe the main characteristics of a tropical rainforest.

8 What are the main effects of forest destruction?

9 What are the stages in regeneration of a rainforest?

10 Why is a rainforest able to regenerate from the disturbances caused by the traditional 'slash and burn' style of agriculture?

11 Why is it unlikely that with the current rate of disturbance, rainforests will regenerate to former levels of complexity?

12 Study Figure 5.4.3.
- **a** What year had the largest loss of tropical rainforests?
- **b** What year had the smallest loss of tropical rainforests?
- **c** Calculate the percentage change in deforestation from 2012 to 2016.
- **d** Describe the pattern of deforestation from 2004 to 2016.

13 Study Figure 5.4.4.
- **a** Which two countries had the largest net loss of rainforest?
- **b** How much rainforest was lost each year by both of these countries?
- **c** What change happened in the USA? Give a reason for this.
- **d** Undertake research into the rate and extent of forest destruction in one of the countries shown in Figure 5.4.4.

14 Study Figure 5.4.7 and explain the impact of rainforest clearing on soil quality.

CASE STUDY

Animals on the brink of extinction

Around the world, species are becoming extinct every day. At the same time other species are at threat of becoming extinct or becoming endangered. The causes include loss of habitat, poaching, human activities and climate change.

The International Union for Conservation (IUCN) has a non-prescriptive list called Red List of Threatened Species that lists all threatened animals. The list highlights how close to extinction specific species are by using quantitative criteria to rank species and places them into one of three categories. The threatened categories are: vulnerable, endangered and critically endangered. Depending where an animal is on the list, the species then has a high, very high, or an extremely high risk of going extinct in the wild. Using the IUCN categories, polar bears are considered vulnerable to extinction, while tigers are endangered (a more critical category), and in 2016, the IUCN declared the Bornean orangutan critically endangered.

Animals at risk of extinction

According to the IUCN the following species are among those at risk of extinction.

Bornean orangutan

5.4.8 Bornean orangutans only reproduce every six to eight years.

Bornean orangutans (*Pongo pygmaeus*) are only found on the island of Borneo. Female orangutans only reproduce every six to eight years.

The orangutans are threatened by illegal hunting but their main threat is habitat loss. Forests are being replaced with plantations (rubber, oil palm and paper). Since 1950, the number of Bornean orangutans has declined by 60 per cent and it is estimated that by 2025 their numbers will fall another 22 per cent.

Pika

5.4.9 It is estimated that only 1000 pikas are left in the wild.

The Ili pika (*Ochontana iliensis*) is found in the Tianshan mountain range, in Xinjiang, China. The mammal is small, only 18 centimetres in length. It lives at high elevations on the bare rock faces and feeds on grasses.

Pikas are threatened by climate change—rising temperatures are forcing the animals further up the mountains, meaning their range is shrinking—as well as threats to their habitat from grazing livestock and pollution. Since 1980, their numbers have decreased by 70 per cent and it is estimated that only 1000 are left in the wild.

Giant otter

5.4.10 The giant otter hunts in groups by herding fish.

These giant otters (*Pteronura brasiliensis*)—also called the 'river wolf'—are found in South America. They are almost 2 metres long, and they have a creamy white patch on their throat that is unique to each otter. The otters are active during the day and live in groups, where they hunt together by herding fish.

Historically, the otters were threatened by hunting for their pelts. In the twenty-first century, the otters are threatened by habitat (rivers and lakes) degradation and destruction. The fish populations on which they rely are declining due to pollution from gold-mining in the region, where mercury enters the food chain. It is estimated that only a few thousand otters are left in the wild.

Amur leopard

5.4.11 The Amur leopard is now only found in eastern Russia.

The Amur leopard (*Panthera pardus orientalis*) is now only found in the Amur River basin of eastern Russia. The animal has become extinct in China and the Korean Peninsula. The leopard can leap more than 5.8 metres and run at speeds up to 60 kilometres per hour.

The leopard is threatened by encroaching human populations, poaching, and climate change. It is estimated that in 2017, only 60 amur leopards were left in the wild.

Sumatran rhinoceros

5.4.14 The Sumatran rhinoceros is covered in long hair to help it stay cool and protect it from insects.

The Sumatran rhinoceros (*Dicerorhinus sumatrensis*) is found in isolated pockets of dense mountain forests in Malaysia, Indonesia and Myanmar. It is the only Asian rhino with two horns. It is covered in long hair, to keep mud caked to its body which helps it stay cool and protects it from insects.

The rhinos are threatened by loss of habitat but mainly by poaching—they are hunted for their horns. It is estimated that there are only 220–275 Sumatran rhinos left in the world. Since 2000, only two captive females have successfully reproduced.

Black-footed ferret

5.4.12 The black-footed ferret

The black-footed ferret (*Mustela nigripes*) is found in North America. A member of the weasel family, it is a highly specialised carnivore and is able to navigate tunnels and burrows.

The ferrets are threatened by disease (notably the plague), loss of habitat and loss of food sources. Prairie dogs—their main diet—were poisoned for many years. Since the 1980s there have been efforts to save the ferrets, including captive-breeding programs. There are about 300–400 black-footed ferrets in the wild who are the descendants of 18 ferrets released into the wild from a 1980s breeding program. Vaccination programs against the plague have also been implemented.

Pangolin

5.4.15 When scared, the pangolin rolls into a ball.

Pangolins are found in the forests and grasslands of Asia and Africa. They are nocturnal creatures with long sticky tongues to slurp up ants and termites. Pangolins are solitary creatures and when scared defend themselves by rolling up into a ball.

Pangolins are threatened by hunting and poaching. An estimated 100 000 pangolins are captured each year for trafficking.

Darwin's Fox

5.4.13 Darwin's fox

Darwin's fox (*Lycalopex fulvipes*) is found in the Nahuelbuta National Park and the island of Chiloè, Chile. These foxes are mainly active in the early evening and early morning. They are important for the ecosystem of their temperate forest homes. The foxes are threatened by habitat loss, hunting, and feral or non-native species, mainly dogs.

White-rumped vulture

5.4.16 Since the 1980s there has been a 99 per cent decline in the white-rumped vulture population.

The white-rumped vulture (*Gyps bengalensis*) is found across the Indian subcontinent. These vultures play an important role in the ecosystem by cleaning up the remains of fallen cows. Their removal from the ecosystem has increased the number of feral dogs who in turn spread disease to humans.

The vultures are threatened because they have been indirectly poisoned by the livestock drug diclofenac, which they ingest from animal carcasses. Since the 1980s there has been a 99 per cent decline in population numbers.

Saola

5.4.17 The saola has only been seen in the wild by scientists four times.

The saola (*Pseudoryx nghetinhensis*) or the Asian unicorn is only found in the forests of the Annamite mountains in Vietnam and Laos. Saolas look like antelopes, however they are cousins of cattle.

The saola was discovered in May 1992, and is critically endangered. The mammal is rare and elusive and has only been seen in the wild by scientists four times; this means that not much is known about it. The soala is threatened by hunting and the loss of its forest habitat.

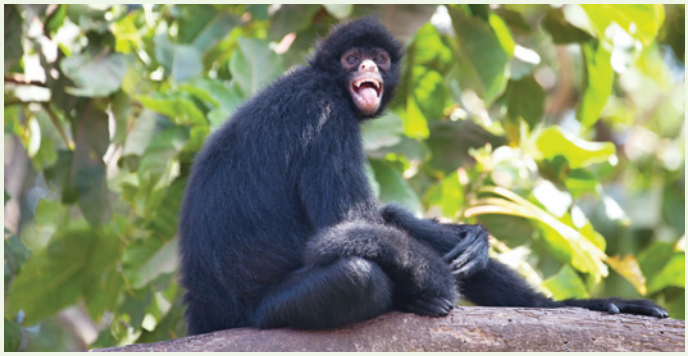
Vaquita

5.4.18 Vaquitas drown when caught in illegal gill-nets.

The vaquita (*Phocoena sinus*) is also known as the Gulf of California harbour porpoise. The vaquita was discovered in 1958, and is regarded as the world's rarest marine mammal; it is on the edge of extinction. Since 2014, the population has decreased around 40 per cent and there are only thought to be around 60 animals left.

The marine mammal is threatened by climate change—warming temperatures in the Gulf of California affect their habitat and food conditions—and the use of gill-nets by illegal fishers; the vaquitas are caught in the nets and drown.

Peruvian black spider monkey



5.4.19 The Peruvian black spider monkey plays a role in seed dispersal.

The Peruvian black spider monkey (*Ateles chamek*) is found in eastern South America, north of the Amazon River. The species spends most of its time in the rainforest canopy and eats mainly fruit. The monkey plays a role in seed dispersal and is an important part of the rainforest ecosystem.

Since the 1970s, the monkey population is believed to have declined by 50 per cent. It is threatened by hunting, forest fragmentation, and the destruction of its tropical rainforest home.

Source: Simone M Scully, '12 rare animals that are teetering on the brink of extinction', Business Insider Science website, 2016

Activities

Working geographically

1 On a map of the world, locate the region where each of the animals listed in this case study live.

2 Draw up and complete a table as shown below. If needed, conduct additional research on the internet.

Name of species	Habitat	Extent of their demise (statistics)	Threats
Bornean orangutan			

Exam-style questions

Extended responses

- Account for the distribution of the world's major terrestrial ecosystems.
- Analyse the nature of people's interaction with the biosphere.
- Write an extended response on biodiversity. In your response, address the following:
  - Explain what is meant by biodiversity.
  - Explain why it is considered important.
  - Outline the threats to biodiversity.
  - Outline the actions that people can take to protect the earth's biodiversity.
- Account for Australia's unique flora and fauna.
- Explain the process of plant succession.
- Write an extended response on tropical rainforests. In your response, address the following:
  - Describe their spatial extent and ecological importance.
  - Explain the impact of people on tropical rainforests.
  - Outline the effects of forest destruction.

Glossary

aquatic ecosystem an ecosystem in a marine or freshwater environment

biological diversity the variety of life, encompassing the different plants, animals and microorganisms, their genes and the ecosystems of which they form a part; also known as biodiversity

biomass the total weight of living things in a given area

biome a very large ecosystem made up of specific vegetation types and their associated fauna; biomes recur on different continents in areas with similar climates

biosphere the surface zone of the earth and its adjacent atmosphere, in which all organic life exists

climax community the end product of succession: a community that is in equilibrium with its environment

disclimax the community that results when a climax community becomes modified or displaced; also known as a plagioclimax

ecology the study of the interactions of living organisms with each other, and with their habitats and environments

ecosystem a community of species and their non-living habitat

fauna the animal life of an area or region

flora the plant life of an area or region

genetic diversity the inherited variation that occurs within populations of species as a result of different genes or biological combinations

habitat the place where a particular plant or animal lives

megafauna large mammals and birds such as those thought to have occupied Australia up to 16 000 to 50 000 years ago

natural vegetation plants originally found in an area

niche the position and function of a plant or animal in its community

photosynthesis the process whereby plants collect energy from the sun and use it to combine carbon dioxide with water to produce organic nutrients

primary succession the sequential development of more complex plant communities; the succession may start on bare, previously uncolonised ground

prisere a complete chain of successive seres beginning with a pioneer community and ending with a climax community

secondary succession the development of a disclimax community once an original community has been removed or destroyed by human activities (such as forest clearance) or by natural activities (such as fires and cyclones)

sere (plural seres) a stage in the sequence of events in which a plant or animal community in an area develops over a period of time

species a group of closely allied plant or animal types that can reproduce with each other

species diversity the number of different species, or species richness

succession natural changes in the structure and species composition of a community over time

symbiotic relationship mutually beneficial relationships that develop between species

terrestrial ecosystems communities of plants and animals spread broadly over the surface of the continents

CHAPTER

6 Coastal environments and management

Coasts are one of the most dynamic and fragile environments on earth. This means that they are constantly changing: reshaped by the relentless forces of the biophysical environment. Waves, tides, currents and the wind are all active agents of change along any coastline.

The exact boundary between land and sea is not always easy to determine. This is because the line where the land and sea meet is constantly changing with the rise and fall of tides and the passing of storms. Most of the interaction between land and sea takes place in the foreshore area: the land lying between the high-water mark and the low-water mark. The coast acts as a vital buffer zone between the land and the sea. It is defined as all areas within or neighbouring the foreshore.

> **In every outthrust headland, in every curving beach, in every grain of sand there is the story of the earth.**
>
> **Rachel Carson, US marine biologist**

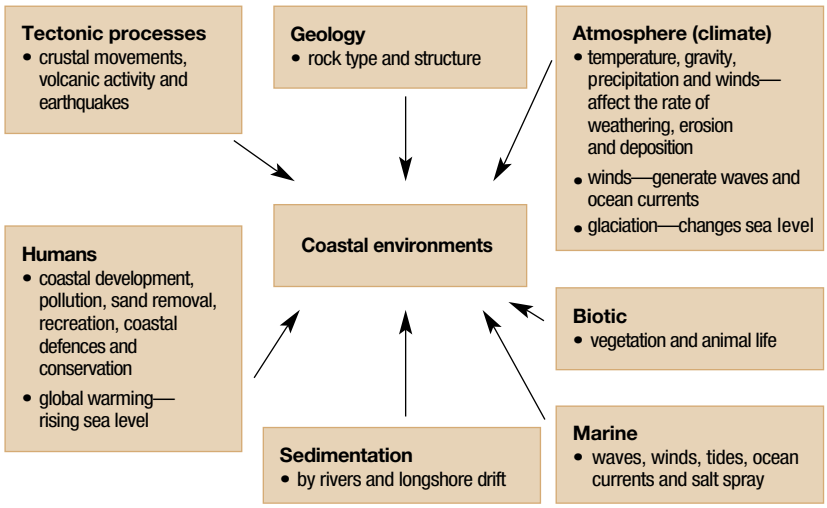
6.0.1 Isle of Wight, United Kingdom

UNIT 6.1

The coastal environment

The coastal environment extends inland as far as salt water, sea spray and wind-blown sands reach, and into the ocean as far as the waves and currents are able to move material on the sea bed. It also takes in all areas to the landward side in which there are physical features, ecological or natural processes or human activities that affect, or potentially affect, the coast or coastal resources. The factors that impact on the nature of the coastal environment are outlined in Figure 6.1.1.

Parts of the coastal environment clearly have strong interactions between the land and sea, including beaches, dune systems, coastal marshes, mangroves and fringing coral reefs. Other parts may be more distant from the coast (either inland or out to sea) but they play a role in shaping it. One of the most important of these is the river systems that bring fresh water and sediments to the coast, shown in Figure 6.1.2.



6.1.1 Factors affecting the nature of the coastal environment

6.1.2 Rivers play a key role in bringing inland sediments onto the coast.

Pressures on coastlines

The coastal environment has been, and will continue to be, placed under multiple, intense and often competing pressures. It is this fact that directs special attention to the planning and management of coastal environment. The challenge is to find sustainable ways of dealing with the demands placed on coastal resources.

Population growth

Population growth is the cause of many, if not all, coastal problems. The scale of this growth has been staggering. The United Nations estimates that more than 40 per cent of the world's population lives within the coastal zone; that is, within 100 kilometres of the coastline. Most of the world's largest cities are also located in the zone.

Population growth reflects the general trend of people moving from inland areas to the coast, which often offers people more economic, social and recreational opportunities than inland areas in both developed and developing countries. In addition, the growth of world trade led to the development of port cities. The coast's attractiveness also draws people who seek a coastal lifestyle and the coast is a popular choice for holidays and retirement. In response, many urban areas are being developed or expanded to meet the needs of new coastal residents for housing, sanitation and transport.

Coastal development and modifications

For thousands of years, humans have deliberately modified the coastal environment and exploited its resources. Ancient civilisations built ports and sea walls throughout the world and diverted the course of rivers. They managed their fisheries and farmed the rich coastal soils. Mangroves were cleared and land reclaimed.

Most of these interventions were works of civil engineering. That is, structures were built to modify the flow of water and/or sediment. Because most of these structures were built by hand, the scale and intensity of their impacts on the coastal environment were limited. Over the centuries, as construction techniques improved, people's ability to influence coastal processes increased. The historic Italian city of Venice (see Figure 6.1.3.) represents one of the most famous examples of people's capacity to modify the coastal environment. Work began on this water-based city in the sixth century in a lagoon off the Adriatic Sea. Small islands were enlarged and connected via a labyrinth of canals creating one of the most unique urban landscapes on earth.

The technological limitations to large-scale modification and exploitation of the coastal environment were dramatically reduced as a result of the Industrial Revolution, which started in Europe in the mid-nineteenth century. Major modifications of the coastal environment were then possible. Large rivers could be dammed or diverted, and vast areas of coastal wetlands could be converted to urban or agricultural land.

6.1.3 Venice is an example of humans' capacity to totally transform the natural world.

Activities

Understanding the text

1. Explain why coasts are described as one of the most 'dynamic' environments on earth.
2. Explain why it is difficult to determine the exact boundary between the land and sea.
3. List the biophysical forces that shape coastal areas.
4. Define the following terms: foreshore, coast and coastal environment.
5. Identify the main problems affecting the coastal environment.
6. Outline the causes of rapid population growth in coastal areas. Describe the impact of this growth.
7. Explain why ancient civilisations had only a limited impact on coastal environments.

Working geographically

8. Study Figure 6.1.1. Write a report outlining the factors affecting the coastal environment, showing how each factor impacts on coastal environments.
9. Using Google Earth™, explore the Venetian Lagoon. Write a report on the nature of Venice and how humans have transformed the lagoon.
10. Write a paragraph outlining the impact that the Industrial Revolution had on people's ability to modify and exploit the biophysical environment.
11. As a class discuss Rachel Carson's claim that 'In every outthrust headland, in every curving beach, in every grain of sand there is the story of the earth'.

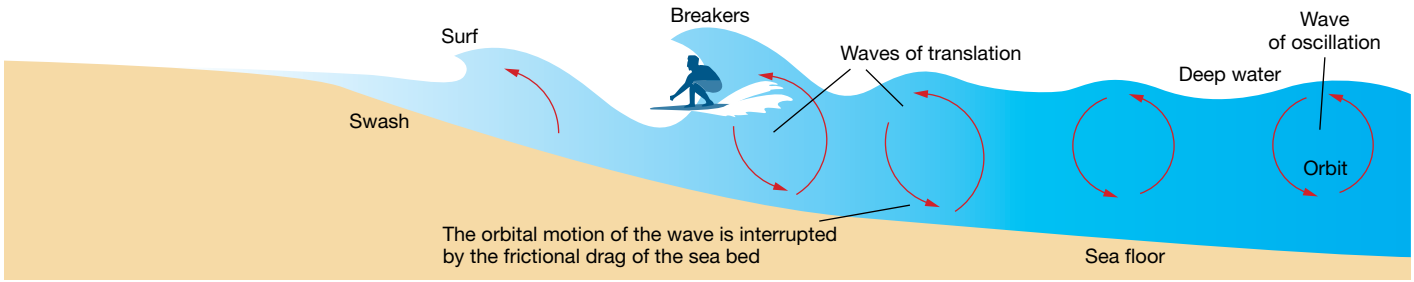
UNIT 6.2

Waves: shaping coastlines

6.2.1 Waves are the most powerful agent of natural change along a coastline.

Of all the agents of erosion active in the shore zone, waves are by far the most important, seen in Figure 6.2.1. The transfer of energy that takes place when a wind blows over a large body of water creates waves. This energy can be carried over vast distances until it is released on the coast. Anyone who has been dumped by a breaking wave can testify to how much power waves have.

Waves move across the open sea as ocean swell and do not change their form until they move into shallow water. When they approach a shoreline, the frictional drag of the sea bed slows the base of the wave more than the crest, and the circular flow of energy is distorted. The wave transforms from a wave of oscillation—where wave energy near the surface completes one vertical circle with the passage of each wavelength—to a wave of translation. When this occurs, both energy and matter are propelled upward and forward. Potential energy is translated into kinetic energy. As the base of the wave slows, the wave increases in height until it breaks as surf. The manner in which waves break is illustrated in Figure 6.2.2.

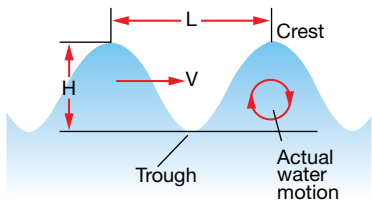


6.2.2 The process of a wave breaking on shore

The terminology of waves

A number of terms are used when discussing waves. They include:

- fetch—the maximum distance the wind has blown across open water without interruption
- frequency—the number of crests passing a fixed point in a minute
- swell waves—waves that move well away from the area where they were generated
- velocity—the distance travelled by a wave in a specified period of time
- wave height—the vertical distance between the top of the wave's crest and the bottom of the wave's trough
- wave length—the horizontal distance between successive crests
- wave period—the time taken for two successive crests to pass a given point
- wind waves—waves produced by the local prevailing wind.



KEY H Height of wave
L Distance between wave crests
V Velocity of wave

6.2.3 Features of a wave

The two main elements of a wave are the crest and the trough (see Figure 6.2.3). The trough is the base of the wave, while the crest is its peak. The different types of wave conditions are described in Figure 6.2.4.

Erosional power of waves

In times of fair weather, waves cause little erosion. Instead, they tend to build beaches by depositing sand and rock fragments. During storms, and especially when coasts are hit by cyclones, massive waves pound the shoreline. The violent uprush of tonnes of water against the shoreline, whether it be a sandy beach or a rocky headland, causes accelerated rates of erosion. In fair weather, the force exerted by a wave is estimated to be about 900 kilograms per square metre. Storm waves, on the other hand, can exert as much as 30 000 kilograms per square metre.

In many cases it is the oblique angle with which storm waves strike the coast that does the most damage. During a storm, the sea often appears grey because of the large amount of sand and other sediments being picked up and carried in suspension.

The constant attack by wind-blown sand and wind-induced waves grinds and abrades the features of the coastline (see Figure 6.2.5). This forms erosional features such as wave-cut platforms and cliffs. The products of this erosion separate: the heavier sands and gravels remain close to shore; the lighter particles settle as layers of silt on the sea bed, where the sea is deep and still. Given the dynamic nature of the earth's crust, they may well emerge above sea level in some future mountain range.

Describing wave conditions

Wave height (m)	Description	Effect
0.0	Calm (water appears 'glassy')	No waves breaking on the beach
0.0–0.1	Calm (water is rippled)	No waves breaking on the beach
0.1–0.5	Smooth	Very small waves breaking on the beach
0.5–1.25	Slight surf	Waves rock buoys and small boats
1.25–2.5	Moderate surf	Sea becoming furrowed
2.5–4.0	Rough surf	Sea deeply furrowed
4.0–6.0	Very rough surf	Sea much disturbed with rollers having steep fronts
6.0–9.0	High waves	Sea very much disturbed with rollers having steep fronts; damage occurring to the sea front
9.0–14.0	Very high waves	Towering seas; severe damage occurring to the sea front
Over 14.0	Phenomenal waves	Huge waves causing very severe damage to the sea front (these conditions are associated with cyclones)

Source: Adapted from the Bureau of Meteorology

6.2.4 Describing wave conditions

6.2.5 The vast and beautiful sandstone cliffs of Sydney's South Head are constantly eroded by wave action.

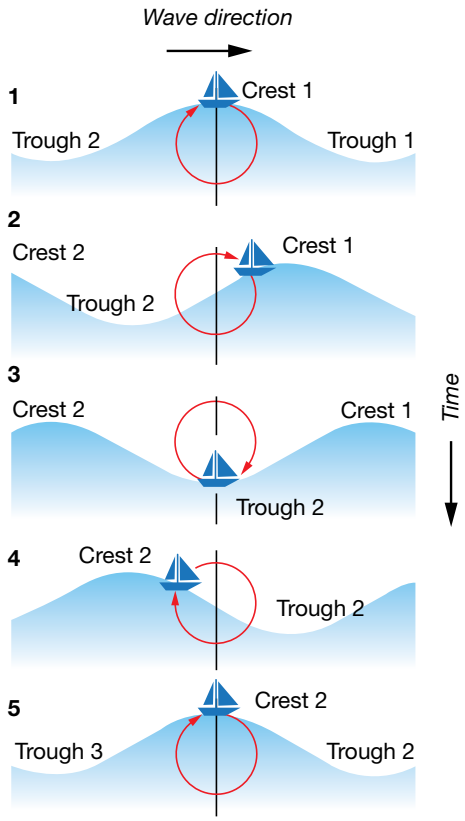
Wave types

Waves are by far the most important agent of erosion shaping the coastal environment. Waves are formed when wind blows over the ocean surface, and the energy of the wind is transferred to the wave. The two main types of waves are wind waves and swell waves.

Wind waves

The offshore and onshore movement of air is the product of the differential heating and cooling of the earth's surface and plays an important role in the formation of wind waves.

Wind waves are produced by local winds and travel in the same direction as the prevailing wind. For example, a north-easterly wind will produce waves that travel towards the south-west. The height of a wind wave is determined by the strength of the wind, the length of time the wind has been blowing and the fetch. The faster the wind speed, and the longer the duration of the fetch, the higher the wave and the longer the wave period. Wind waves are steeper than swell waves and have shorter periods and wavelengths.



6.2.6 Movement of an object in swell

Swell waves

Swell waves are wind-generated waves that have moved away from the area in which they were formed. They often originate in deep oceans affected by intense low-pressure systems. As swell waves move away from areas of low pressure, they become more rounded and regular in height and period. Swell waves can travel thousands of kilometres. As they move, their height decreases and their period and wavelength increase; that is, they gradually lose energy. The most common swell waves impacting on the coast of south-east Australia are produced by the low-pressure systems that pass to the south of the continent. In summer and autumn this pattern can be disrupted by lows and tropical cyclones in the Coral Sea, which can generate large north-easterly swells.

In deep water, the frictional drag of the wind on the sea surface causes water and floating objects to move in an orbital (circular) motion. As shown in Figure 6.2.6, floating objects don't move forward. Instead, they have quite significant vertical movements.

When you look at the surface of the open sea you will notice that waves form a complicated pattern of crests and troughs, with waves of different shapes moving in different directions. There is considerable interaction between waves: faster moving waves overtake slower waves. Sometimes the waves combine to create an abnormally high wave (referred to as a king, or rogue wave). It is these king waves that cause much of the damage to the shoreline and put property and boats at risk.

Why waves break

The breaking of a wave is the result of an interaction between the hydrosphere and lithosphere. As the wave moves closer to the coast it begins to interact with the sea floor. This increases friction and the orbital movement of the water becomes elliptical (oval-shaped). With increased interaction, the wave begins to change shape. As the depth between the wave and the sea floor declines, the wave steepens. As the water depth continues to decline, the wave continues to steepen until it collapses under its own weight. The critical depth is around 1.3 times the height of the wave. Therefore, a wave with a height of 1 metre will break when the water depth reduces to 1.3 metres. Higher waves break further from the shore.

Wave refraction

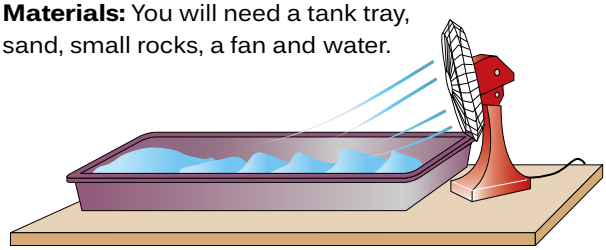
Wave refraction or bending occurs when the waves encounter an uneven coastline. The direction of the wave is changed. Advancing waves first come into contact with the headland where their forward motion is slowed by the frictional drag of the sea floor. The waves entering the bay continue at their original velocity (speed). As they advance, the wave front bends to reflect the shape of the coastline. As a result, all waves strike the shoreline head on. This refraction causes energy to be concentrated on the headlands, which are actively eroded while the bays become areas of sediment deposition, as outlined in Figure 6.2.8.

SKILLS BUILDER

Experiment: the effect of wind on waves

Aim: To investigate the relationship between wind and waves

Materials: You will need a tank tray, sand, small rocks, a fan and water.



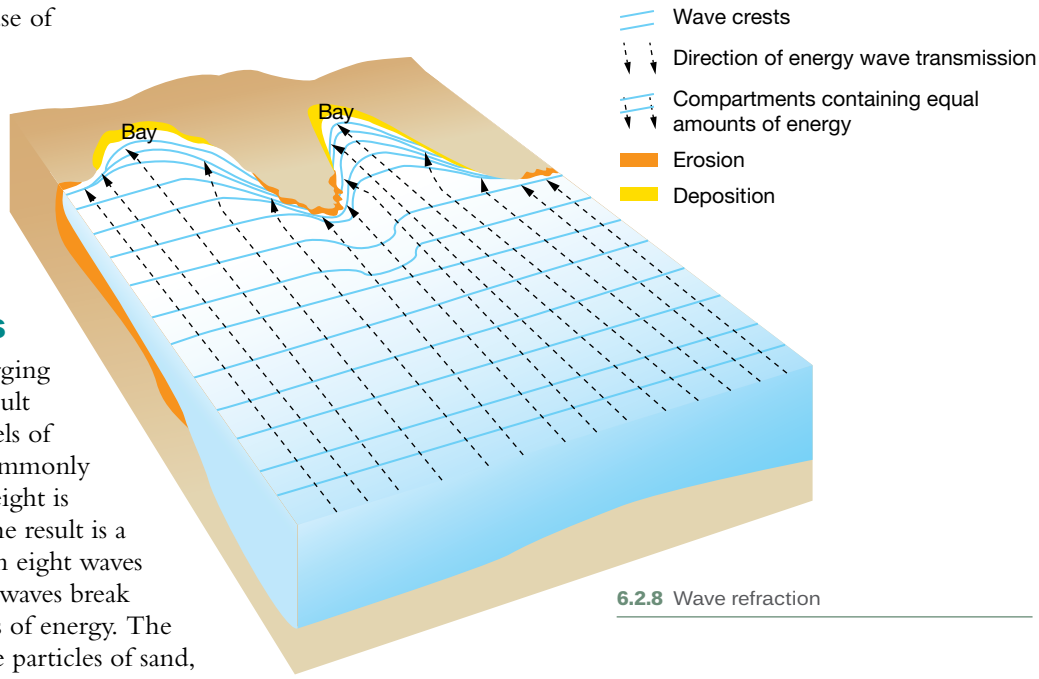
6.2.7 Wind and wave experiment

Method: Construct a 'beach' at one end of the tray and then fill the tray with water to a depth of about 3 cm. Point the fan at a 45° angle to the water, shown in Figure 6.2.7. **WARNING! Do not let the fan or its power cord touch the water.**

Turn the fan on low and observe the height and the frequency of the waves. Gradually increase the speed of the fan and observe the changes to the size and number of waves.

Constructive and destructive waves

Waves are the most important cause of change on beaches and other landforms that are created by the movement of sand and other sediment. Whether waves serve to build (construct) beaches or to erode (destruct) them depends on the characteristics of the wave.



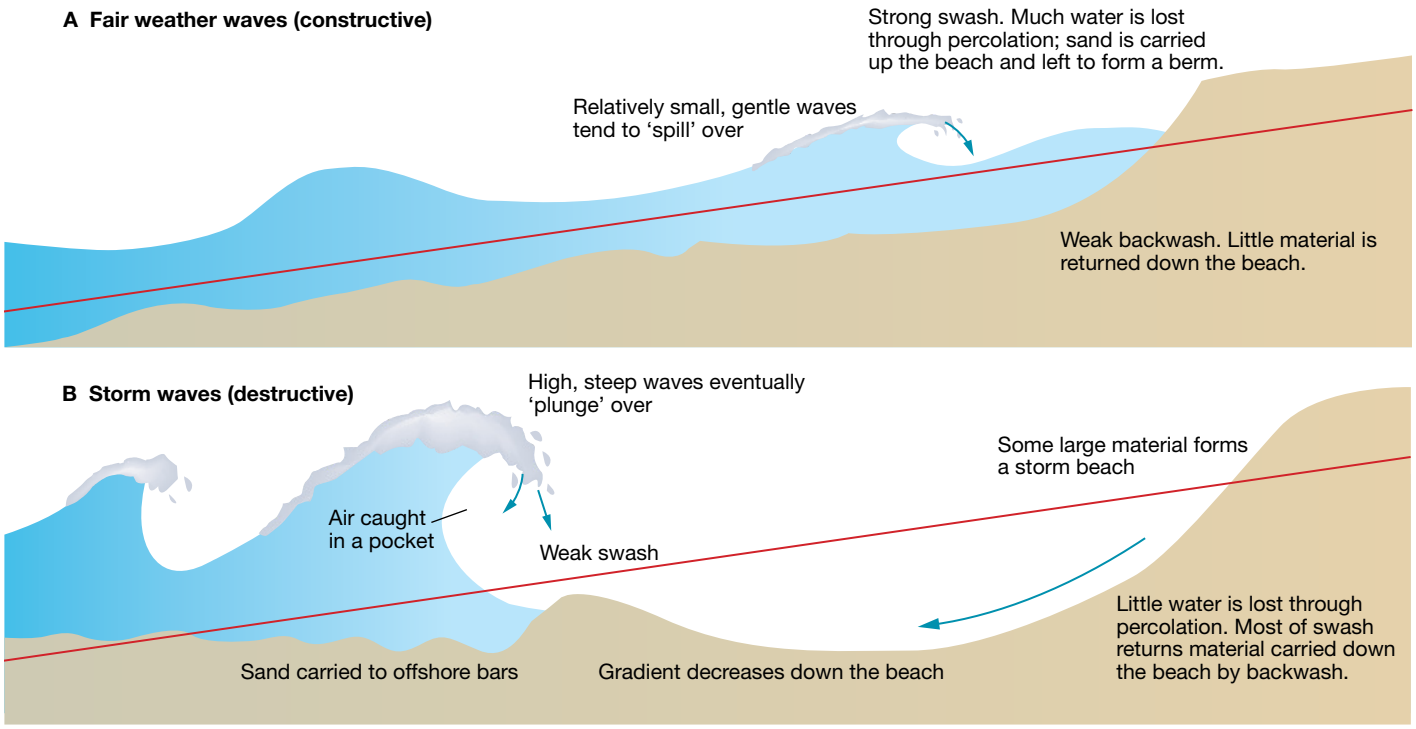
6.2.8 Wave refraction

Constructive waves

Constructive waves tend to be surging or spilling waves. They are the result of swell and usually have high levels of fetch. The wavelength is long (commonly over 100 metres), but the wave height is small (often less than 1 metre). The result is a long wave period, with fewer than eight waves breaking each minute. Individual waves break near the shore and have low levels of energy. The swash is quickly dispersed into the particles of sand, or other sediments, that make up the beach. Over time, constructive waves deposit large quantities of sediment on the shoreline. This causes the beach to grow, seen in Figure 6.2.9 A.

Destructive waves

Destructive waves serve to remove sediment from beaches and other landforms. They are steep waves that are usually plunging. They are more common where the fetch is short and are often the result of localised storm activity. The waves break out from the shore and their energy is very high. As the wave moves up the beach, the backwash remains strong. It removes sediment particles as it goes, shown in Figure 6.2.9 B.



6.2.9 Constructive and destructive waves

Four main types of waves		
Wave type	**Description**	
Collapsing	The whole wave becomes unstable and collapses on top of itself.	
Plunging	The crest of the wave curls over the front face into the base of the wave. A large amount of foam is produced as is a high splash. This type of wave is often called a 'dumper'.	
Surging	The crest of the wave remains unbroken while the base of the water moves up the beach.	
Spilling	The wave crest becomes unstable and topples down the face of the wave. This type of wave is often called a 'roller'.	

6.2.10 Wave types

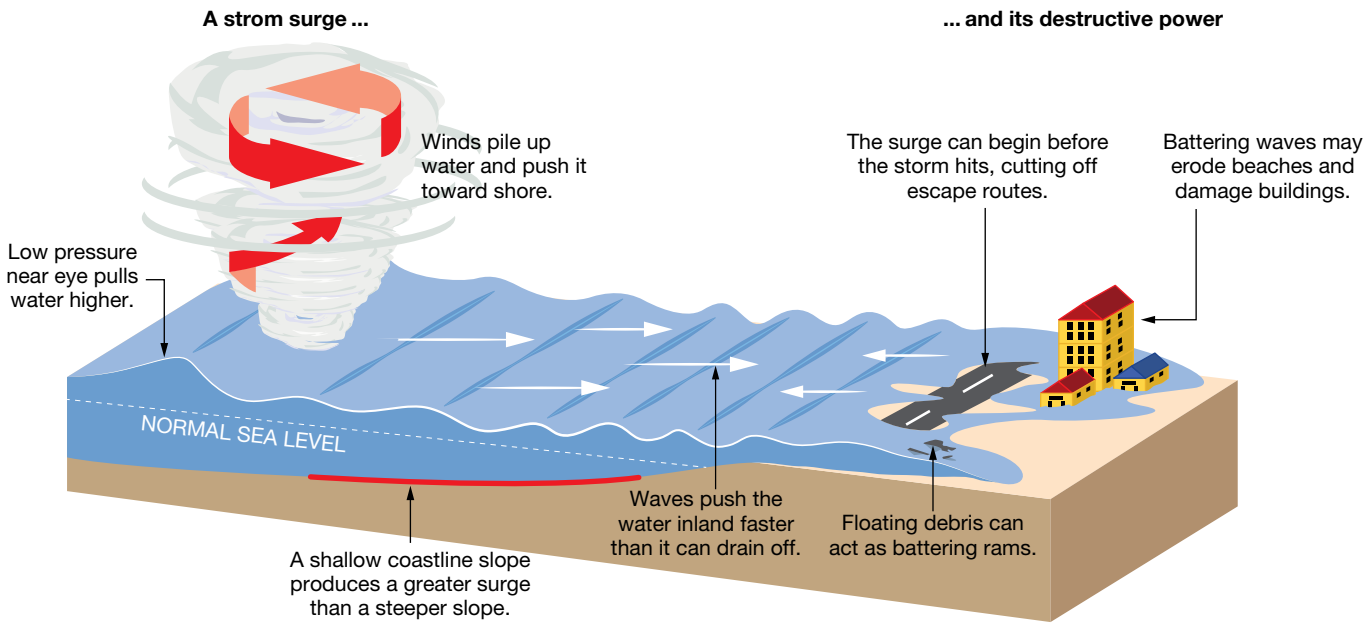
Waves types in the near-shore zone

The gradient (or steepness) of the sea floor ultimately determines the types of waves that will break onto the shore. The four main wave types are summarised in Figure 6.2.10.

Storm surges

A storm surge is created by intense low-pressure systems or cells (cyclones). Cyclones (called hurricanes in North America) form over the ocean and cause air to rise rapidly. This rising air 'pulls' up the sea surface with it (see Figure 6.2.11). Storm surges can do enormous damage to coastal areas. They can cause widespread erosion of beaches and destruction of the built environment.

In 2017 Hurricane Irma, thought to be the biggest Atlantic hurricane ever recorded, caused storm surges in Florida and other parts of the Caribbean. In Australia, the highest storm surge ever recorded to date was associated with a 1939 cyclone in northern Western Australia which coincided with a king tide, resulting in a 5.7 metre storm surge in Port Hedland. In 2005, a massive storm surge of several metres was generated by Hurricane Katrina in the southern states of the United States. The surge caused billions of dollars worth of damage and is considered one of the worst ever.



6.2.11 The destructive power of a storm surge

SPOTLIGHT

Hurricane Katrina

Katrina was the costliest and one of the deadliest hurricanes in US history. Katrina formed over the Bahamas on 23 August 2005 and crossed southern Florida before intensifying to a Category 5 hurricane in the Gulf of Mexico. The storm weakened to a Category 3 before crossing into Louisiana and Mississippi.

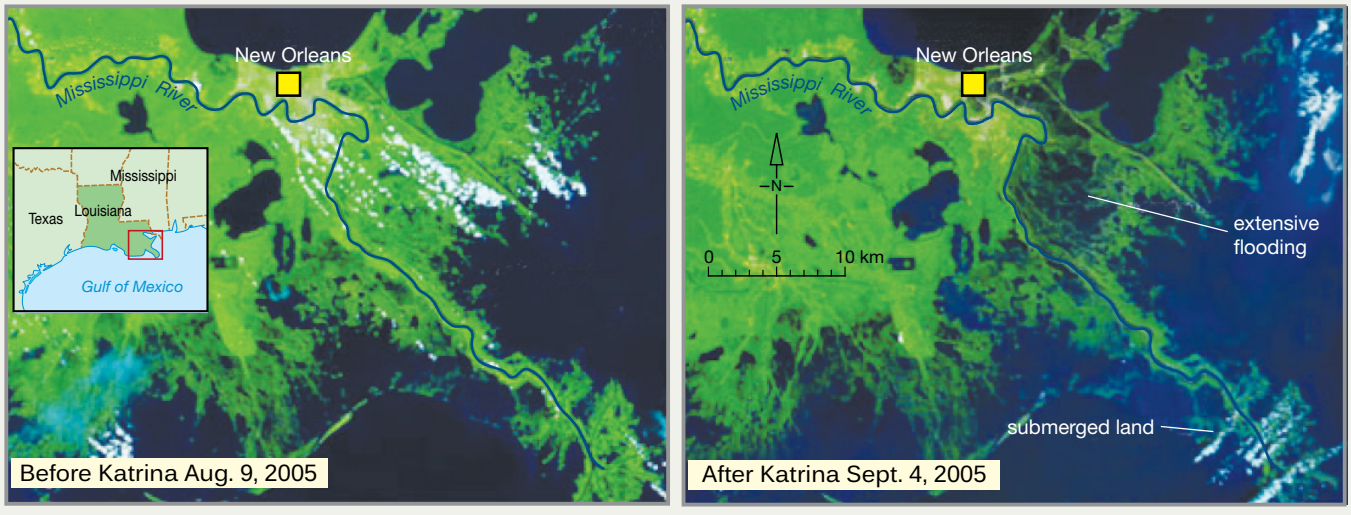
The storm surge generated by the storm caused severe damage along the Gulf coast, as seen in Figures 6.2.12 and 6.2.13. It devastated the Mississippi cities of Bay St Louis, Waveland, Biloxi, Gulfport, Ocean Springs and Pascagoula. In Louisiana, the flood-protection system of New Orleans failed in 53 different locations, ultimately flooding 80 per cent of the city. At least 1836 people died as a result of Hurricane Katrina and the subsequent flooding. The damage done by the storm cost an estimated US$81.2 billion.

The floodwaters of New Orleans contained a mix of raw sewage, bacteria, heavy metals, pesticides, toxic chemicals and about 24.6 million litres of oil. During the clean-up effort, the floodwaters were pumped into Lake Pontchartrain, seriously affecting the ecology of the lake.

Hurricane Katrina had a major impact on the biophysical environment. The hurricane and accompanying storm surge caused extensive beach erosion. In some cases, coastal environments were completely devastated. Approximately 150 kilometres east of the point where the hurricane made landfall, the sand of Dauphin Island (a barrier island) was transported across the island and dumped into the Mississippi Sound. This effectively relocated the island closer to the land. The storm surge and waves from Katrina also devastated the Chandeleur Islands, which had already been affected by Hurricane Ivan in 2004. Overall, more than 20 per cent of the local marsh wetlands were permanently inundated by water as a result of the storm (see Figure 6.2.14). The lands lost were the breeding grounds for marine mammals, brown pelicans, turtles and fish and a range of migratory bird species.

6.2.12 The foreshore of Biloxi, Missouri, in 1998 and the same location again in 2005 following the impact of the Hurricane Katrina storm surge

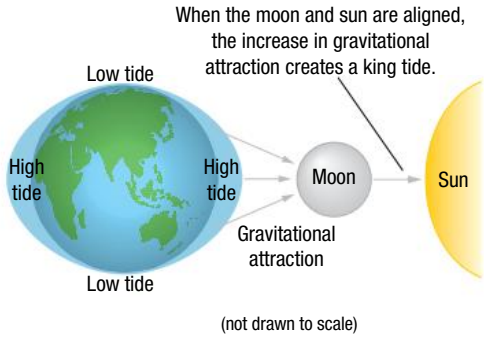
6.2.13 A bridge in Biloxi destroyed by the Hurricane Katrina storm surge



6.2.14 The impact of Hurricane Katrina on wetlands in Louisiana

Tides and currents

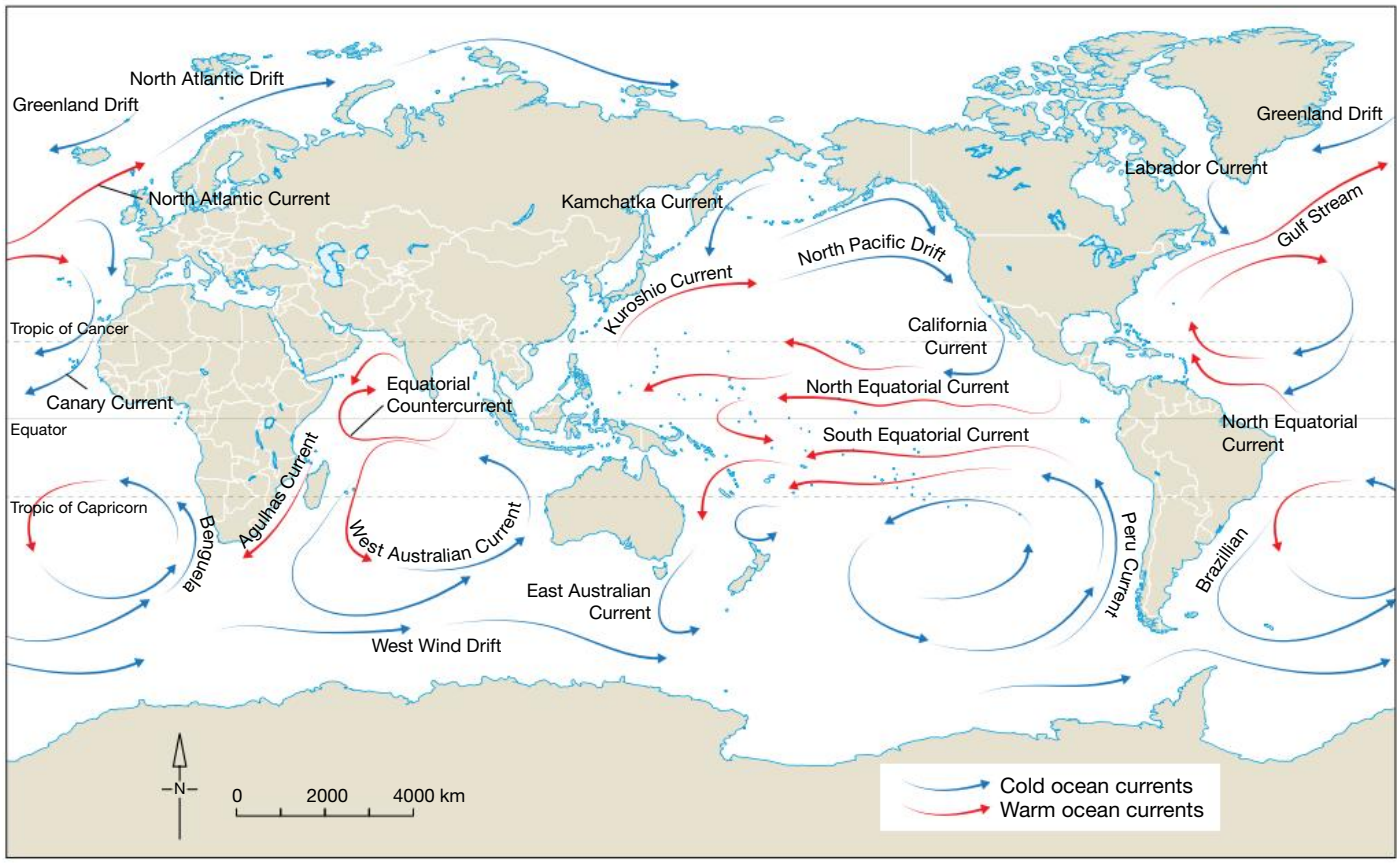
A tide is the alternate rise and fall in the level of the sea. These twice-daily variations are caused by the gravitational pull of the moon and, to a lesser extent, the pull of the sun and the rotation of the earth. The moon pulls water to the side of the earth closest to it. This creates a bulge, or high tide. A similar bulge develops on the opposite side of the earth to compensate. Between the two bulges, water is repelled, causing a low tide, shown in Figure 6.2.15.



6.2.15 Tides are created by gravitational forces, especially the gravitational pull of the moon.

Once every 14 days, the moon and sun are in alignment. The increased gravitational attraction results in a king tide. When king tides and storm surges coincide, the destructive power of the latter is enhanced.

The flow or movement of a large body of water in an ocean is referred to as an ocean current. These movements are caused by prevailing winds, the earth's rotation and the distribution of its land mass. They are also attributed to differences in the temperature and salinity of water bodies. Ocean currents play an important role in determining climate and are capable of transporting sediments over long distances. Currents are either warm currents flowing away from the Equator or cold currents flowing away from the poles towards the Equator (see Figure 6.2.16).



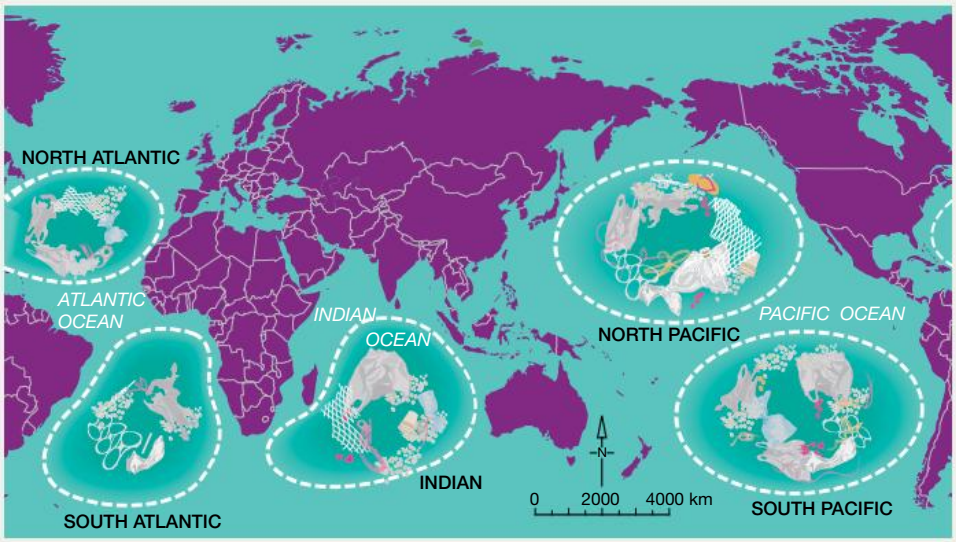
6.2.16 World ocean currents

SPOTLIGHT

Ocean gyres

Every year, billions of kilograms of plastic waste pour into the oceans. There is an estimated 5.25 trillion pieces of plastic floating in the ocean, and this number is increasing. The plastics are caught in natural ocean currents in five main locations, as shown in Figure 6.2.17.

The plastics are polluting the oceans, killing animals and fish and destroying ecosystems. Efforts are being made to clean up the oceans, however, this is an extremely difficult process. Other efforts are being made to ban single-use plastic items and prevent plastics from ending up in the oceans.



6.2.17 The five gyres around the world

Activities

Understanding the text

1 Explain how waves are created.
2 State what a swell is.
3 Explain what happens when waves enter shallow water.
4 Explain the difference between wind waves and swell waves. Outline how each is formed.
5 Outline the factors that determine the height of wind waves.
6 Explain how king, or rogue, waves develop.
7 Define in your own words the term fetch.
8 Identify the critical depth at which a wave breaks.
9 Explain how wave refraction creates headlands.
10 Distinguish between constructive waves and destructive waves. Under what conditions do each occur?
11 Describe what a storm surge is. Outline the processes that create one.
12 Define the term tide.
13 Explain the importance of ocean currents.

Working geographically

14 Study Figure 6.2.2 and the text on waves. Prepare a flow chart summarising the processes that led from a swell wave to swash.
15 Undertake fieldwork at a beach to examine waves. Using the data in Figures 6.2.4 and 6.2.10, report on the types of waves evident.
16 Study Figure 6.2.6. Describe what happens to a floating object in an area affected by swell waves.
17 a Study the information in the Skills builder 'Experiment: the effect of wind on waves'. Undertake this experiment with your classmates.
b In your workbook, draw a table with four columns. Use these column headings:
- fan speed (V)
- wave height (H)
- wave period (T)
- effect on beach.

Record your observations of wave height and period.
c Examine the effect that the waves had on the beach you have constructed. In the table, write a brief outline of what happens to the sand and small rocks as the speed increases.
18 Describe, in brief and with the aid of a sketch, the process of wave refraction. Outline how refraction affects the pattern of erosion in coastal regions.
19 Study Figures 6.2.12, 6.2.13 and 6.2.14. Write a brief report outlining the impact of the storm surge created by Hurricane Katrina on coastal areas in the southern United States.
20 Undertake library and internet research. Investigate the economic and social costs to coastal communities of storm surges associated with recent storm events. Write a report outlining your findings.
21 Study Figure 6.2.15. Write an explanation outlining the causes of the earth's tidal variations.
22 Study Figure 6.2.16. Outline the main currents that impact on the Australian coastline.

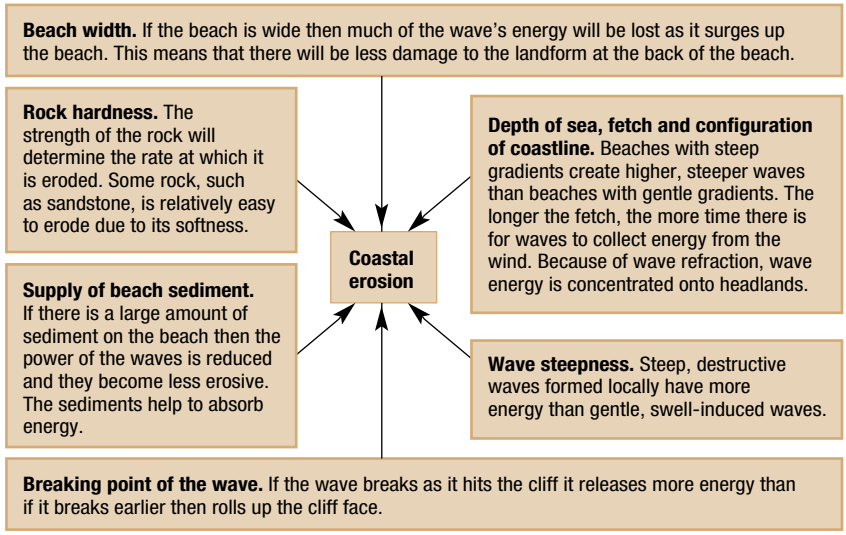
UNIT 6.3

Coastal erosion and deposition

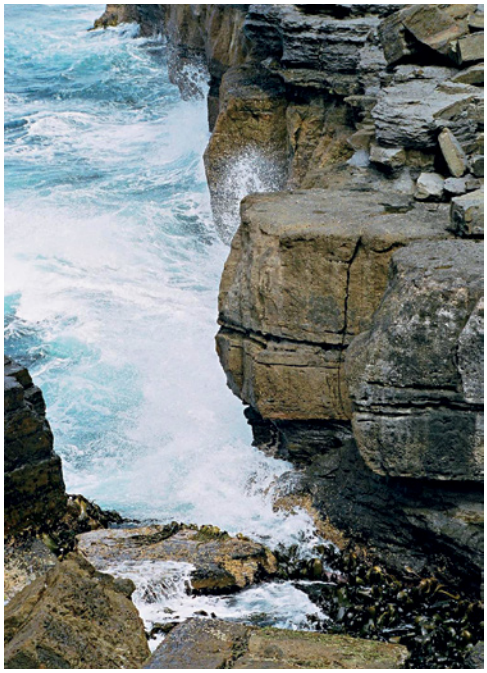
Coastal landform features can be classified as either erosional or depositional, depending on the nature of the processes responsible for their formation.

Coastal erosion

The sand and other sediments that make up beaches had to come from somewhere. While some comes from the transportation of inland sediment through the river system, a great deal comes from within the coastal environment itself. Waves, tides and wind actively erode the coast and create sediment. Figure 6.3.1 summarises the main factors affecting the rates of erosion.



6.3.1 Factors affecting erosion rates along a coastline



6.3.2 Wave pounding is the main source of coastal erosion.

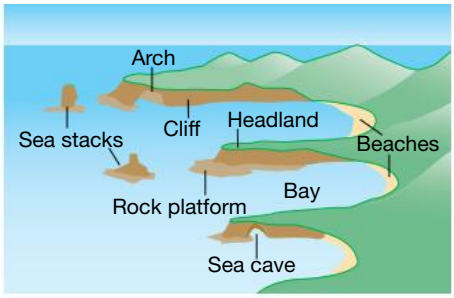
The processes of erosion include:

- **Wave pounding:** When steep waves break, they have considerable energy, generating shock waves of up to 30 tonnes per square metre. This weakens rock particles, causing them to become dislodged (see Figure 6.3.2).
- **Hydraulic pressure:** As waves smash against headlands, small parcels of air are trapped in cracks in the cliff face. The air becomes compressed, and the resultant pressure may, over time, break off pieces of rock.
- **Abrasion/corrosion:** Breaking waves hurl sand, fine rock particles or even boulders at the cliff face and rock platform, wearing them away. This is the most rapid and effective form of coastal erosion.
- **Attrition:** Large pieces of rock that have already been broken away from the cliff are broken down into smaller and more rounded particles as they collide with each other.
- **Corrosion/solution:** This involves chemical reactions that cause the bindings between rock particles to weaken. Salt crystals, for example, expand as they form, eventually causing rocks to disintegrate. The carbonic acid in salt water is particularly effective at corroding rocks containing limestone.
- **Non-marine processes:** Cliffs can also be eroded by rain either falling directly onto them or as a result of run-off and flow-through. This may result in mass movements; that is, landslides, soil creep and slumping.

Erosional landforms

Headlands and bays

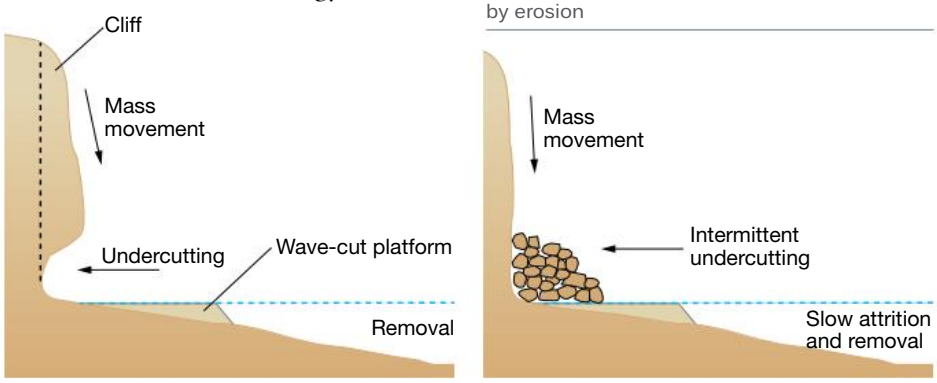
Headlands and bays are found in coastal areas where there are alternating masses of erosion-resistant and less-resistant rock. The less-resistant rock is eroded at a faster rate than the surrounding harder rock. This process is referred to as differential erosion. The more-resistant rock outcrops form headlands, with bays occupying the areas where the softer rock has been eroded (see Figure 6.3.3). Over time, the headlands retreat due to wave refraction, which concentrates wave energy onto the headland.



6.3.3 Main coastal landforms created by erosion

Wave-cut platforms

The erosive power of waves is greatest when they break at the foot of a cliff. This results in the undercutting of the cliff face. The processes of hydraulic action and abrasion create a wave-cut notch. Over time the notch becomes deeper until the rock above it collapses. The process is then repeated. Eventually a wave-cut platform is created (see Figures 6.3.4 and 6.3.5).



6.3.4 Formation of a wave-cut platform

Sea caves

Caves develop along a line of weakness at the base of a cliff that has been subjected to wave action over an extended period of time. As the rock weakens, the cave is extended deeper into the cliff face.

Blowholes

If the weakness in the rock extends up from the roof of a sea cave to the top of the cliff then a blowhole may develop. As waves crash into the sea cave, the water and air are compressed and forced up the line of weakness to be expelled from the top of the cliff as a jet of water.

6.3.5 Wave-cut platform at Ulladulla on the south coast of New South Wales

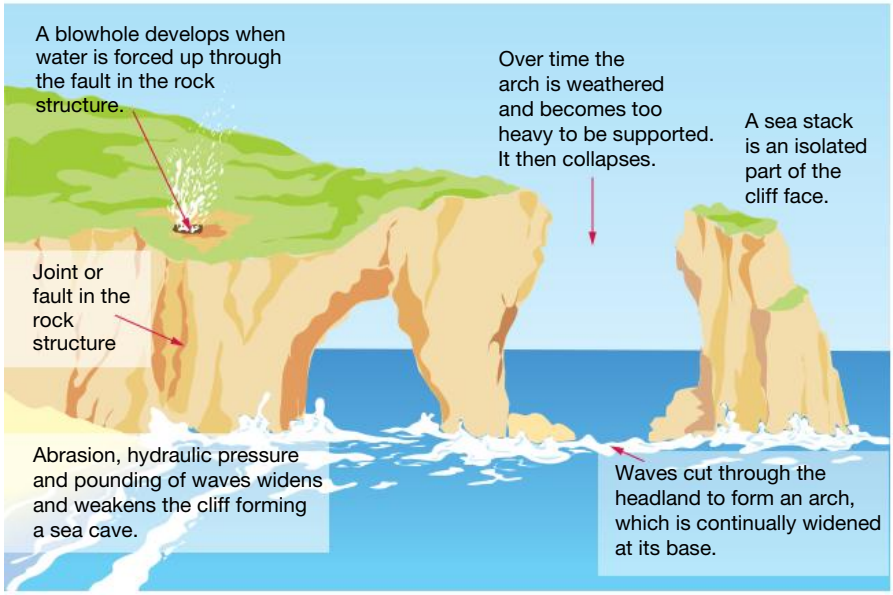
Arches and stacks

Arches are created when sea caves are cut horizontally through a headland, forming a land bridge (see Figure 6.3.6). Eventually the bridge collapses, leaving a sea stack. Victoria's famous Twelve Apostles were formed this way (see Figure 6.3.7).

Figure 6.3.8 illustrates the formation of blowholes, arches and sea stacks.

6.3.6 The famous Durdle Door, an arch on the Dorset coast of England

6.3.7 The Twelve Apostles, a series of sea stacks off the Victorian coastline



6.3.8 Formation of blowholes, arches and sea stacks

Coastal deposition

Waves, tides and currents move and sort coastal sediments. Under natural conditions this process involves constant movement, with sediments being brought into and out of the coastal zone. Beaches act as a temporary store of sediment. Beach sediments can be removed by the process of sediment erosion and then relocated within the coastal zone. Consequently, the sediment being used to build one beach may have come from the erosion taking place on another.

As each wave moves onto the beach it carries sediment with it. However, the energy of the wave also gives it the potential to remove sediment from the beach. The strength of the wave will ultimately determine whether it is constructive or destructive. Because steep, plunging waves have high levels of energy they tend to be destructive. This explains why our beaches are often left with little sand after severe storms. During storms, the strong winds increase the energy in waves.

Sediment movement within waves

As the wave enters shallow water and breaks, turbulence and the to-and-fro movement of the water place stress on individual grains of sediment. This causes the grains to become detached from the main body of sediment. The grains can then be held in suspension, where they can be carried along by the energy of the wave.

6.3.9 Swash and backwash transport sediment on and off beaches.

Movement of sediment up and down the beach

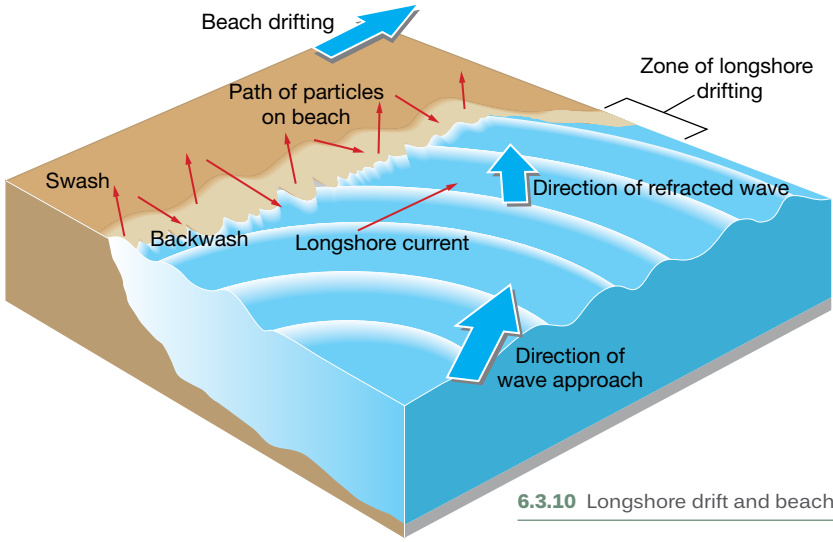
When waves break on beaches, they produce a turbulent body of water known as swash. This surges up the beach slope, carrying with it fine sediment, as seen in Figure 6.3.9. The uprush stops when the wave's energy is spent. Much of the water soaks into the beach. The rest flows back down the beach slope under the influence of gravity as backwash, taking some sediment with it. In fair weather, (constructive) waves move sand and other sediments up and down the beach in this manner. In big storms, (destructive) waves erode or scour the beach downwards and move this material out to sea. This often causes serious erosion problems.

Beach drifting

Swash and backwash can also result in the movement of material along a beach. When waves strike the coast at an angle, the swash is directed onto the shore at an angle. When the wave is spent, the backwash retreats down the beach by the most direct route. Thus, particles pushed up the beach come to rest along the beach at a different point from where they started.

Longshore drift

A related process to beach drifting is longshore drift. When a coast is hit by strong, onshore, wind-induced waves or swell there is an accumulation of excess water. This escapes as a current that runs parallel to the shore and away from the wind. This is known as a longshore current. Turbulence in the surf zone keeps material suspended. These wave-induced currents are very effective in moving sediment. Figure 6.3.10 shows how beach drifting and longshore currents move sediment on a beach. The rate of drift depends on the energy of the wave and the angle at which it strikes the beach. An angle of 30° is believed to be the most effective for longshore movement of sediment.



6.3.10 Longshore drift and beach drifting

The impact of longshore drift can be seen along most beaches in eastern Australia. The southern ends of beaches are usually narrower than the northern ends. This is because the prevailing longshore currents tend to run from the south towards the north and the waves strike the beaches from a more southerly direction.

When humans block the longshore movement of sediments, this impacts on the beaches to the north of the obstruction by reducing the amount of sediment available for beach building. (This will be examined in greater detail later in the unit.)

SKILLS BUILDER

Investigating longshore drift

The impacts of longshore drift can be seen along almost any beach in eastern Australia. This activity gives you an opportunity to study the process in the field.

Pre-excursion activities: Use topographic maps and aerial photographs to familiarise yourself with the coastal environment you will study. Make sure you have a thorough understanding of the relevant concepts and terminology. Note the season.

Study 1: Visit the southern end of a beach and, with a measurement app on a smart phone or with a long tape measure, determine the width of the beach by measuring from the established (incipient) foredune to the low-tide mark. Move along the beach in a northerly direction, taking measurements as you go.

Study 2: Throw a piece of buoyant material, such as foam or a tennis ball, at the water's edge. Remember to recover whatever you throw into the water.

Draw up the following table and complete it as you move along the beach.

Location	Estimated distance from southern end	Width of beach (m)

Record the length of time it takes for the object to move a measured distance along the beach. Also note the direction that it moves. Record the data and compare them with your results from the activity for Study 1.

Draw field sketches or use a camera to record the shape of the berm and the characteristics of the dune vegetation.

Construct an annotated cross-sectional profile of the beach. Mark the following features: offshore bar, low-tide mark, high-tide mark, beach berm, foredune and colonising plant species. Use accurate measurements to construct your profile.

Display the results of your fieldwork in the classroom or mount a display in a public area of the school.

Activities

Understanding the text

1 Outline the main sources of sand and other sediments along a coast.
2 Explain the processes of wave pounding and hydraulic pressure.
3 Distinguish between the processes of corrosion (abrasion) and corrosion (solution).
4 Name the erosional process by which large pieces of rock are broken into smaller and more rounded particles.
5 Outline the non-marine processes that contribute to the erosion of coastal landforms.
6 Define the term differential erosion.
7 Identify the processes that move and sort coastal sediments.
8 Define the term sediment erosion.
9 Distinguish between swash and backwash.
10 Outline the impact that constructive and destructive waves have on the beach profile.
11 Explain the process of beach drifting.
12 State the angle of attack or incidence that is thought to be the most effective for longshore movement of sediment.
13 Explain the effects of longshore drift along the east coast of Australia.

Working geographically

14 Construct a mind map to illustrate the processes of coastal erosion.
15 Study Figure 6.3.1. Write a report outlining the factors affecting the rate of coastal erosion.
16 Write an explanation outlining how beach width and rock hardness determine the rate of coastal erosion.
17 Study Figure 6.3.4. Produce a flow chart showing the processes that lead to a wave-cut platform developing.
18 With the aid of a series of diagrams, explain how a sea stack is formed.
19 Draw a series of diagrams to illustrate the formation of sea caves and blowholes.
20 Using Figure 6.3.10 and the text, write a short report explaining the process of longshore drift.

CASE STUDY

Erosion of the Norfolk coast

The Norfolk coastline is located on Britain's mid-east coast. Wild storms that form in the arctic region then move through the North Sea and bring huge, damaging waves. The small village of Happisburgh has become symbolic of the extent of coastal retreat along the coastline. The village—with a population of around 1400—used to be some distance from the sea; now it is slowly disappearing into the sea, as seen in Figure 6.3.11. Whimpwell, a whole other village, used to sit between Happisburgh and the sea. Whimpwell disappeared long ago.

The cliffs around Happisburgh are between 6 and 10 metres high and are made up of very soft rock with layers of sand and silt in between. This makes them very easy to erode. Geologists believe that the Norfolk coastline has been eroding at its present rate for around 5000 years. Along much of the coastline, historical analysis shows that between 1600 and 1850 the cliffs retreated more than 250 metres, allowing the sea to flood inland.

In winter, erosion is caused by the region's high rainfall. The rainwater seeps into the sandy ground and weakens the cliffs, causing landslides. During storms that occur all year round, the base of the cliffs is attacked by waves causing scour. This is where the base of the cliff is gradually undercut until it becomes top heavy and collapses, see Figure 6.3.12.

Coastal defences have been built along the Norfolk coastline to help reduce the rate of erosion. These defences include barrages along the beach; built with timber or steel these look like fences and cause the waves to break on them instead of the base of the cliffs. Other solutions have included piling thousands of large boulders along the base of the cliffs. These measures have been very costly and cause environmental impacts.

6.3.11 Collapsed cliffs in Happisburgh, Norfolk coast

Studies by the British Geological Survey have found that the rate of erosion along the Norfolk Coast is likely to accelerate in the future. This is because agricultural and tourist developments along the coast continue to weaken the cliffs.

As the climate warms, sea levels will rise which increases the rates of erosion. An increase in large storms is another consequence of climate change. More frequent and more violent storms will overwhelm the already failing sea defences and cause further erosion and cliff retreat.

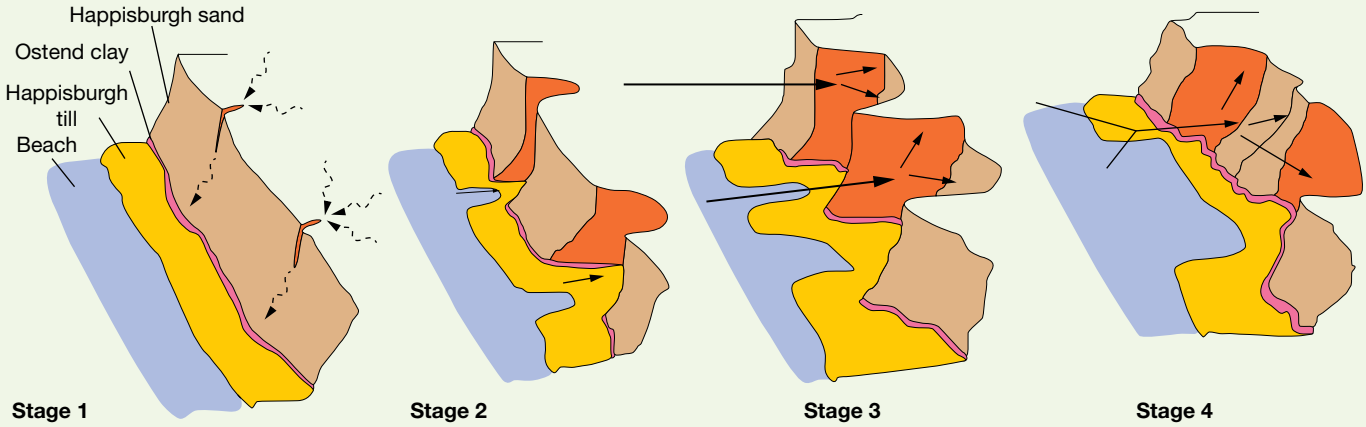
Authorities have decided that the costs of replacing the sea defences is so great that in many areas, including Happisburgh, they will not be repaired or replaced. This policy is called 'planned retreat' and takes the view that instead of trying to stop the erosion, the natural processes of erosion should be allowed to continue. The money saved from not repairing the sea defence is then used to relocate people whose properties have been lost to the sea.

Activities

Working geographically

1 Describe the impact of coastal erosion along the Norfolk coastline.

2 Outline the strategies that have been used to reduce the erosion.



Stage 1
Two small gullies form due to surface run-off and groundwater seepage and by a trough in the upper surface of the till. Toe is eroded by sea. Ostend clay provides an impermeable horizon.

Stage 2
Gullies enlarge to form small embayments. Upper surface of till is eroded. Landslipped Happisburgh sand material is removed by sea.

Stage 3
Embayments increase in size leaving a promontory between embayments

Stage 4
Promontory collapses creating one large embayment

6.3.12 Coastal erosion along the Norfolk coastline

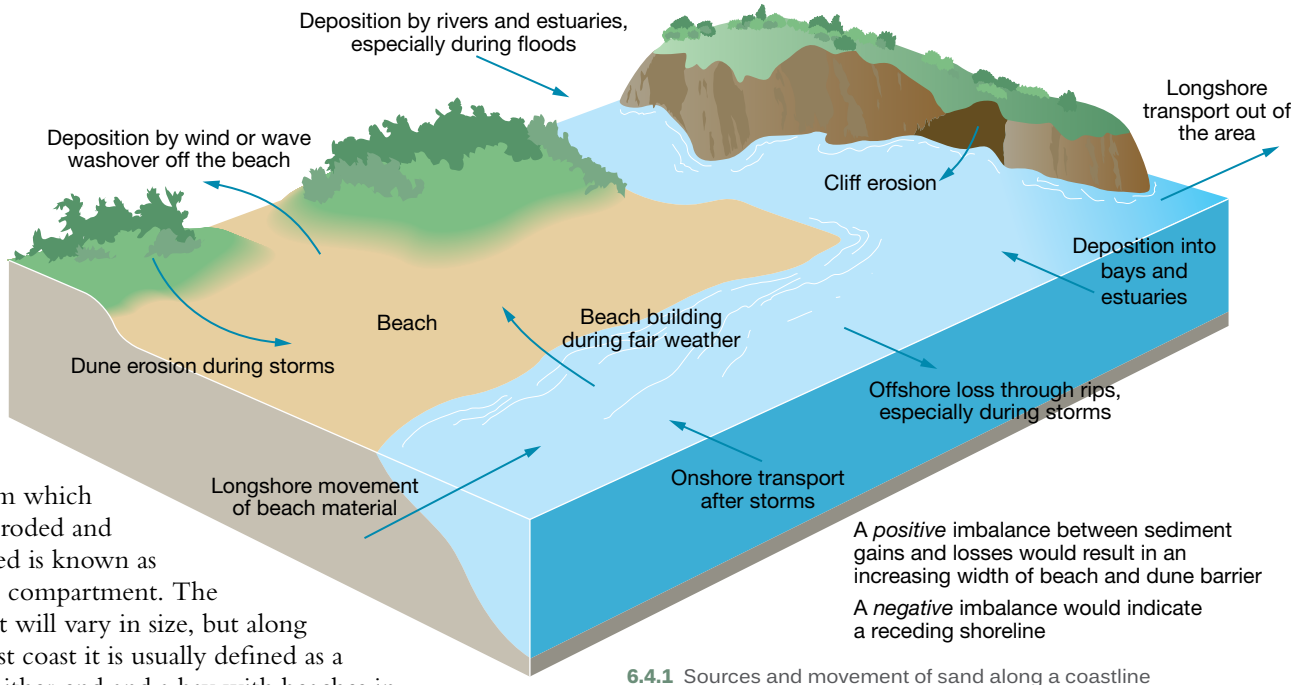
UNIT 6.4

Coastal sediment budgets

Sediment is material that is transported to and from coasts by the wind (atmosphere) and water (hydrosphere). Sediment is usually sand, shingle, coral and silt (very fine mud). Processes of erosion in inland areas and along coasts produce the sediment. Inland sediments are transported to the coast via river systems. Rivers erode their banks and transport the soil and sand washed into them by run-off.

Sediment flows in and out of coastal systems. Waves, tides, currents and the wind constantly move sediment around the system and to different systems. The amount of sediment that enters the system is referred to as the sediment input, while the amount that leaves is known as the sediment output. By subtracting the sediment outputs from the sediment inputs we are able to determine the coastal sediment budget, shown in Figure 6.4.1.

Sediment budget = Sediment inputs – Sediment outputs

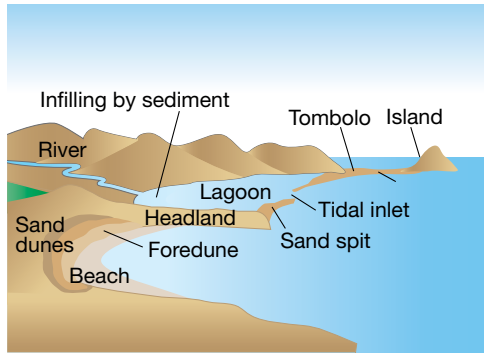


6.4.1 Sources and movement of sand along a coastline

The area from which sediment is eroded and then deposited is known as the sediment compartment. The compartment will vary in size, but along Australia's east coast it is usually defined as a headland at either end and a bay with beaches in between. Sediment is moved both within and between compartments.

Depositional landforms

Depositional landforms develop where the rate of accumulation of sediment exceeds the rate of depletion. Areas that are sheltered from strong prevailing winds are more likely to accumulate sand and other sediments. Figure 6.4.2 shows the main depositional landforms.



6.4.2 Depositional landforms

Beaches

Beaches are accumulations of loose sediment built up by the actions of waves and near-shore currents. They extend from the low-tide level to the upper limit reached by the largest storm waves. Beaches are one of the most dynamic and fragile landforms on earth; their profile is constantly changing as sediments are removed and then replenished. Beaches are sensitive to the strength of winds and currents, the height of waves and tides, and the ever-increasing impact of humans.

Most beaches are composed of sand or pebbles. The characteristics of beach material are ultimately determined by the type of sediment transported to the coast by rivers and the type of material stored in the offshore deposits.

The nature of the lithosphere in headwaters of river systems is a very important factor in determining the nature of beaches. Most beaches in Australia are composed of sand derived from the weathering and erosion of sandstone. This material makes up many of Australia's coastal and inland geological features.

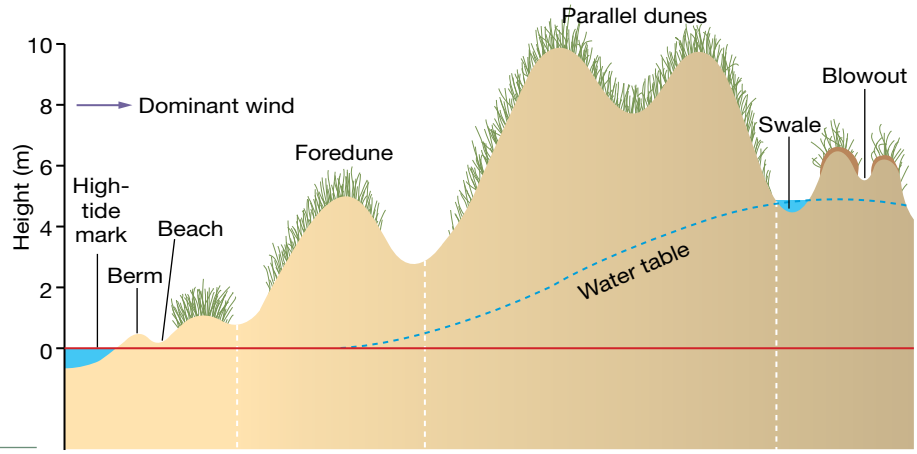
Beaches can be divided into three main zones: the swash zone, the berm and foredune, and coastal sand dunes. The swash zone is the part of the beach where the waves 'run up' the beach face. The further up the beach the wave runs, the more energy it loses. Eventually the wave ceases to have any forward energy and the swash returns to the sea as backwash.

The berm and foredune (see Figure 6.4.3) are accumulations of sediments at the edge of the swash zone. A berm is a ridge or terrace of sand. The berm and foredune have two very important functions:

- They act as a protective barrier against the erosive power of the sea and also against the inland movement of sand and salt.
- They are reservoirs of sand that feed eroding seas. During a constructive phase, sediments are deposited on the beach and foredune; the berm is extended seaward. During a destructive phase, sand is taken from the foredune. This leaves the main dune system protected from erosion. The berm retreats towards the back of the beach.

Sand dunes

Sand dunes are large accumulations of sand on the landward side of beaches. They are formed when onshore winds blow sand inland. Sand dunes are particularly important because they provide a vital buffer zone between the sea and the land. They are a store of sand from which sand can be withdrawn in times of attack by destructive storm waves. Dunes that run parallel to the main beach are often referred to as parallel dunes.



6.4.3 Cross-section of a beach and dune system

6.4.4 Pioneer grasses colonise dune systems and help to stabilise them.

Formation of dunes

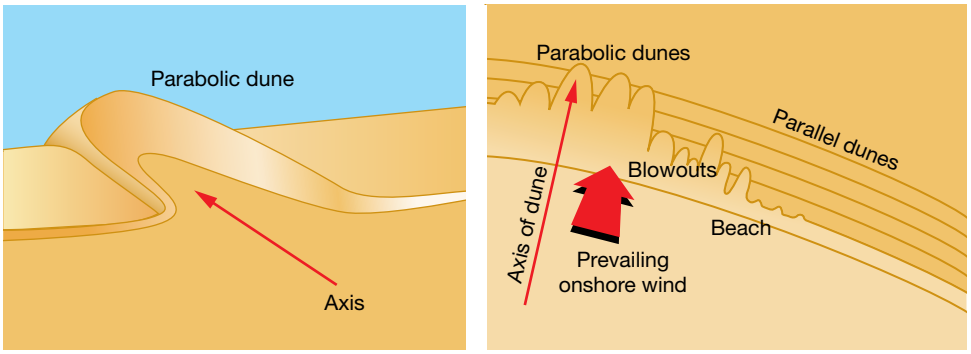
Waves and longshore drift deposit sand in the swash zone. As the tide recedes, the sand deposits dry out, allowing sea breezes to move the sand inland. This is known as aeolian transport. Seaweed and other debris may trap some of this sand. Over time plants begin to colonise the sand deposits, making them stable. Embryo dunes are the first to develop and gradually become stabilised by grasses known as pioneer grasses, as seen in Figure 6.4.4. These grasses trap more and more sand, causing the dune to grow. As more and more sand accumulates, the embryo dune may develop into a foredune. The dune continues to grow until its increasing distance from the shoreline cuts off the supply of sand. A new generation of dunes becomes established in front of the initial dune.

As the dune matures, other plants and animals begin to move in and establish their dominance. This causes the dune to become even more stable. The soil profile takes on a grey colour, as the amount of organic matter increases. Eventually, a more complex soil profile develops, capable of supporting more complex plant communities.

The impact of people on dunes has been substantial, as shown in Figure 6.4.5. Dune systems have been levelled to make way for car parks, housing estates, commercial developments and parklands. This has a major impact on the amount of sand available for beach replenishment and exposes the coastal environment to greater destruction during severe storms.

6.4.5 Urban development, such as here in Queensland's Surfers Paradise, has caused the destruction of dune systems.

Where dunes remain intact they can be seriously degraded if access is not restricted. Trampling of dune vegetation by people and animals exposes the dune to erosion by wind. Wind is funnelled along the tracks, gouging out the sand and creating a dune blowout. At this stage the dune is said to be wasting. Blowouts allow sand to continue moving inland. A blowout may develop into a parabolic dune. These are U-shaped dunes with the open end pointing upwind, shown in Figure 6.4.6.



6.4.6 Formation of parabolic dunes

Sand spits

Sand spits are long, relatively narrow accumulations of sand extending from the coast into the sea (see Figure 6.4.7). They usually end in a recurve (hook shape) that bends back towards the land. Their creation is related to wave action and their shape is determined by the rate and direction of sediment flow. Salt marshes often develop on the landward side of a sand spit which, over time, can become quite stable. The waterway behind the spit is often shallow and calm, making them popular places for human recreation. When a spit extends across a bay linking two headlands it is called a bar.

Tombolos

A tombolo (see Figure 6.4.8) is a sand spit that links an island to the mainland or another island. There are several well-known tombolos in Australia. One joins Barrenjoey to the mainland at Palm Beach on Sydney's Northern Beaches; another is located at Port Stephens. Tombolos form when sediment accumulates in the less turbulent water on the sheltered side of an island.

6.4.7 This satellite image shows Cape Cod, a huge sand spit on the north-east coast of the USA.

6.4.8 Barrenjoey Headland is in fact an island that is joined to the mainland by a tombolo.

6.4.9 The Coorong—a vast barrier and lagoon system east of Adelaide on the South Australian coast

6.4.10 Dredging of the Murray River mouth is often needed to keep the barrier open between the sea and lakes.

6.4.11 Mangrove forests, such as this one on the island of Borneo, line many estuarine rivers.

Barriers

Barriers are elongated accumulations of sand running roughly parallel to the shore and separated from it by a lagoon. Barriers are similar in structure and composition to offshore bars but they are never completely covered by water. During large storms the barrier may be breached, allowing the sea access. With time and the movement of sediment, the breach will be repaired. Extensive barriers are located in Victoria's Gippsland region east of Melbourne and in the Coorong, a huge area east of Adelaide in South Australia.

The Coorong

The Coorong, shown in Figure 6.4.9, is one of Australia's most important and fragile coastal environments. The Coorong is found along South Australia's southern coastline east of Adelaide. It is a complex coastal system that includes a very large shallow lake system that stretches along the coast for more than 140 kilometres.

This lagoon is saline, meaning that it contains high levels of salt water. It is separated from the Southern Ocean, which has some of the world's roughest and most powerful seas, by a narrow barrier system, called the Younghusband Peninsula. This barrier is made up of coastal sand dunes and acts like a wall keeping the powerful sea from flooding into the lagoon.

In its natural state, the Coorong would receive fresh water from the Murray River and salt water from the ocean. However, in the 1940s a series of barrages was built across the Murray River to stop the flow of sea water into the lake system. In addition to the barrages a series of weirs and dams along the Murray River and the other rivers that flow into the Murray have significantly reduced the flow of water down the river.

As water is diverted from the Murray for human use, the amount left to flow down the river and into the lakes of Coorong shrinks. In the droughts of the first decade of the twenty-first century, almost no water flowed into the lakes. Water levels dropped and the lakes began to dry.

Emergency dredging of the mouth of the river, shown Figure 6.4.10, was necessary to allow salt water to flow in and keep water in the Coorong lakes. However, large amounts of salt water that is not balanced with fresh water is changing the ecosystem of the Coorong. The lakes have evolved to have brackish water, a combination of salt and fresh water. In some parts of the Coorong, the water is actually saltier than the sea water. This has meant that plants and animals have died and a whole new range of species that thrive in saltier conditions are taking hold.

Estuaries

Estuaries develop where rivers enter the sea. They are often funnel-shaped and affected by the ebb and flow of the tide. In the estuary the river's fresh water and sediment mix with the salty sea water. This constant mixing creates nutrient-rich silt, which supports a number of complex plant and animal communities.

The banks of estuaries are often lined with estuarine mangroves, shown in Figure 6.4.11. Mangroves play an important role in cleansing the environment and providing habitats and breeding grounds for a number of important fish and bird species. They also have significant commercial value. The economic viability of the fishing industry, for example, depends on the fish that breed in the mangrove ecosystem.

The environmental importance of estuarine mangroves has only been recently acknowledged. In the past, large areas of mangroves were destroyed to make way for canal estates, factories, playing fields and rubbish dumps.

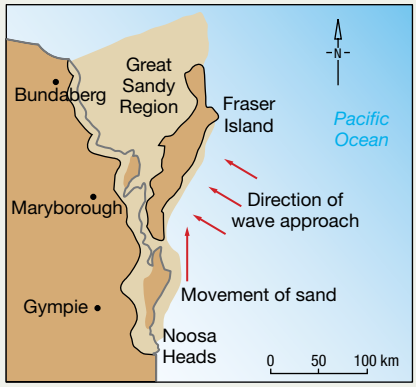
Salt marshes

Salt marshes are found in sheltered coastal areas, such as estuaries, and behind spits. They are areas that are inundated by sea water regularly, but only for short periods of time. As the tide retreats, the remaining seawater evaporates, creating saltpans. The only vegetation that can grow in these areas are certain algae and a small number of salt-tolerant plants, such as grassworts and cord grasses. Salt marshes are easily eroded. This makes them very fragile and susceptible to human interference. Salt marshes are one of the most at-risk environments. Sea level rise due to climate change is leading to more and extensive inundation of marshes. Extensive salt marshes are found on Rottnest Island off the Western Australian coast. In New South Wales, salt marshes are found in 101 of the state's river estuaries.

SPOTLIGHT

Formation of Fraser Island

Fraser Island provides a good example of the way that interactions between the various components of the biophysical environment affect coastal sediment processes and landforms. In common with other landforms resulting from the accumulation of coastal sediments, the island is constantly changing. It started to take shape millions of years ago as the sandstone mountain ranges of eastern Australia were eroded. The sediment produced by this erosion was swept out to sea by large and powerful rivers. The prevailing currents and longshore drift moved the sediment towards the north, shown in Figure 6.4.12.



6.4.12 Sediment flow and wave patterns along the east coast of Australia lead to an accumulation of sand around Fraser Island in the Great Sandy Region.

Over thousands of years, the sediment banked up against the rocky headlands of Hervey Bay. During the last great Ice Age, the sea level rose and fell several times, exposing and submerging the sandy sediment. During times of low sea level the exposed sand was transported by wind and heaped into huge dune systems, in a process known as aeolian deposition. With the ending of the Ice Age, the sea rose to its current level. It flooded the area, leaving only the tops of these great sand dunes exposed as islands.

With time, the exposed dunes have been stabilised by primary vegetation, such as grasses. This has gradually created the nutrients that could support larger shrubs and ultimately trees seen in Figure 6.4.13. With a high annual rainfall (in excess of 1500 millimetres) the conditions for plant growth are ideal. Furthermore, a thick blanket of humus (decaying plant matter) and minerals formed an almost watertight layer just below the surface. This trapped rain water, providing a rich source of fresh water across the island.

6.4.13 A complex ecosystem has evolved on Fraser Island.

Activities

Understanding the text

1 Outline the function of an offshore bar. Where are they found?
2 Identify the materials that are classified as coastal sediment.
3 Write your own definition for the term sediment budget.
4 Explain the origin of coastal sediments.
5 State what a sediment compartment is.
6 Describe the structure of most sediment compartments found along Australia's east coast.
7 Outline the circumstances under which depositional landforms develop.
8 Describe the formation of a beach.
9 State what the 'swash zone' is.
10 Explain the role that dunes play in the functioning of a coastal environment.
11 Outline the importance of vegetation to dune systems.
12 Outline the impact of human activities on dune systems.
13 Describe the formation of a sand spit.
14 Define the term tombolo.
15 Explain what a barrier system is. Why is it a vulnerable environment?
16 State what an estuary is.
17 Explain why salt marshes are ecosystems at risk.

Working geographically

18 Study Figure 6.4.1. Write a report outlining the sources and movement of sediments in the coastal environment.
19 Construct a simple table that summarises the main features of a beach.
20 Write a paragraph describing the structure of a dune system.
21 Construct a flowchart diagram to explain the processes involved in the formation of a dune system.
22 Study Figure 6.4.6. Explain how a parabolic dune is formed.
23 Study Figure 6.4.9. Write a short description of a barrier system.
24 Write a report on how human activities have impacted on the environment of the Coorong.
25 Prepare a descriptive report on the processes that have led to the formation of Fraser Island. Describe the environment that has developed there.

UNIT 6.5

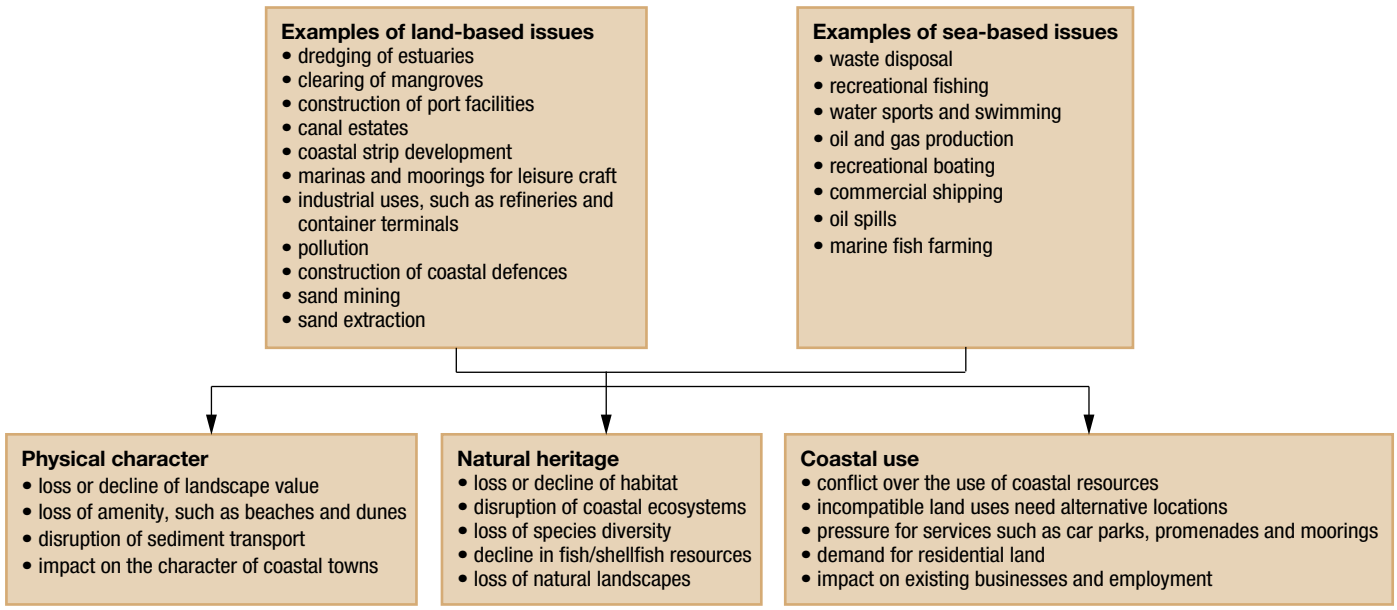
Human impacts on coastal processes

In a natural system, the processes of sediment deposition and erosion ensure that the coastal environment can recover from the impact of major disturbances, such as storms. In their natural state, therefore, coastal environments are resilient and able to cope with significant change.

Issues arise when human activities begin to disturb these coastal processes. Major problems are created when humans interfere with the coastal sediment budget through:

- sediment removal; for example, during sand mining operations
- blocking the flow of sediment into or out of a sediment compartment
- damaging coastal sediment landforms.

Figure 6.5.1 summarises the main human impacts on the coastal environment.



6.5.1 Major human impacts on the coastal zone and their consequences

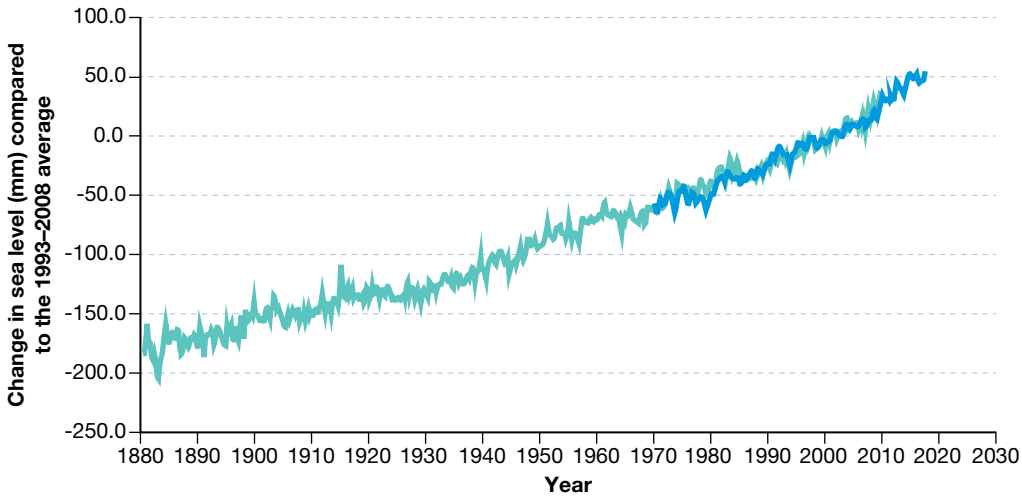
Impacts of climate change

The last decade has been the warmest in recorded history and there is now overwhelming evidence that the global climate is beginning to change. Global warming will have a profound effect on the coastal zone. As temperatures rise, the particles that make up seawater expand, which in turn causes the ocean level to rise. This is known as thermal expansion, and will cause the sea level to rise between 30 centimetres and 1 metre over the coming century. In some scenarios the rate is even higher. Such a rise in sea level will have catastrophic consequences for coastal environments and the communities that live in them.

Sea level rises

Data from the National Oceanographic and Atmospheric Agency (NOAA) of the USA has found that throughout the twentieth century, sea levels rose by an average of 1.7 millimetres per year. Since 1993, the rate of rise has been increasing steadily, and the average for this period was 3.2 millimetres per year. By 2016 the world's oceans were 82 millimetres higher than they were on average in 1993.

Figure 6.5.2 shows this upward trend. The two different lines on the graph show two different data sets. The light blue is from Australia's CSIRO measuring change up to 2011 and the dark blue is from University of Hawaii data and includes predictions for the future. Low-lying areas such as the tiny Pacific island countries of Kiribati and Tuvalu may disappear altogether as sea levels rise and consume these low-lying countries.



6.5.2 Sea level change since 1880

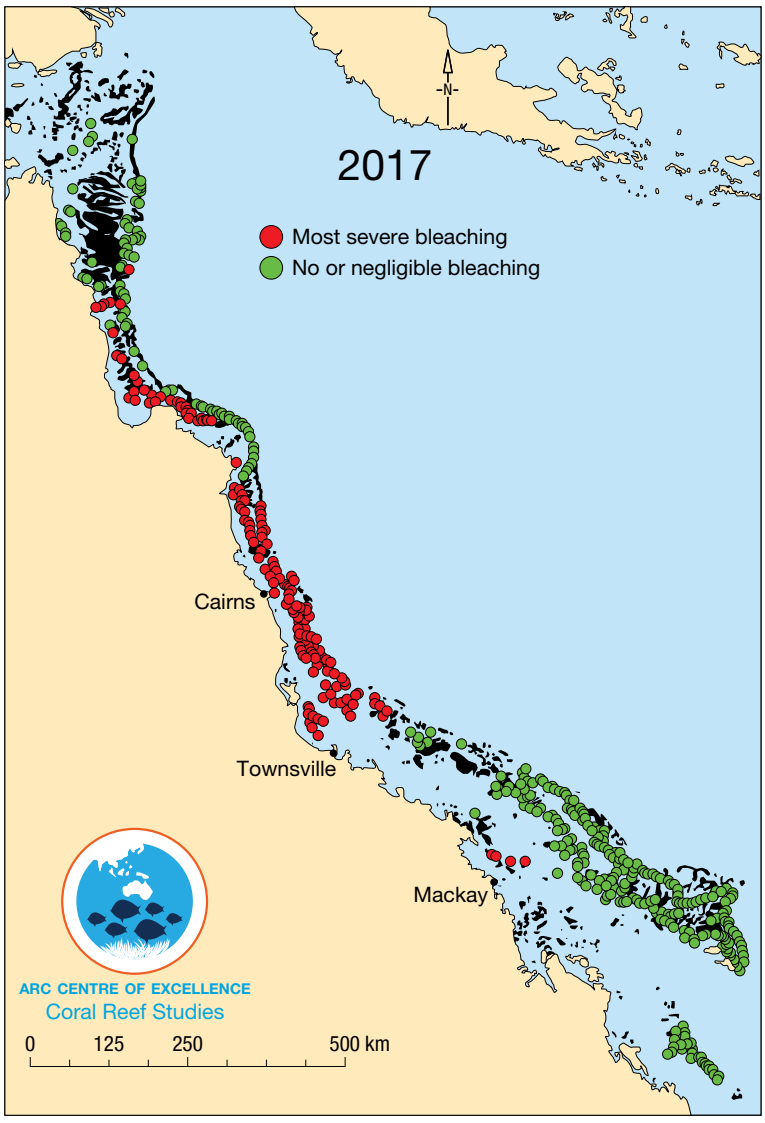
Coral bleaching

Changes in sea temperature are also impacting on aquatic species. For example, coral reefs require very specific temperature ranges in order to survive. Even a slight change can be enough to kill off the reefs. In 2016, 93 per cent of the Great Barrier Reef suffered from coral bleaching, with 29 per cent of the more shallow reefs severely affected. This is a consequence of higher water temperatures and in extreme cases can lead to the total destruction of a reef system. In 2016 the Coral Sea recorded its highest sea surface temperatures ever. The extent of coral bleaching on the reef in 2017 is shown in Figure 6.5.3.

Sediment budget

Sea level rise will also impact on the coastal sediment budget. As levels rise, more land is covered by ocean. A study conducted in the Republic of Ireland found that as much as 150 000 hectares of coastal land is at risk of severe erosion along the west coast. Erosion on such a scale will dramatically alter the natural flow of sediments in the region.

In 2009 the New South Wales Government adopted a formal policy on dealing with coastal erosion and produced a risk management guide in recognition of the increased risk associated with rising sea levels. The policy addresses the potential impacts of projected sea level rise, including flood risk and coastal hazard assessments, development assessment, coastal infrastructure design processes and land use planning exercises.



6.5.3 Extent of coral bleaching on the Great Barrier Reef in the summer of 2017

6.5.4 In June 2016, an intense storm in Sydney caused massive erosion along the coast, especially on the Northern Beaches. Such storms are becoming more common as the climate changes.

Severe storms

Another major consequence of climate change will be the increased risk of severe storm events. Massive storm events, such as Hurricanes Katrina and Irma in the southern United States, have caused huge damage to the coastal environment around the Gulf of Mexico. Such storms are expected to increase in frequency and ferocity, driven by warmer sea surface temperatures. These types of storms cause massive erosion of the coastline (see Figure 6.5.4), placing human development as well as natural ecosystems such as mangroves and salt marshes at risk.

Impact of sediment removal

Coastal sediments are a rich source of minerals. They are used in a range of industrial processes, including glass manufacturing. Sand mining involves the total destruction of the dune system and associated vegetation. While storm waves have the power to remove thousands of cubic metres of sand, it is usually replaced over a period of months. As the dune is rebuilt and revegetated, it regains its stability and the dune system recovers.

The impact of mining is often far more extensive and the rate of recovery much slower. Even where the dunes have been artificially restored and vegetated, the dune and vegetation patterns are different from those that naturally occur; that is, former levels of complexity do not return for many years. Because of this, sand mining is often the source of widespread community debate and opposition.

6.5.5 Massive sand dredges such as this one have the capacity to move vast quantities of sediment and disrupt sediment flow patterns.

Across parts of the developing world, especially in North Africa, there is trend of illegal sand mining. Organised crime gangs run this trade and illegally export mineral-rich sands to cater for booming construction industries in China and the Middle East. For example, authorities in Morocco estimate that over half the sand used in construction there is illegally mined. This type of mining is totally unregulated and has led to widespread impacts to coastal areas.

Sediment is also taken from offshore bars and the barriers that accumulate around the mouths of estuaries. This is done to clear a channel for shipping and to gather sediment for sand-replenishment activities, as seen in Figure 6.5.5.

The dredging of sediment disturbs the balance of the sediment budget. By reducing the amount of sediment held in storage, less sand is available to rebuild the beach after major storms.

Blocking sediment flows

The unimpeded flow of sediment is critical to the natural processes that shape the coastal environment. When people alter or block the flow of sediment, the impact on the coastal environment can be significant. It is rare that the movement of sediment is intentionally disturbed or blocked. Instead, it usually results from the construction of 'coastal-management' devices, such as sea walls, groynes and breakwaters. This is often referred to as 'hard engineering' as the devices often work against natural processes.

Blocking the flow of sediment from inland areas to the sea can also have a major impact on the coastal environment. The construction of large dams, for example, can prevent sediment reaching the sea.

Impacts of too much sediment

The amount of sediment in a compartment is a fine balance between having enough for rebuilding after storm damage and having room to store any 'spare' sediment. Human actions usually result in there being too little sediment. However, land clearing and poor management of inland soils can greatly increase sediment inputs and disturb the equilibrium of the sediment budget. When this occurs there can be a range of impacts. Estuaries can become clogged and animal and plant communities can be degraded. Coral reefs and sea grass beds are particularly vulnerable. Sediments can smother sea grass beds and increased turbidity can destroy corals, causing them to die.

SPOTLIGHT

The effects of Iron Gates Dam

The huge Iron Gates Dam stretches across the River Danube on the border of Romania and Serbia. Since its completion in 1972, the dam has had a major impact on the amount of sediment reaching the Black Sea. The dam protects more than 26 000 square kilometres of land from flooding. However, the dam also stops the flow of essential sediments downriver. Instead of being swept out to sea, the sediments are now being trapped behind the dam wall.

The loss of sediment has reduced the ability of coastal landforms to rebuild after storms and has had a significant impact on marine life. The tiny particles of sand washed down by the Danube are the main source of dissolved silicates in sea water (silicate is a glassy or stony component of sand made up primarily of the element silicon). Silicates are essential nutrients for diatoms, single-cell algae that bloom in huge numbers on the sea surface. Diatoms (see Figure 6.5.6) are a critical link in the food chain of the Black Sea. With fewer silicates reaching the Black Sea, the diatoms are being replaced by other species of algae that do not have a silicate requirement. These new algae are poisonous and cannot be eaten by other marine creatures. This has placed the whole ecosystem under stress.

6.5.6 Diatoms form the basis of the Black Sea food chain but rely on silicate washed down in sediments by the Danube River.

Impacts of sea defences

The dynamic nature of the coastal environment does not always fit the needs of people. Constant change and unpredictability in their environment are not desired by people who live on the coast. To overcome this, people have sought to exercise a degree of control over coastal processes. The construction of groynes and sea walls are examples of the methods used to control coastal erosion and manage the movement of sediment.

Groynes

Groynes are rock or concrete structures that are built at right angles to the beach and extend into the littoral zone; that is, the area between high-tide and low-tide levels. In this zone, sediment is moved by longshore drift. The purpose of the groyne is to stop the flow of sediments within or between compartments. They are often used to prevent sand barriers extending across the mouth of a river or harbour. Breakwaters, which are similar to groynes, are used to protect estuaries from storm waves and to prevent the channel from becoming clogged with sediment.

Sea walls

Sea walls, like groynes, are examples of a 'hard' management strategy. They are usually made of concrete or stone and are designed to protect the coastline from erosion, as seen in Figure 6.5.7.

People often build too close to the active zones of the beach: the areas that are subject to constant change. Wave action can undermine these buildings and, in some cases, destroy them.

While sea walls are an effective means of preventing erosion at specific points of the coastline they often have detrimental impacts on the adjacent beach. The main problem is scouring, seen in Figure 6.5.8. Under normal conditions, wave energy dissipates (spreads out or is absorbed) as the wave surges up the beach. When sea walls are present, the surging wave is brought to a stop before it has lost all its energy. The resulting turbulence gouges or scours out the sand at the base of the sea wall. The presence of sea walls make it very difficult for a beach to develop a profile similar to that found under normal conditions.

Sea walls have become a major source of controversy in recent years. Residents and property owners along coastal areas argue that sea walls are needed and should be built and maintained in order to protect their properties. Others have argued that with sea level rise and increases in storm activity due to climate change, building sea walls is not an effective strategy.

6.5.7 Sea walls, like this one in Glenelg in South Australia, are designed to protect coastal areas from erosion.

6.5.8 Scour is evident on this sea wall in Teignmouth on the Devon coast in Southern England where erosion has exposed the foundations of the sea wall.

In Australia, Sydney's Northern Beaches is an area of high vulnerability. Housing, including some significant apartment buildings, were constructed on very active parts of beaches, such as Narrabeen and Collaroy. Sea walls protect some of these buildings but others have been destroyed in storm events, such as the intense east coast low of 2016. A strategy adopted here has been a buyback scheme where authorities purchase at-risk houses as they come onto the market. They then demolish the home and restore the natural dune system.

6.5.9 Palm Island, part of massive land reclamation projects in Dubai

6.5.10 Mandurah, in Western Australia, has more than 22 kilometres of canals carved out of the mud flats and intertidal wetlands of the Peel Inlet and Harvey River.

Impacts of coastal development

More than 3 billion people live within 100 kilometres of the world's coastline, the majority in large cities. Coastal areas are also the most densely visited areas by tourists. The urban development that accompanies this is extensive, which has considerable impacts on the coastal environment. Since coastal areas are so active human engineering, such as sea walls, have been installed to create stability in this dynamic environment.

Land reclamation

In extreme cases humans have even reclaimed land from the sea, destroying coastal ecosystems entirely. Some of these projects are on a vast scale, such as those in Dubai (see Figure 6.5.9), Singapore, Hong Kong and the Netherlands. These types of projects have significant impacts on sediment flows, disturbing natural patterns as well as destroying inshore ecosystems, such as mud flats, mangroves, salt marshes and estuaries.

Canal housing estates are another example of urban development that has significant consequences. These estates are common in low-lying coastal areas and are very popular as they provide water access. The Gold Coast, in southern Queensland, has many of these estates along the Nerang River. These have significantly changed the river's natural flow and destroyed the estuarine system.

A similar situation has emerged in the Western Australian town of Mandurah. As the town's population has boomed to more than 80 000, with predictions this will continue to grow, it has ceased to be the small quiet fishing village it once was. Large shopping malls and housing estates now dominate much of the city, as seen in Figure 6.5.10. There are more than 22 kilometres of canals in the city with more planned. These canals are carved out of the natural intertidal wetland and mud flats that form along the Mandurah Estuary, the river that flows through the city.

Activities

Understanding the text

1. Identify the ways in which people interfere with coastal sediment budgets.
2. Explain how climate change affects sea levels.
3. Outline the impacts of rising sea levels.
4. Describe the impact of climate change on coral reef environments.
5. Explain the link between storm events and climate change.
6. Describe the impact of sand mining on coastal dune ecosystems.
7. Outline the impact that sand dredging has on local sediment budgets.
8. List some of the ways people impede the flow of coastal sediments.
9. Outline the roles of sea defences.
10. Describe the construction and purpose of groynes.
11. Outline the functions that sea walls perform.
12. Explain why sea walls have become necessary in some places.
13. Define, in your own words, the term scour.
14. Explain the link between the construction of sea walls and beach scouring.

Working geographically

15. Write a report describing the impact of climate change on coastal environments.
16. Study Figure 6.5.2. Outline the trend shown in the data.
17. Investigate the long-term impacts of sea level rise on coastal communities, especially those on the small island nations of the Pacific.
18. Prepare a short report on how the construction of Iron Gates Dam has impacted on the coastal environment.
19. Study Figure 6.5.7. Describe the construction of the sea wall and suggest reasons why it was necessary to build the wall at this location.
20. Conduct a class debate on the topic: 'Sea walls should be removed even if it means people lose property.'
21. Using Figures 6.5.9, 6.5.10 and the text, write a report on how urban development can impact on the coastal environment.

CASE STUDY

The Tweed River groynes

The Tweed River is located on the far north coast of New South Wales. The river provides a sheltered port for the area's extensive fishing fleet and a growing number of leisure craft. For many years, longshore drift has resulted in accumulation of large quantities of sand in the mouth of the river. This has caused the river to become shallow and dangerous for the increasing number of boats using the river. In the 1960s, the decision was made to construct two groynes (or breakwaters as they are more commonly known) seen in Figure 6.5.11, to protect the mouth of the river. Once in place, the groynes would ensure that the river mouth remained open and navigable at all times.

6.5.11 Groynes on the Tweed River have reduced the flow of sediment northwards associated with longshore drift.

The NSW Department of Public Works constructed the two groynes, one either side of the river mouth. This effectively extended the river to beyond the littoral zone and thus overcame the problems caused by longshore drift. Sand is now being trapped behind the southern groyne rather than building up in the river mouth.

Along the east coast of Australia, longshore drift moves sand from the south towards the north. The construction of the groynes stopped this movement, starving the beaches to the north of the Tweed River of sand. Experts calculate that the beaches of Coolangatta and Surfers Paradise were deprived of between 5 to 15 million cubic metres of sand in the 20 years following the construction of the groynes.

Isolated from their source of sediment, the beaches of the Gold Coast have been stripped of their sand by storm waves on a number of occasions. Kirra Beach has been among the worst affected. Storm waves have eroded the beach and threatened property. To address the problem, expensive sea defences (including sea walls) have been constructed. These, in turn, have impacted on nearby beaches.

In an effort to artificially maintain the northerly movement of sediment, sand has been dredged from the mouth of the Tweed River and pumped to Kirra Beach in a complex series of pipes using water jets. From there, wave action transports it along the beaches of the Gold Coast. While this provides some temporary relief, the sand remains vulnerable to erosion during storms. Sand pumping is also an expensive process to maintain on a permanent basis.

The example of the Tweed River defences demonstrates the coastal environment's sensitivity to change. The importance of sediment transport, via longshore drift, was not taken into account when this management plan was put in place. Consequently, the beaches to the north have been degraded and attacked by the sea.

Activities

Working geographically

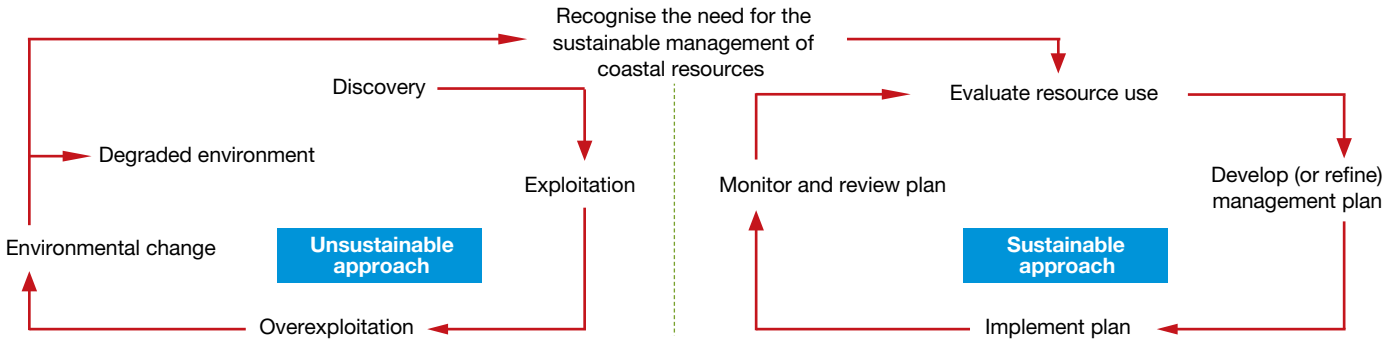
1. Outline the reasons for the construction of the groynes and their impact on the environment. Assess the effectiveness of the management strategies used to reduce these impacts.
2. Construct an annotated photo sketch of Figure 6.5.11.
3. Conduct a class role-play of a Tweed Council meeting about whether to demolish the Tweed River groynes. One group will take the perspective of a Tweed River tourist-boat operator, another a fishing boat captain, a third group the perspective of a surfer and the fourth a rate-payer. Each group should present an argument to the council outlining their perspective on the proposal.

UNIT 6.6

Coastal management and sustainable development

The demands that humans place on coasts are many and varied. Humans rely on coastal areas for settlement, recreation, economic gain and as a buffer against the power of the sea. Effective management of this critically important ecosystem can only occur if its managers have a thorough understanding of the functioning of the ecosystem and the processes that operate within it.

By developing an understanding of coastal processes, environmental managers can adopt strategies that allow humans to make use of the coast but at the same time minimise their impact. The management strategies that are adopted need to be compatible with the principles of sustainable development. When the principles of sustainability are applied, unsustainable practices can also be identified. Plans can then be developed to better manage our environment. Figure 6.6.1 illustrates the sustainable and unsustainable approaches to the use of coastal resources.



6.6.1 Sustainable and unsustainable approaches to coastal management

Sustainable development

Sustainable development is not, in itself, a management strategy; it is a way of thinking about how specific management strategies can be assessed and evaluated. The central idea of sustainability is that the current generation leaves important environmental assets, such as the coastal environment, in at least as good condition as when the current generation inherited them. Of particular importance is the influence that sustainable thinking has on decision-making processes. Economic and environmental decisions can no longer be made in isolation from each other.

Sustainable development involves reassessing the way in which resource, environmental, social and equity issues are addressed in decision-making processes. It requires us to consider the environmental impact of a development proposal before it is allowed to proceed. If the proposal is likely to have a detrimental impact on the environment, and the impact cannot be successfully managed, then it should be modified or abandoned. Translating the principles of sustainable development into actions aimed at improving the long-term management of coastal areas involves careful planning.

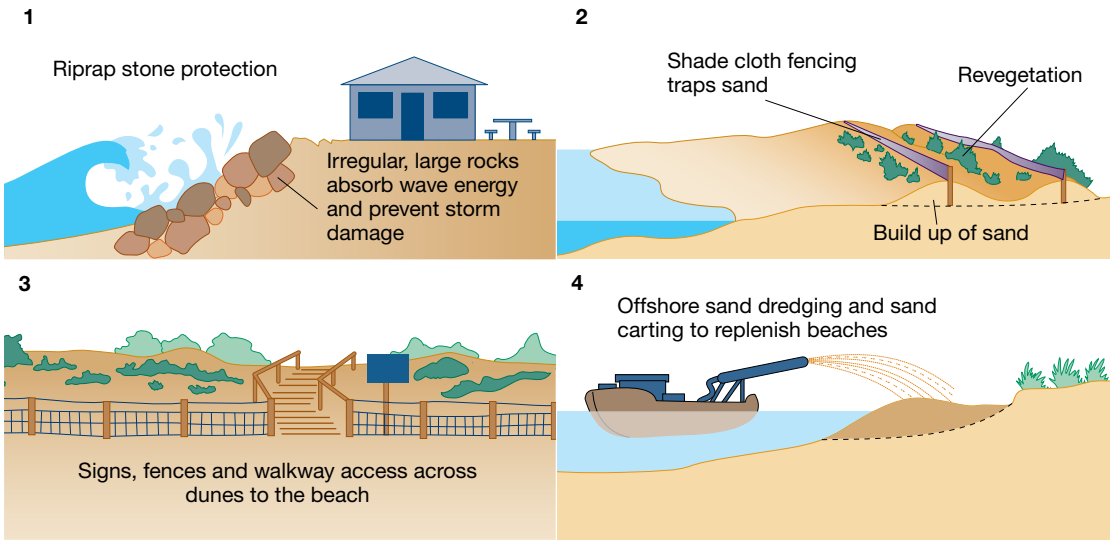
Effective planning can minimise the impact of people on coastal environments. Urban and transport planning can, for example, avoid developments that degrade the coastal environment. Recreational uses of coasts can be organised in a way that does not concentrate the impact on vulnerable parts of the environment. Pollutants can be intercepted and treated before they are able to degrade the coastal environment. Computer modelling can be used to predict the likely impact of a groyne or sea wall on the flow of sediment.

To achieve its objectives, coastal planning needs to involve all the relevant stakeholders in the day-to-day management of coastal areas. These include the local residents, government departments, industrial and recreational users, the fishing industry and tourism operators.

Management strategies

Using advanced technology and scientific processes, new developments in the area of coastal management have emerged in recent years. Figure 6.6.2 summarises some of these strategies. These have enabled authorities to better manage the coastal environment and repair some of the damage caused by poor management practices in the past. Some of these (structural) developments are outlined below.

The best way to manage our coastal environments is to lessen the impacts that humans have on them. This involves reducing the level of development in coastal areas, particularly on dune fields. By leaving this natural buffer in place we greatly reduce the need for expensive engineering solutions. Such an approach requires the adoption of land use zoning regulations that control urban development in coastal areas.



6.6.2 Various approaches to coastal management

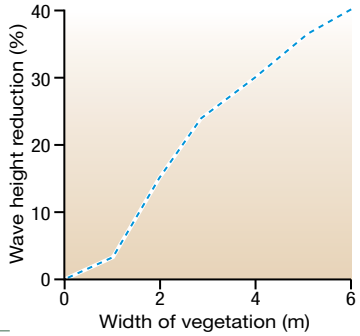
Honeycomb sea walls

The major problem associated with sea walls is the reflection of wave energy, leading to an increase in scour. Honeycomb walls offer a solution to this problem because they allow wave energy to dissipate. As seen in Figure 6.6.3, these walls are built from interlocking cellular blocks. The holes in the middle of the blocks are filled with sand, and pioneer grasses are encouraged to take root. The vegetation binds the sand together, reducing the effects of aeolian (wind-related) erosion and trapping wind-blown sands. This replicates a sand dune, and the concrete blocks also act as a defence against severe wave erosion.

6.6.3 Honeycomb sea walls, like this one in Cronulla in Sydney's south, reduce scour by absorbing wave energy rather than reflecting it.

Using plants to reduce wave energy

When reed-like plants are grown in shallow waters near the beach they significantly reduce the erosive power of waves. The stems of the plants are a source of frictional drag, which reduces the water's velocity. The roots of the reeds give strength to sediment structures. Figure 6.6.4 demonstrates the effect that vegetation can have on wave height. Given that the height of a wave bears a direct relationship to its erosive power, any reduction in wave height will result in reduced rates of erosion. When mangroves are used, the power of waves is reduced even further. This is another reason why it is vital to protect mangrove ecosystems.



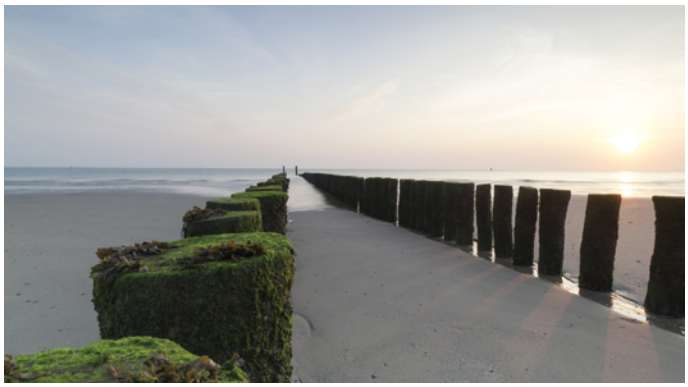
6.6.4 The relationship between vegetation and wave height

Wave breakers

Wave breakers are designed to reduce the power of waves by creating friction and slowing the flow of water. They can take the form of large concrete structures, timber posts laid on the shoreline (see Figure 6.6.5) or, in extreme cases, rocks placed inside a wire mesh and placed in the shallows.

Dune-protection methods

Dunes are vital components of coastal ecosystems. They are also one of the most fragile parts of these ecosystems. Beach users can easily damage dunes by trampling (walking over) their sand-binding vegetation. By fencing off the dunes, people can be funnelled onto specially constructed pathways. This greatly reduces the amount of disturbance (see Figure 6.6.6). Well-vegetated dunes reduce the rate of erosion and increase the level of coastal protection.



6.6.5 This wave breaker on the Dutch coast uses a simple wooden post construction to reduce the velocity of waves.

6.6.6 Fencing dunes helps to protect the fragile vegetation that stabilises the dune system from being trampled.

Activities

Understanding the text

1 Explain why it is so important we understand coastal processes in terms of management of coasts.

2 Outline the concept of sustainable development.

3 Explain how honeycomb sea walls differ from the more conventional types of sea walls. Why are honeycomb sea walls effective in reducing beach scouring?

4 Describe how wave breakers reduce the power of waves.

5 Outline strategies for protecting dune systems.

Working geographically

6 Write a newspaper editorial explaining why coastal managers need to have a thorough understanding of coastal processes in order to correctly manage the coastal environment.

7 Study Figure 6.6.1. Write a report outlining sustainable and unsustainable approaches to the use of coastal resources.

8 Study Figure 6.6.2. Select one of the management strategies shown. Using the internet, conduct research into this strategy. Prepare a short digital presentation on the purpose of the strategy and its advantages and disadvantages.

9 Using Figure 6.6.4, write a paragraph describing the relationship between wave height and the width of vegetation.

10 Consider the following scenario on coastal management, then complete the task.

Background: You are now a coastal management expert. The Jackson Shire Council has asked you to prepare a report on the best ways to manage Golden Beach.

- The beach is heavily developed, with high-rise apartments and hotels built on the foredune area. The parallel dunes have been destroyed, except for a small section. This section is privately owned by a company whose main activity is the development of shopping centres.
- About 10 years ago, in response to repeated requests by local property owners, the local council constructed a sea wall. The wall has increased scouring along most of the beach.
- A sand-replenishment program was developed to replace the disappearing sand. A groyne has been built at the southern end to protect a private marina. This has further reduced the supply of sediment.

Task: With your knowledge of coastal processes and the latest coastal management strategies (both structural and non-structural), develop a long-term plan for the protection of this beach.

Exam-style questions

Extended responses

- Explain the biophysical processes that shape the coastal environment.
- With reference to a coastal environment you have studied, describe the interactions between the four components of the biophysical environment.
- Explain how an understanding of biophysical processes contributes to the sustainable management of the coastal environment.
- Analyse the impact of human activities on the coastal environment.
- Write an extended response on the management of coastal sediments. Include the following in your answer:
  - Identify and explain the key biophysical processes related to the origin, transportation and deposition of coastal sediments.
  - Outline how the activities of people can disrupt coastal sediment budgets.
  - Evaluate the strategies used to manage coastal sediments.

Glossary

coastal dunes the deposits of wind-blown sand that accumulate behind a beach

coastal environment an area extending as far inland as the salt water, sea spray and wind-blown sands reach, and into the ocean as far as waves and currents are able to move material on the sea bed

coastal resources the natural and cultural resources of the coastal environment

coastal sediment budget the amount of sediment available for beach construction; it is determined by deducting sediment outputs from sediment inputs

coastline the boundary between the land and the sea; the coastline's landward limit is normally determined by the reach of storm waves

constructive waves flat waves with low levels of energy that bring sediment from offshore stores onto the coastline

currents the flow or movement of a large body of water in an ocean, caused mainly by prevailing winds, the earth's rotation and the distribution of land masses

destructive waves steep waves with high levels of energy that cause coastal landforms to be eroded

foredune the coastal dune or line of dunes nearest the sea that usually are eroded by storm waves and later rebuilt by further wind deposits of sand

foreshore the land lying between the high-water mark and the low-water mark; the area covered and uncovered by the ebb and flow of the tide

groyne a rock or concrete wall built at right angles to the beach to obstruct the drift of sediment or to minimise beach erosion

longshore drift the movement of sediment by currents running parallel to a beach

sea wall rock and concrete structure commonly built at the foot of the foredune; it is designed to protect property from coastal erosion

sediment sand and small rock particles or silt created by the erosion of rock structures along coasts or in inland areas

swash the upward surge of water that moves up a beach slope when breakers crash onto the shore

swell ocean waves that spread out from their area of origin; their wavelength increases and their height decreases as they travel

tides the rise and fall of the sea twice a day, primarily associated with the gravitational pull of the moon as it orbits the earth

waves caused by the frictional drag of wind blowing over a body of water, the formation of waves involves the transfer of energy from the wind to the surface of the body of water

CHAPTER

7 Catchments and river regulation

Rivers are the veins that carry life-sustaining water across the landscape. They play a crucial role in the water cycle, and human society relies on them to provide our water needs.

Many of the world's rivers show signs of degradation. Excessive water extraction, regulation of water through dams, land clearing and salinity all threaten the availability and quality of the world's water resources. Nowhere are these stresses more apparent than in the catchment of the Murray River—Australia's largest and most important river system.

The Murray is the lifeblood of Australia's farming country, and flows from its headwaters in the Snowy Mountains to the Southern Ocean. Today it is a river in crisis. Climate change and a prolonged drought, combined with excessive water withdrawals and salinity, have taken a heavy toll on the river's ecosystem.

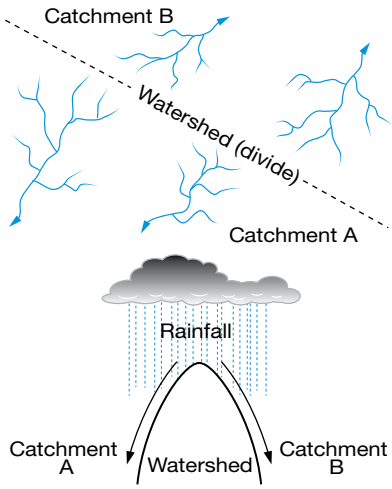
This chapter focuses on catchments and river regulation, including an understanding of how biophysical processes contribute to the sustainable management of such environments. The River Murray is examined in detail.

> **To put your hands in a river is to feel the cords that bind the earth together.**
>
> **Barry Lopez, US author and environmentalist**

7.0.1 The Murray River—Australia's largest river system

UNIT 7.1

River catchments and functions



7.1.1 Two river catchments and the watershed that divides them

River catchments are separated by a ridge of land called a watershed; when rain falls at higher points in the natural landscape it is divided between two river systems. The watershed marks the boundary between river catchments, as shown in Figure 7.1.1. Rivers are generally fed by a network of smaller rivers or streams and these are called tributaries. An example of such a catchment is the Murray–Darling catchment, which covers more than 1 million square kilometres.

A catchment can be described as an open system. It forms part of the hydrological or water cycle. When a catchment is viewed as a system it is characterised by:

- inputs—precipitation (mainly rain and snow)
- outputs—water is lost from the system to the sea or through evaporation, transpiration (from plants) or human use.

Within the system some of the water is stored, either in lakes or in the soil, or it passes through a series of transfers. For example, it infiltrates and becomes part of the groundwater or it passes into another catchment, in a process known as throughflow. The system is more than a flow of water, it also transports nutrients, soil and organic material. As such, rivers have a crucial function in transforming the lithosphere and biosphere and should be seen as more than just systems of the hydrosphere.

7.1.2 Rivers play a key role in the hydrological cycle.

Hydrological functions

Rivers are drainage systems that transport water (under the influence of gravity) from higher points to lower points of the topography; see Figure 7.1.2. The systems are generally fed by precipitation.

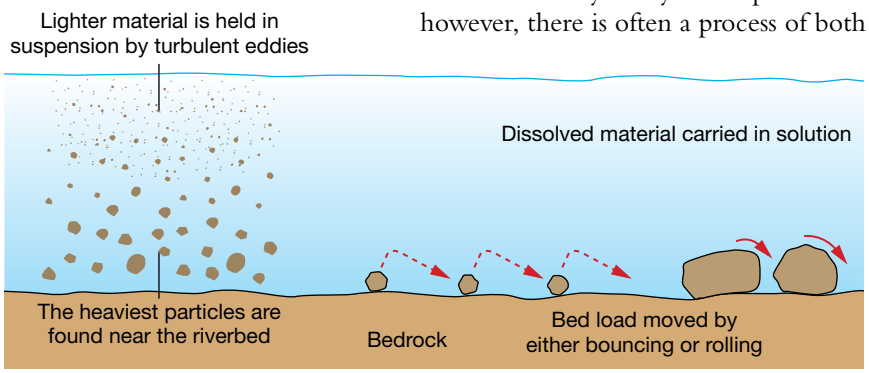
River systems do not always drain into the oceans; some rivers drain into lakes (such as Lake Eyre in South Australia) or inland seas, where the water is lost through evaporation. The water flow in unregulated rivers—those without dams or weirs—responds directly to precipitation in the catchment; although, there may be considerable rainfall without run-off reaching the rivers.

Geomorphic functions

River systems transport many materials, either as solids or in solution. In effect, rivers are part of the mechanism that moves and redistributes the products of the weathering that breaks down the catchment's landform features. With the appropriate river channel and flow characteristics, a river is able to move substantial-sized boulders.

Unless the flows are particularly rapid, most objects larger than small pebbles tend to be carried along the riverbed. As Figure 7.1.3 demonstrates, it is the finer materials (the sands, silts and clays) that are suspended and carried in the turbulent waters.

On its way downstream, the river water and the material carried in it erode the riverbed and banks. Only rocky outcrops resist the action of a river. For the banks and gravel beds, however, there is often a process of both erosion and deposition. Even with this general downstream movement of material through the system, most of the river features often remain relatively static. However, too much supply may create excess deposits that raise the riverbed or banks; too little supply may lead to erosion with inadequate replenishment.



7.1.3 The process of sediment transport by rivers

Sand, being a coarser material, generally stays within the river channel, where it is suspended by the faster-flowing water. Provided it is not obstructed in its path, the sand may eventually pass from the river system to the coastal zone and nourish the beaches, while silts and clays may eventually reach the ocean. As a river moves across the flatter coastal plain it loses velocity and often branches out to form vast river deltas, such as the Nile Delta (see Figure 7.1.4). Sediments can also be carried away from the river channel and deposited onto floodplains in times of flood.

Not all processes involving river flow and movement of materials are in equilibrium or balance. Periodically, the geometry of the river becomes unbalanced and the course takes a different path. The landform features remaining after this redirection of flow are known as relict features.

Ecological and scientific functions

Rivers are described as linear ecosystems because many life forms depend on life-supporting materials passing through their habitat. Major changes to the river environment may threaten the more sensitive plants and animals. Modification of their habitat may jeopardise their ability to reproduce or to seek shelter from predators. In addition, a native aquatic species may be displaced by the entry of another competitor in the food web; that is, an introduced species.

The aquatic ecosystem performs a crucial function in terms of the health of the river itself. A balanced system will help maintain good water quality, this is known as an environmental service (see Figure 7.1.5). If all natural checks and balances are maintained, the chance of devastating ecological problems, such as algal blooms, will be minimised. The aquatic ecosystem has a certain degree of resilience and can, to some extent, adapt to change and adjust to long-term environmental trends. However, rapid alterations can upset the balance and lead to irreparable river degradation. Occasionally, natural events bring about substantial changes, yet it is the human impacts that almost always represent the key factor responsible for the stress threatening the health of river systems.

Value to humans

Rivers are particularly important in an economic sense. People rely on them for watering stock, irrigation, domestic and industrial water supplies, hydro-electric power, commercial fishing and river transport. They are also a source of sand and gravel for building and construction. Rivers also offer considerable recreational opportunities. In some locations they are sites of cultural significance, particularly to Aboriginal and Torres Strait Islander people. The Ganges River has spiritual significance and is considered holy for India's vast Hindu population.

7.1.4 The Nile River Delta in Egypt

7.1.5 Freshwater wetlands perform an important environmental service in cleaning water as well as providing habitat.

Activities

Understanding the text

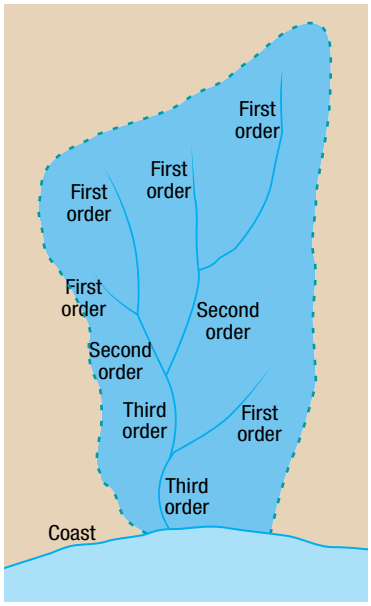
1. Define the term river catchment. How are the boundaries of a catchment determined?
2. Explain why a catchment can be described as an 'open system'.
3. Outline the hydrological functions of rivers.
4. Outline the geomorphic functions of rivers.
5. Explain what happens to the sediment carried by rivers.
6. Explain why rivers are described as 'linear ecosystems'.
7. Outline the ecological functions of rivers.

Working geographically

8. Develop an annotated flowchart that shows rivers as an open system.
9. Study Figure 7.1.3. Write a report outlining the processes by which sediments are transported by rivers.

UNIT 7.2

Nature and characteristics of rivers



7.2.1 Stream order

Virtually all river systems are comprised of a network of tributaries occurring in a hierarchical system or stream order, as shown in Figure 7.2.1. When managing river systems it is important to consider that all these watercourses are interconnected.

There are three relatively stable factors that influence the character of a river. These are the climate, the geology (the nature of the earth's crust) and the morphology, or shape, of the river basin.

Climate

The primary function of the river is to transport catchment run-off to a lower point in the topography. Obviously the climate, in particular precipitation and temperature, has a major bearing on the volume of water flowing directly from the catchment to the river channel.

Higher temperatures increase the rate of evaporation during and following rainfall and so reduce run-off. Under cold conditions, precipitation reaching the surface as snow has the potential to accumulate and does not provide substantial run-off until it melts. For catchments originating in cold alpine regions (see Figure 7.2.2), the winter accumulation of snow and the subsequent spring thaw results in a marked seasonal flow regime in the river.

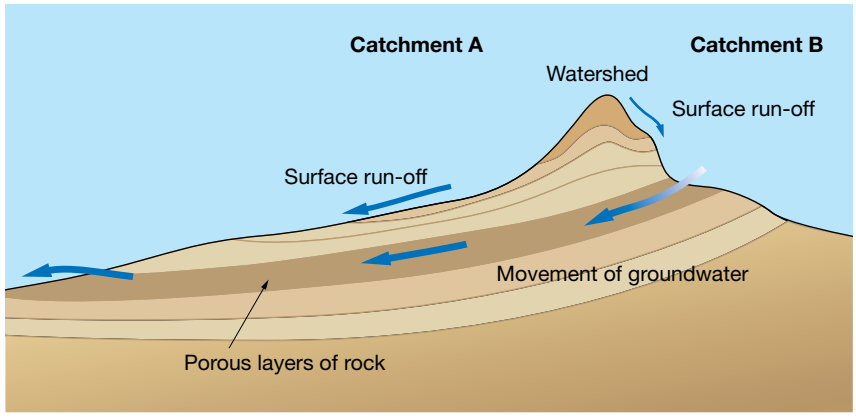
Geology

The geology of the catchment affects the nature of a river in two important ways. The nature of the soil produced as a result of weathering and deposition reflects the parent material from which it has derived. Therefore, the degree of infiltration (movement of water though the soil's surface) and the nature and amount of sediment yield will be very much a function of the geology. Sandstone-dominated landscapes, for example, produce very porous, sandy soils. Erosion of these soils contributes sand to the river system. The geology will also strongly influence the river channel pattern, either by encouraging the channels to follow fault lines or by encouraging the river to flow through channels that have eroded into weaker rock types.

Although not generally observable in the short term, unless due to earthquakes, tectonic activity can have a major bearing on the paths of rivers. If a plateau is uplifted, river gradients can be modified, causing flow reversals and river capture (the diversion of one river into the channel of another). Volcanic activity may also obstruct river channels and cause a diversion or form a lake.

Figure 7.2.3 shows how the underlying geology of a region can divert water from one catchment into another. Figure 7.2.4 shows the impact of geology on drainage patterns.

7.2.2 The flow of alpine rivers is highly variable, based on climatic conditions. During the spring thaw, flows are at their highest, fed by melting snow and ice.



7.2.3 The relationship between the lithosphere and river systems—in this instance, precipitation falling in Catchment B does not flow to Catchment A and is lost as a result of the porous underlying rock.

River basin morphology

The size, shape and gradient (slope) of the catchment basin will have a considerable bearing on the discharge rate of the river (see Figures 7.2.5 and 7.2.6). Obviously, large catchments will tend to discharge more water, and over a longer period, than smaller ones. A steeper gradient will also cause water to drain more rapidly.

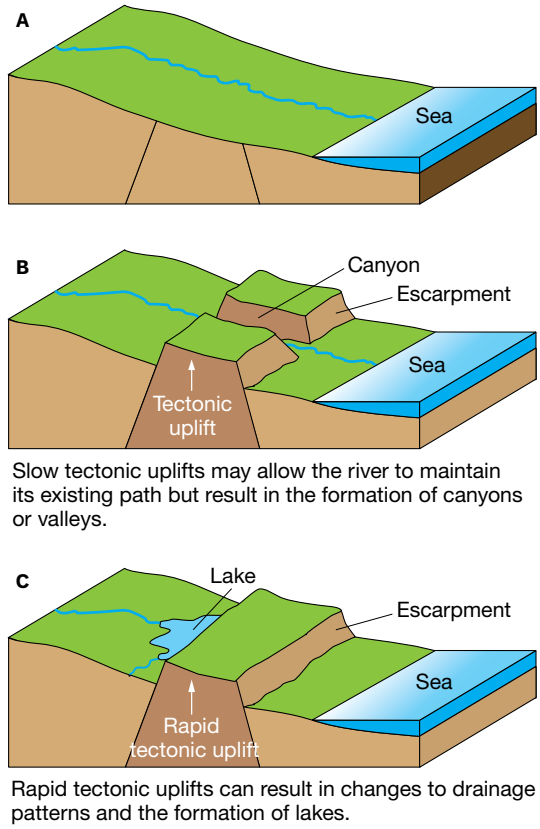
Catchment soils and vegetation

Both the nature of the soils and the vegetative cover of catchments will influence the volume and rate of run-off. If soils are sandy, much of the water will infiltrate the soils. The presence of dense ground-cover vegetation will also increase infiltration. In contrast, impermeable clay-rich soils with little vegetation cover, or soils saturated from previous rainfall, will yield the most run-off and the highest flood peaks.

Water that infiltrates the soil may be added to the groundwater, which may slowly flow into the river system. Due to the delay in the passage of this water, this provides a more constant base flow in the river. This will be examined in more detail later in this unit.

Depending on soil type and extent of vegetation cover, heavy rains will cause sediment and organic matter to be washed into rivers. Thus, the water quality in the river is dependent on the conditions and land management in the catchment area. It is also obvious that run-off can include nutrients and pesticides that have been used in agricultural activities in the catchment.

The most efficient channel shape is deep and almost semicircular, with smooth channel beds and banks that have minimal obstructions. Engineers employ these principles in designing stormwater channels. (See Figure 7.2.7.) Such channels are particularly important in urban areas where there is a lot of impermeable ground cover (concrete and asphalt). In such an area, unless there is a well-designed network of drains and stormwater channels, local flooding will be common. Of course, if the drains are efficient in removing local water, the problem of flooding does not disappear. Instead, it is simply transferred downstream where it may become someone else's problem.



7.2.4 Possible impacts of geological processes on river systems

7.2.5 The Cononaco River in Ecuador flows gently across flat terrain, leading to this meandering shape.

7.2.6 Fed by glaciers in the mountains of Alberta, Canada, the Kootenay River is fast flowing.

7.2.7 Stormwater drains mimic the ideal shape of a river channel for carrying water.

The terminology of rivers

Discharge

Discharge is the amount of water that flows from the catchment into another river system, the sea or a lake. Discharge (Q) is calculated by multiplying the mean stream velocity (V) by the cross-sectional area (A); that is, $Q = A \times V$. It is expressed as cubic metres per second.

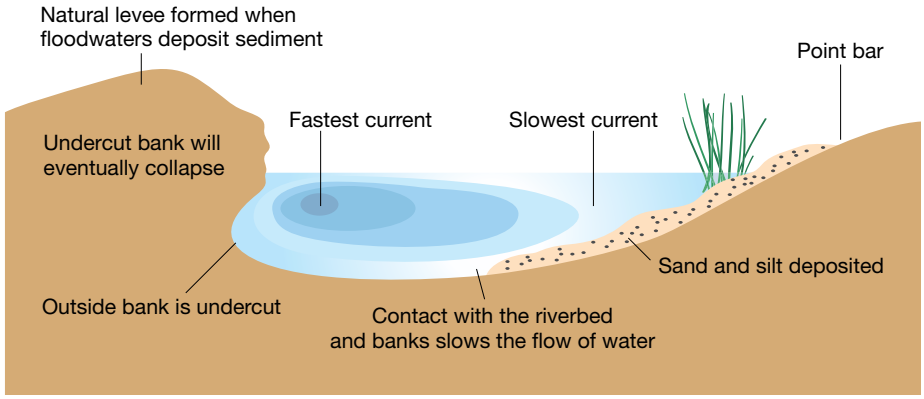
Within a catchment-based river system, discharge (including materials carried by water) is a function of eight major factors: inputs, vegetation, slope, drainage texture, infiltration, groundwater, sediment and nutrient yield.

Stream velocity

Stream velocity is the speed at which water flows within its channel. Figure 7.2.8 outlines some of the factors that affect the velocity of water in a river. Stream velocity is also influenced by the following factors:

- **The shape of the channel:** The speed of flow is faster in channels that are as deep as they are wide compared with channels that are wide but very shallow or very deep and narrow.
- **The roughness of the channel's bed and banks:** Water flowing through a channel full of large rocks is more turbulent but slower than water flowing through a channel lined with fine silt.
- **The gradient, or slope, of the river:** In general, the steeper the downward slope, the faster the river will flow. Often, however, other factors combine with gradient to impact on velocity. As a river approaches the sea, for example, its gradient decreases. However, because the channel is deeper, the velocity of the river actually increases.

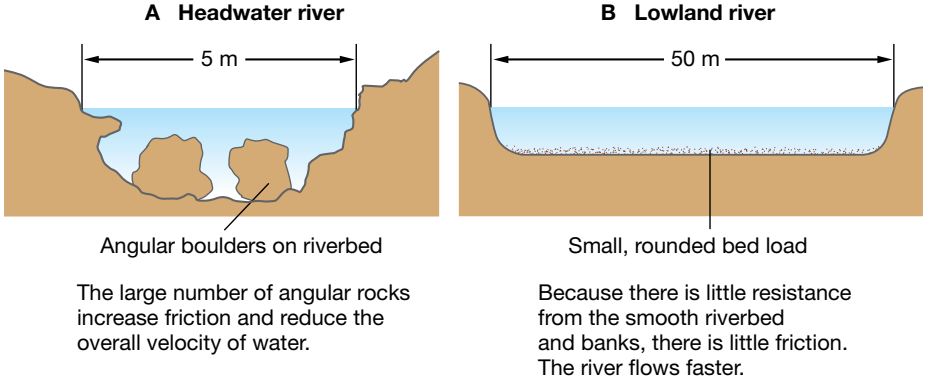
The velocity of water within a river channel can vary. Figure 7.2.9 A shows the headwater (the beginning) of a river where slowest flow occurs due to the water coming into contact with the riverbed and banks. Figure 7.2.9 B shows the lowland (near the mouth of a river) where the flow is the quickest.



7.2.8 Water velocity in the cross-section of a river

Stream capacity

This refers to the ability of a river to transport its load. It is expressed as the amount of sediment that can be moved past a particular point over a specified period of time. Stream capacity increases as sediment size within the channel decreases, and as stream discharge increases.

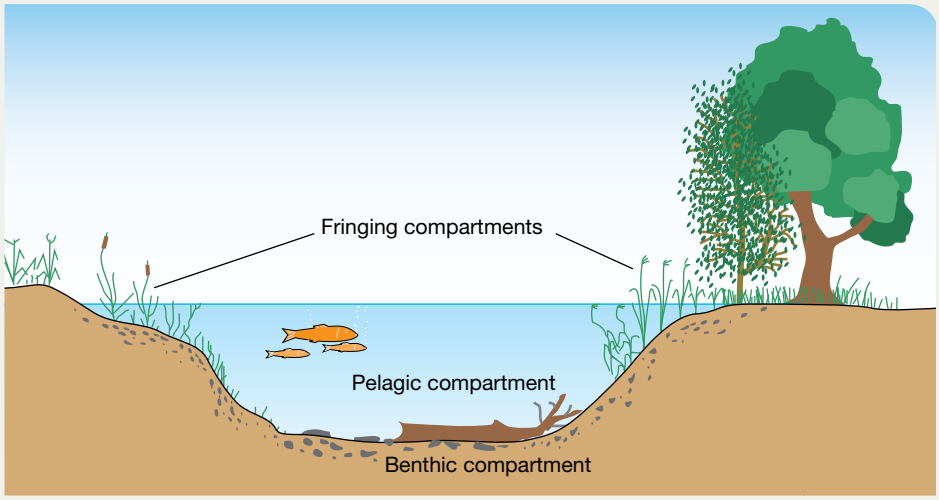


7.2.9 The velocity of flow changes as it approaches the mouth of a river.

SPOTLIGHT

Aquatic ecosystems

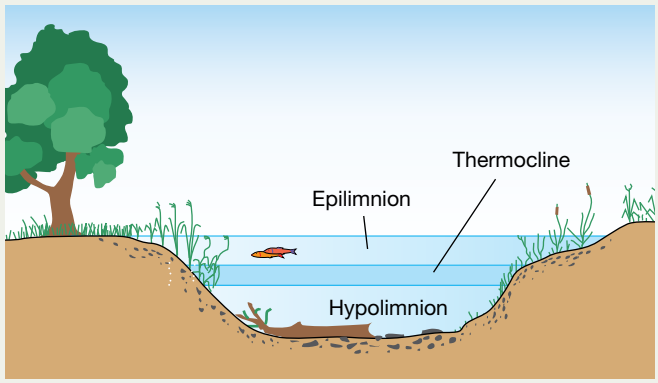
The stream banks and beds are more than just the physical boundaries of the river channel; they are part of the aquatic ecosystem. A simple classification of riverine compartments is shown in Figure 7.2.10. In many ways there is an interrelationship between the compartments: the fringing compartments provide shade and shelter; the pelagic compartment provides the area for fish and other organisms to swim or drift; and the benthic zone provides a source of food for fish and waterbirds.



7.2.10 Cross-section showing the major compartments of a typical river

The velocity of the river flow has a very strong influence on the characteristics of the aquatic zone. Slower-moving waters, or lentic environments, will have greater amounts of debris along the riverbed, which will be silty or muddy. By comparison, lotic environments, with faster flows, will have less fine sediment on the riverbed and be relatively clear of debris. The more turbulent flow in lotic environments will also ensure a greater degree of mixing, giving a more even water temperature and ensuring good oxygenation of the river to some depth. Slow-moving rivers, lagoons and billabongs do not experience similar mixing, unless put in motion by strong winds.

Particularly in the summer, the upper layer of water is heated by the sun. This causes a layering, or thermal stratification, to develop (see Figure 7.2.11). In deeper waters of 5 or 6 metres and more, the epilimnion (surface layer) becomes less dense through warming. It remains floating over the cooler, dense hypolimnion, with the thermocline separating the two. Even when wind moves the surface, provided the resultant turbulence is not excessive, the epilimnion will continue to circulate independently. The stratification restricts the degree of oxygenation in the hypolimnion. The anaerobic (oxygen-free) conditions can cause the production of elements that are toxic to some living organisms. The problem is greatly exacerbated when there is a large amount of decaying river material with a high biochemical oxygen demand (BOD). Many fish and other marine life cannot exist in these stressed conditions.



7.2.11 Thermal stratification in a slow-moving river

Due to the flow velocity, lotic environments are less likely than lentic environments to have a wealth of benthic (riverbed dwelling) organisms. Nor will they include the single-celled floating plants, the phytoplankton or algae. These are more likely to be found in lentic systems and form the basis of a distinctly different food web. Due to the greater diversity of conditions in a lentic environment, a greater range of organisms will flourish there. Although, as indicated above, some compartments may not be suitable for some biota.

SKILLS BUILDER

Investigating rivers through fieldwork

Measure the discharge of a river

A simple way to assess the flow of water in a small creek is to measure the rate at which a barely floating object, such as an orange, moves down a measured distance of the channel. Here are the basic steps:

1. Locate a relatively straight section of creek about 10 to 20 metres long.
2. Mark the beginning and end of the channel, measure the length and mark the mid-point.
3. By measuring the depth of the cross-section of the channel (at, say, intervals of 1 or 2 metres), calculate the area of the cross-section at each end and at the middle. Calculate the average cross-section in square metres (see Figures 7.2.12 and 7.2.13).
4. By multiplying the cross-section by the length of the channel being used, calculate the stream volume over that section in cubic metres.
5. Release an orange at, say, five equally spaced points across the stream. Calculate the average time, in seconds, for the orange to pass from the upstream to the downstream limits of the channel.
6. Now, you can calculate the discharge because you know the volume of the water in the channel and the time taken for that water to move downstream. Use the following formula.

   Discharge = [volume (m^3)/time (seconds)] = m^3/second

Note: This method provides an approximation only because the floating objects may not follow direct paths downstream.

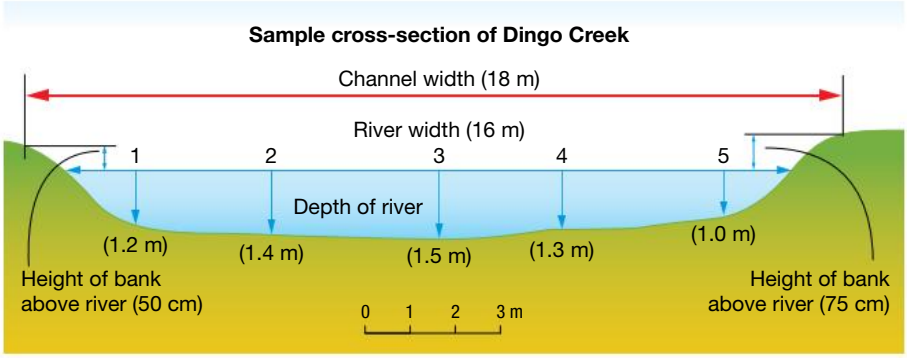
Investigate river sediment load

1. Should the opportunity arise where rapidly flowing water carrying heavy sediment can be safely collected, collect several 1 litre samples of water in a turbulent part of the stream (see Figure 7.2.14). Also collect several 1 litre samples from a more sluggish part of the same stream.
2. Shaking the water first, pour the samples into 1 litre measuring cylinders and allow the sediment to settle. Are there differences in the amount and type (colour and size) of sediment? What would you expect to see?
3. Let the samples stand for a couple of days until most of the sediment has settled.
4. Carefully drain off the water, collect the sediment and let it dry.
5. After weighing the sediment, you are in a position to calculate the mass of suspended sediment per unit volume of water. If you could measure the run-off, you could then estimate the total mass of sediment being removed.

Investigate the relative proportions of sand, silt and clay found in a soil

1. Collect three or four 200 gram samples of soil, and place each in a container. Preferably, one of your samples will be sandy and one will have more clay.
2. Break down the soil into small clods. Then, to each sample, add a heaped teaspoon of Calgon (or an equivalent water softener) and add about 500 millilitres of water. Allow the samples to soak for a few minutes.
3. After the samples have soaked for five to 10 minutes, stir them until they have broken down.
4. Pour the samples into 1 litre measuring cylinders. Top up the solution to the 1 litre mark. Carefully, invert the cylinders a few times and then stand them upright. Note the time each cylinder is left to stand.
5. Measure the depth of sediment that has settled after periods of five minutes, two hours and several days. These measurements will provide a rough indication of the relative proportions of sand, silt and clay in the soil.

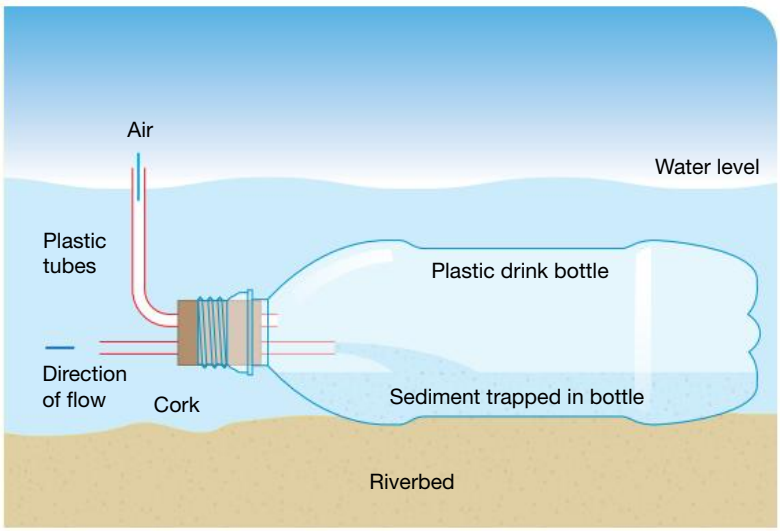
   Note: More precise methods using hydrometers may be found in some texts on soils.



7.2.12 Sample cross-section

Width of channel (bank to bank)	18 metres					
Average width of river	16 metres					
Height of bank above the river	Left side: 50 centimetres			Right side: 75 centimetres		
Depth of river		Left bank				Right bank
	Reading	1	2	3	4	5
	Depth	1.2 m	1.4 m	1.5 m	1.3 m	1.0 m

7.2.13 Data sample for a cross-section



7.2.14 Sediment sampler

Investigate the river bed

1 Choose a section of a river where you can study one complete meander loop.

2 Study the bed of the river and identify the deep pools and shallow riffles. Describe the nature of the streamflow in the pools and over the riffles. (Is it turbulent or laminar?) As energy is lost through friction, what part of the meander loop will experience most erosion?

3 Draw a sketch of the meander loop, labelling the pools and riffles, and the direction of streamflow. Identify sites of erosion and deposition.

4 Observe the bend in the meander loop and draw a profile across the river channel. Label the undercut bank and the point bar deposits.

5 How would you expect the position of the river channel to change in the future?

Investigate the river banks

1 Study the banks of the channels of your local creek.

2 Look for the layers of muds (the deposits of fine material from suspension) and sands and gravels (the deposits of bed load).

3 When there is little evidence of deposition try to identify those parts of the stream profile where some deposition occurs. This would include those parts of the channel where stream velocity decreases and deposition is most likely. Draw an aerial view of the channel, labelling the areas of deposition.

4 Work out the sequence of deposits; that is, the layers of silt. These become progressively finer upwards, often with a sharp break at their base. Such sequences are usually the product of a single storm or a flood. As the flood recedes, the movement of the bed load will cease first. Then the finer suspended material will settle.

5 Draw a profile of the bank, labelling the different layers of deposits.

6 Collect past rainfall data for the catchment. Report on any correlation you can make between these data and recent deposits.

Activities

Understanding the text

1 Outline the major factors that influence the nature of rivers.

2 Describe the impact of climate on the nature of rivers.

3 Explain the effect of geology on river systems.

4 Describe the relationship between soils and river flow.

5 Define the term river discharge.

6 Explain the concept of stream velocity.

7 List the factors affecting stream velocity.

8 Define thermal stratification. How does it impact on rivers?

Working geographically

9 Study Figure 7.2.1. Write a paragraph explaining the concept of stream order.

10 Examine Figure 7.2.3. Write a brief report describing the impact of tectonic processes on the rivers shown in Catchment A and Catchment B.

11 Study Figure 7.2.8. Describe how velocity changes across the cross-section of a river.

12 Use Figure 7.2.10 and the information contained in the Spotlight box on river ecology to prepare a short report on the nature of the ecology of river systems.

13 Describe the functions of the fringing, pelagic and benthic compartments.

14 Distinguish between lentic and lotic environments.

15 Outline the conditions under which toxic elements are produced in slow-moving rivers, lagoons and billabongs. What impact do they have on fish and other marine life?

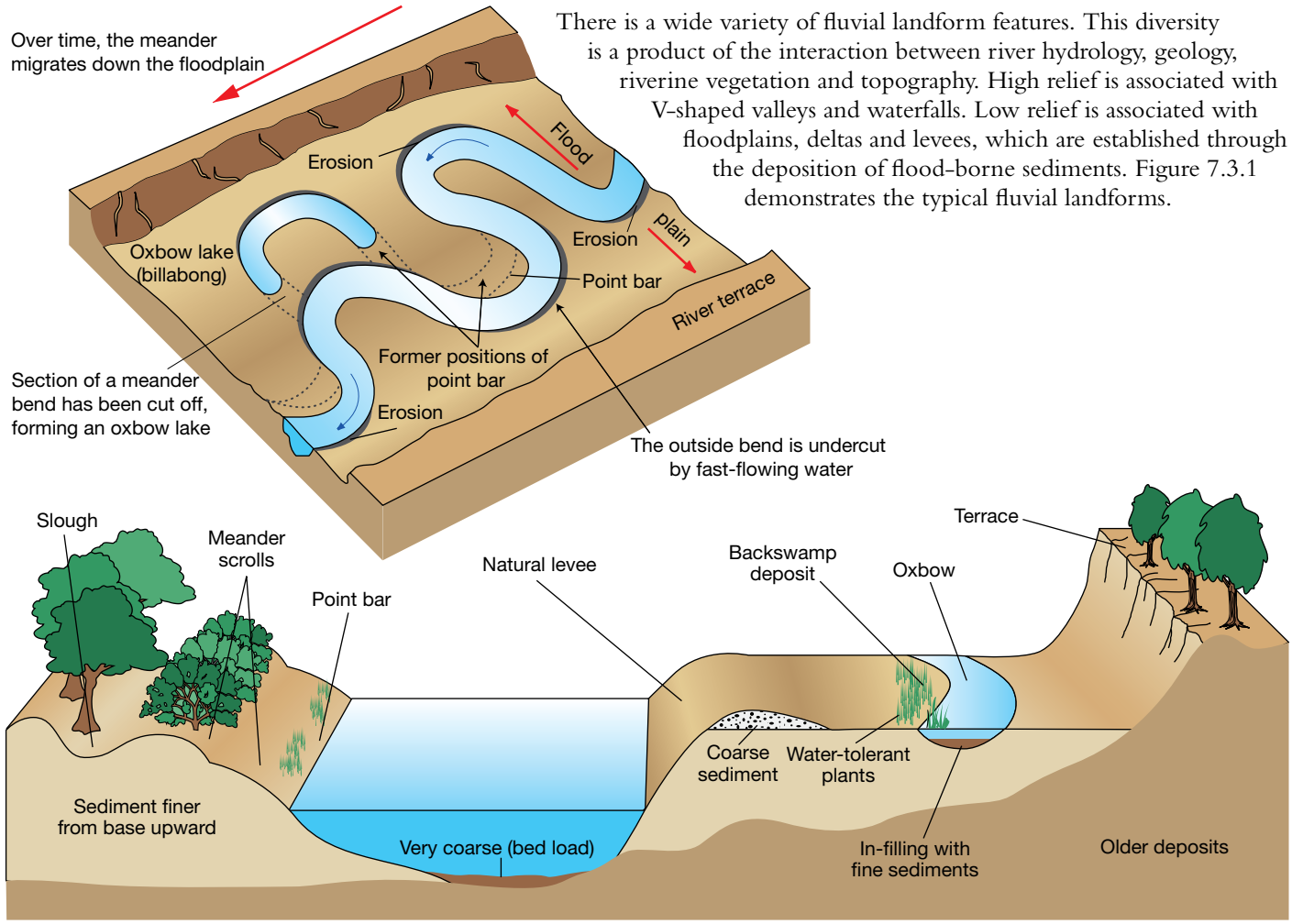
16 In a relatively natural outdoor setting, trace the path of overland flow via identifiable rills and rivulets. If possible, photograph the path taken by water in several situations for the purposes of comparison. Write a brief report describing your observations with an explanation of possible reasons. If few signs of the path of water are evident, write a paragraph or two about likely reasons why this may be so.

17 Divide the class into small groups. Each group conducts research into a different river. Compile a list of the uses of the chosen river. Present your findings to the class.

UNIT 7.3

Fluvial landforms

There is a wide variety of fluvial landform features. This diversity is a product of the interaction between river hydrology, geology, riverine vegetation and topography. High relief is associated with V-shaped valleys and waterfalls. Low relief is associated with floodplains, deltas and levees, which are established through the deposition of flood-borne sediments. Figure 7.3.1 demonstrates the typical fluvial landforms.



7.3.1 Typical fluvial landforms

Braiding

When a river becomes choked with sediments it will divide into a series of diverging and converging channels. The 'islands' are known as eyots and each channel is referred to as an anabranch. Braided channels are common in regions with relatively short periods of high discharge and heavy bed loads, such as alpine and semi-arid areas (see Figure 7.3.2) and in high alpine rivers where glaciers have created considerable debris fields. For example, there are many braided rivers found on New Zealand's South Island.

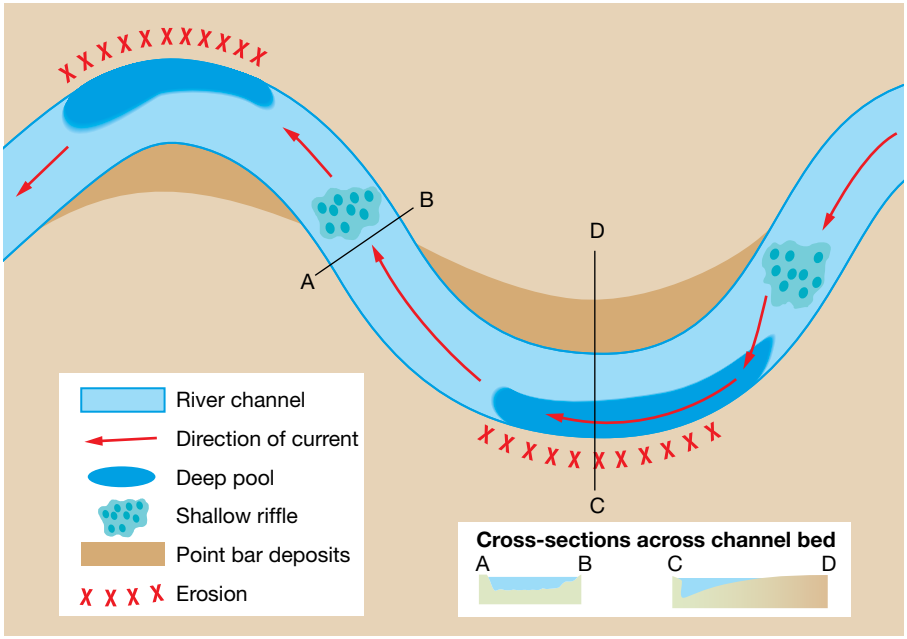
7.3.2 A braided river channel

Meanders

A widely recognisable feature of rivers is the development of meanders, which are the repeated curves of the river channel. Meanders are best developed where rivers flow at low gradients through the alluvial deposits in the middle and lower reaches of a river system. It was once thought that obstructions, such as fallen logs and large rocks, diverted the river channel. However, laboratory testing designed to recreate the flow of water in river channels revealed that, even on the smoothest surface, water followed an irregular wave-like pattern of flow.

This pattern is shown in Figure 7.3.3. The development of an alternating deep pool and shallow riffle sequence in the river channel is now regarded as being responsible for the deflection of the water within the river channel and for the development of meanders.

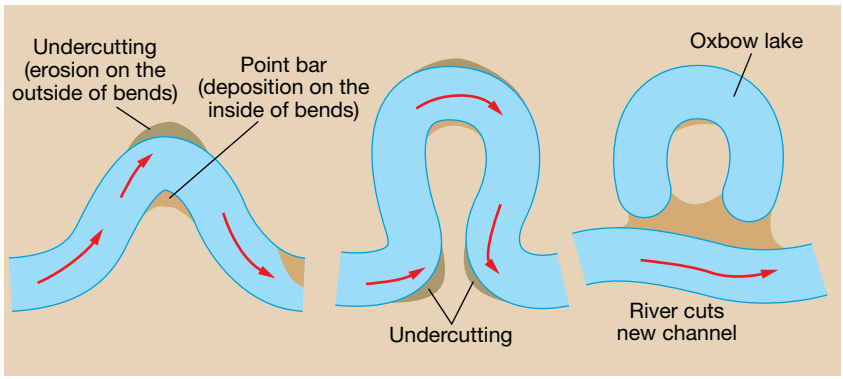
As water travels through a riffle it is deflected onto the outside bank at the next bend by centrifugal forces. As the river scours and undercuts the outside bank, the meander migrates outwards. Point bar deposits build up on the inside of the loop on what is known as the slipoff slope.



7.3.3 Features of a meandering river

Oxbow lakes and meander scars

The meander loops in the river channel grow larger and larger until the channels almost meet. During floods, there is an increased volume and velocity of discharge in a river. As shown in Figure 7.3.4, this may cause the river to cut straight across the narrow neck of land separating two meander loops. The old, abandoned sections of the former channel are called cutoffs or oxbow lakes. These, in time, fill with sediment, becoming backswamps or, as they are called in Australia, billabongs. The still waters of the billabongs (see Figure 7.3.5) create a very different ecosystem to the main river channel. Eventually, backswamps dry out and become vegetated depressions known as meander scars.



7.3.4 The formation of an oxbow lake

7.3.5 Billabongs develop a different ecology to the main river channel.

Floodplains

Casual observers of river floodplains often assume that past flooding built the broad, flat areas adjacent to the channel. This is indeed the case within confined river valleys where lateral movement of the river channel is restricted by the nature of the topography or geology of the catchment. In these circumstances, over-bank deposits of sediment during flooding are largely responsible for floodplain development.

In broader valleys, however, closer study has revealed that both erosion and deposition are constantly taking place within the river channel. There is an accumulation of material deposited on the inside of meander curves as the river migrates laterally. It is this build-up that is largely responsible for the development of the floodplain.

Natural levees

A floodplain, as the name implies, is normally inundated in times of peak flows. As the sediment-laden floodwaters spread out across the floodplain they quickly lose velocity. Much of the suspended silt and sand will settle on the ground. The greatest amount of deposition is adjacent to the channel. This causes a natural levee of elevated ground to develop on either side of the main channel.

SKILLS BUILDER

Topographic maps

A topographic map is a detailed, large-scale map of part of the earth's surface, illustrating selected features of the biophysical and built environments (see the top map in Figure 7.3.6). Topographic maps generally show the height, relief and slope of the land, drainage patterns and vegetation. They also show a range of built features, such as settlements and transport linkages.

Being able to interpret topographic maps is an important geographical skill. It allows us to:

- locate features of the biophysical and built environment
- describe distributions and patterns
- identify relationships between features.

Legends and map symbols

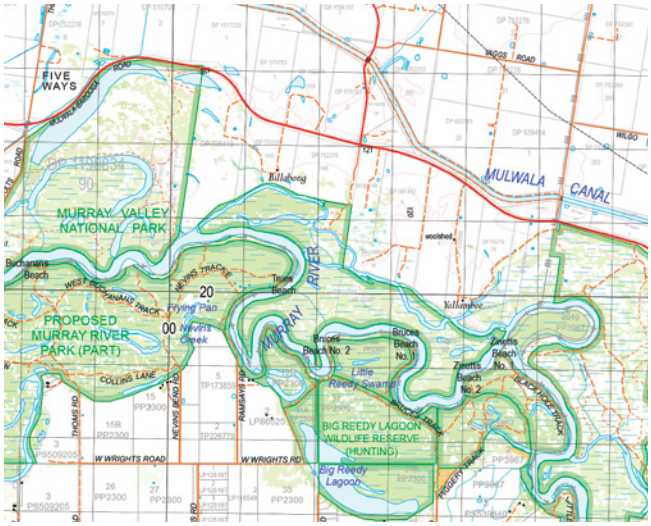
Symbols are used on maps to show the location of features, such as towns, roads, rivers and vegetation. Many symbols look like the features they represent. The colours used for the symbols may also provide a clue to their meaning. The importance of a feature might be shown by the size of the symbol, the thickness of the line or the size of the font used. The meaning of each symbol is explained in the map's key, or legend.

The legend is an important part of any map. It allows us to interpret the features shown, and it provides us with information about the scale of the map and the contour interval selected. When working with maps, always check these details; never assume that the cartographer has used a particular scale or contour interval.

Grid and area references

The location of features on a topographic map can be found by using grid and area references.

Grid lines are a series of numbered vertical and horizontal lines drawn on a map. The horizontal lines are called northings and the vertical lines are called eastings. Northings are numbered from the south to the north (from bottom to top). Eastings are numbered from west to east (from left to right).



7.3.6 The Murray River: This topographic map (left) and vertical aerial photograph (right) show relict features.

Activities

Understanding the text

1 Outline how the biophysical environment interacts to produce the diversity of fluvial landform features.

2 Describe the conditions that are likely to create a braided river.

3 Describe a river meander.

4 Explain how natural levees are formed.

Working geographically

5 Write a report describing the changes in the form of a river from its upper reaches to the end of its course. Use a river with which you are familiar as a model and/or use a topographic map to provide information.

6 Study Figure 7.3.3. With the aid of an annotated sketch, write an explanation outlining why rivers develop meanders in their lower reaches.

7 Examine Figure 7.3.4. Explain the formation of oxbow lakes.

8 Draw your own annotated block diagram to illustrate the fluvial landform features of the valley floor.

UNIT 7.4

River catchments

The catchments that collect water for rivers can be viewed as simple input/output models. The inputs are generally precipitation, but may also include water introduced from other catchments or sources.

Catchment run-off

Water that infiltrates the ground surface but is not taken up by vegetation may eventually pass through to the river system via groundwater flows. Water that passes deeper into aquifers may be lost from the catchment altogether. The remaining water passes as overland flow or run-off to the river. Depending on the nature of the rainfall and land management in the catchment, other inputs arriving at the river include eroded material, nutrients, organic matter and, particularly from some groundwater additions, high levels of salts. The loss of inputs is substantially in the form of evaporation from land, vegetation and water surfaces, and transpiration from growing vegetation.

The relationship between the inputs (rainfall) and their pathway can be expressed in the following form.

inputs = run-off + evaporation + transpiration + groundwater + loss to other catchments + change in soil/surface storage

Alternatively, the relationship can be expressed in the following form.

run-off = inputs − evaporation − transpiration − groundwater − loss to other catchments − change in soil/surface storage

The amount of run-off (and the sediment and other materials carried by it) entering rivers is dependent on the nature of the rainfall, and the soils, vegetation cover, natural processes and land management. Vegetation, for example, can result in ponding (or water retention) over the catchment surface. This impedes the flow of surface water, which helps to increase the infiltration of surface water into the soil.

Human-induced impacts on run-off

Human activities can affect the amount of run-off within a catchment. Climate change is changing rainfall patterns and the rates of rainfall. In some places, such as southern Australia, rainfall is becoming more sporadic with more intense but less frequent rainfall events. Overall, climate change is reducing rainfall in southern Australia. In northern Australia, rainfall is actually increasing.

Humans also disrupt the operation of the natural water cycle by withdrawing and transferring water within the system. Water is often moved from one catchment where there is excess water for human needs to another where there is a deficit of water. Large-scale irrigation projects capture water in dams, transfer the water through pipes and canals and therefore modify natural run-off patterns. For example, the vast Snowy Mountains Scheme (see Figure 7.4.1) in the south-east of Australia diverts water from the Snowy River (that normally flows eastwards towards the sea) westwards and down the inland rivers to irrigation areas in western NSW, Victoria and South Australia.

Water is also diverted for direct human use. Cities consume vast quantities of water and in many cases have been constructed in areas that have nowhere near enough water to support them.

7.4.1 Guthega Dam high in the Snowy Mountains, part of the Snowy Mountains Scheme that transfers water westwards towards inland Australia

7.4.2 Located in the desert, Las Vegas relies on water transfers to meet its considerable water needs.

Las Vegas, famous for its lavish hotels and casinos, relies on water transferred from other catchments, most notably the Colorado River. The city uses around 145 million litres of water a day, about 70 per cent of this is used for outdoor use (see Figure 7.4.2). The city has introduced strategies to reduce water usage which have had some positive effects but as the overall population and visitor numbers to this popular tourist destination grow the city is consuming around 1.5 per cent more water each year. This places considerable stress on catchments that supply the city's water.

Sediment and nutrient yield

Weathering, soil formation and erosion are naturally occurring processes that, unless there is further tectonic uplifting, eventually result in a virtually flat landscape. The removal and transportation of the weathered material and some topsoil is part of this natural system in which rivers play a significant role. In a system that is in equilibrium, the inputs will closely follow the outputs. For example, eroded riverbanks may often be replaced by newly deposited landforms; although the gradients of the rivers will steadily be reduced.

7.4.3 Intensive agriculture, such as this feedlot, produces huge quantities of sewerage that affect nutrient levels in river systems.

The biophysical environment will also generate naturally occurring nutrients, both from the soil and biotic material (from plants and animals). Again, apart from exceptional events, river systems find a balance between these inputs (that is, the river ecosystems) and the outputs.

Human-induced impacts on sediment and nutrient yield

Sediment yield rises following disturbance of the soil surface, particularly if the protective vegetation is removed and the run-off is increased. Faster sheet-water flows will ensure that more sediment flows into rivers. If the land is used more intensively and fertilisers are applied, the chance of higher nutrient loads reaching the river systems also rises. Similarly, intensive stocking, the development of feed lots (see Figure 7.4.3) and urban sewage-treatment works all have the potential to contribute to the nutrient load of the river.

7.4.4 High levels of nutrients in waterways can lead to the growth of toxic blue-green algae.

The nutrients, attached to the sediment, are transported into the aquatic system, making the system vulnerable to eutrophication. Eutrophication is the addition of plant nutrients into water. It often causes a rapid increase (bloom) in the growth of algae, as seen in Figure 7.4.4. The death and eventual decomposition of the algae results in a release of toxins, which can harm animals. It also lowers the oxygen level until the water cannot support aerobic (air-dependent) organisms.

SPOTLIGHT

Gulf of Mexico Dead Zone

The Mississippi River is one of the major river systems of the world. With a length of 3800 kilometres, it has a vast catchment of almost 2 million square kilometres—the world's fourth largest—which includes 31 states of the United States and two provinces of Canada. As shown in Figure 7.4.5, the catchment has a number of major rivers that act as tributaries to the Mississippi eventually flowing into the Gulf of Mexico.

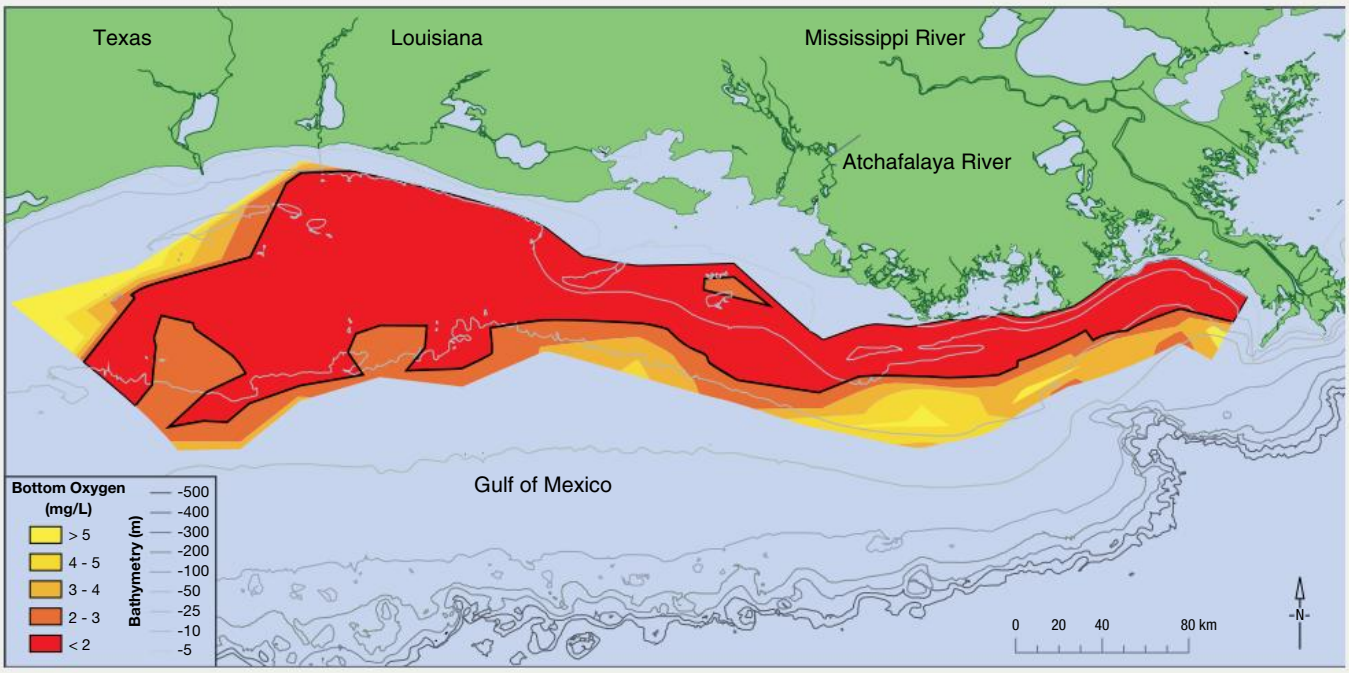
7.4.5 The Mississippi River catchment is vast and covers more 40 per cent of continental United States.

The Mississippi catchment contains some of the most intensely farmed regions of the United States. Large cities, such as Chicago, Memphis, St. Louis, Oklahoma City and Minneapolis and countless smaller urban centres are located within the catchment.

Great quantities of additional nutrients are added into the Mississippi River annually from these activities. Nitrogen-based fertilisers (see Figure 7.4.6), sewerage from urban areas and agriculture have led to more than 1.6 million tonnes of nitrogen entering the Gulf of Mexico annually via the Mississippi River. Much of this arrives in spring when snowmelt significantly increases run-off and river flows.

7.4.6 Nitrogen-based fertilisers are applied to farms across the Mississippi catchment leading to increased nutrient levels in the rivers.

The impact of this massive nitrogen load is the formation of the Gulf of Mexico Dead Zone. The zone is a vast area off the coasts of Texas and Louisiana that often measures more than 20 000 square kilometres (see Figure 7.4.7). The nutrients promote algal growth that extracts the oxygen from the waters, leading to hypoxic water—water with very low oxygen levels—that supports very little life.



7.4.7 The 2017 Gulf of Mexico Dead Zone—the largest ever recorded

Factors affecting the nature of a catchment

Vegetation

Vegetation has a multifunctional role in a catchment. Apart from modifying local climatic conditions, it intercepts rainfall, effectively protecting the soil surface from more intense precipitation. It also acts as a barrier to overland flow by:

- reducing the velocity of run-off and thereby reducing surface erosion
- causing ponding, which increases the time in which infiltration can occur.

An established stand of vegetation can also assist infiltration by developing a relatively permeable layer of organic material. It also assists by providing a network of fissures, or cracks, through the soil profile. These result from the decay of old root systems.

The presence of vegetation and a thick layer of humus provide an ideal habitat for soil fauna. The fauna's presence in the soil enhances its condition and may assist the movement of water into the soil. Earthworms, in particular, establish a tunnel network that can improve infiltration, particularly in heavy clay soils. As Figure 7.4.8 shows, infiltration is highest in established, well-vegetated pasture paddocks.

Impacts of specific soil types on infiltration

Vegetation and topography	Open sandy loam (% of total precipitation)	Clay and silt loam (% of total precipitation)	Tight clay (% of total precipitation)
Woodland			
■ Flat: 0–5% slope	90	70	60
■ Gentle: 5–10% slope	75	65	50
■ Hilly: 10–30% slope	70	50	40
Pasture			
■ Flat	90	70	60
■ Gentle	84	64	45
■ Hilly	78	58	40
Cultivated			
■ Flat	70	50	40
■ Gentle	60	40	30
■ Hilly	48	28	18
Urban areas	30% impervious	50% impervious	70% impervious
■ Flat	60	45	35
■ Gentle	50	65	80

7.4.8 Impacts of specific soil types on infiltration under various land uses and slope conditions expressed as a percentage of total precipitation

7.4.9 Ploughing increases the risk of erosion.

Human activities

Figure 7.4.8 provides a summary of the way that different soil types, gradients and human activities affect run-off and infiltration. In terms of run-off, it is evident that the act of cultivating or ploughing a field does not increase infiltration. These types of practices appear to increase run-off and the potential for erosion; see Figure 7.4.9. This is due to two factors: cultivation and urban development.

Cultivation disturbs any existing soil fauna pathways and closes off other fissures. Probably even more effective in this regard is the second action of turning over the soil, as occurs with some methods of cultivation. This buries any accumulated organic debris, and brings a subsurface horizon to the top. The normal process of soil formation involves the removal of finer clay particles from the shallow surface horizon: the A horizon. They accumulate lower in the soil: the B horizon. Should soil be overturned in the process of cultivation, even only to a depth of 10 centimetres, the more clay-rich soil may be brought to the surface.

Despite the rough nature of the cultivated surface, moderate rainfall will 'puddle' on the soil surface, breaking down the soil structure and bringing the clays into solution (that is, suspending the clays in water). Depending upon the clay content in solution, it effectively reduces infiltration by reducing the porosity of the soil.

Urban development can greatly impact the local hydrology. Widely spaced residential development in leafy areas may have minimal effect on run-off. However, most urban development is on relatively small blocks with a high proportion of land covered by impermeable surfaces, including roofs, driveways, patios, paths and roadways, such as those seen in Figure 7.4.10. The natural drainage system in an area that is intensively urbanised will have difficulty coping with the higher run-off yields. This is of even greater significance in areas with sandy soils, which would have experienced very high infiltration under normal circumstances. These areas would not, under natural conditions, have a well-developed drainage system. Thus, an impermeable layer over these soils will vastly increase the run-off. In addition, the incidence and severity of flooding and erosion in river channels is made worse by the use of efficient drainage systems transporting water from rooftop to river.

7.4.10 The hard surfaces contained in urban areas increase rates of run-off.

Groundwater

Some of the water that infiltrates into the soil seeps into aquifers, where it is stored as groundwater. Groundwater is an important resource, often accessible at considerable distances from rivers. Not all groundwater in Australia is of high quality. Approximately 90 per cent of groundwater sources have water that is too saline (salty) for human consumption and not fit for irrigation of salt-sensitive crops.

In some areas, including the Murray Basin, additions to the water table through excessive infiltration from irrigation have caused saline water to rise to the root zone of crops, rendering the soil sterile. (This is discussed in greater detail later in this chapter.) Reports from other areas suggest that pesticides, particularly those used on irrigated crops, have found their way into aquifers. This is a matter of serious concern because in aquifers there is virtually no flushing mechanism to dilute such concentrations. Should serious contamination occur, the aquifers would be virtually destroyed for most purposes.

Land use and the riverine environment

The impacts of changes in land use are readily observable in river ecosystems. Increases in sediment yield will lead to siltation. It will also increase the turbidity, or cloudiness, of the river and the level of nutrients in the water. The latter is a major problem where point sources, such as urban sewage outfall and seepage from feedlots, contribute effluent. If the flow is high, or there is regular flushing of the system, the river is better able to handle higher inputs of sediment and nutrients.

Rivers also provide valuable breeding grounds for fish that migrate up-river for spawning. Fish breeding may be limited by alterations to rivers in terms of water quality and temperature, regulation of flows and other factors. Since some species migrate considerable distances during their life cycle, the impact may be felt many kilometres away.

SPOTLIGHT

Illegal gold mining in Venezuela

The tropical rainforests of Venezuela are among the most extensive wilderness areas in the world. Illegal gold mining in the state of Bolivar, in the south of the country, is posing a serious threat to several rivers in the region, most notably the Caroni River.

Miners clear vast tracts of forest to expose the rich gold-yielding gravels. They also spray riverbanks with high-powered water cannons to loosen the gravels. These processes have dramatically increased sediment in the river, seen in Figure 7.4.11. Another problem is the use of mercury to separate gold from the rest of the gravel. Much of the toxic mercury is simply washed down the river, where it contaminates the food chain.

Environmental groups also hold fears for another major river system in the region: the Caura River. In recent years, civil unrest, chronic corruption and out-of-control inflation have further reduced monitoring of illegal activities and mining has expanded considerably.

7.4.11 Gold mining, Guayana Region, Venezuela. Miners use hydraulic techniques to mine gold deposits. This increases sediment in the river, and has a major impact on the rainforest environment.

Activities

Understanding the text

1 Outline the factors that cause a loss of inputs to river systems.
2 State what run-off is. How does it impact on inputs?
3 Outline the factors that affect run-off.
4 Describe the ways that human activities influence the water inputs in a catchment.
5 Explain the impact of human activities on sediment yields.
6 Define the term eutrophication. Outline its main sources in river systems.
7 Explain how vegetation affects the nature of catchments.
8 Describe how human activities impact on soils in catchments.
9 Define the term groundwater.
10 Explain the impact of human activities on groundwater.

Working geographically

11 Construct a flowchart to illustrate the inputs and outputs of a catchment.
12 Conduct research into water supply to Las Vegas. Explain where the water is drawn from and the impacts of this diversion. Outline the strategies being used in Las Vegas to reduce its water consumption.
13 Take on the role of an environmental consultant working for WaterNSW. Prepare a brochure to be distributed to farmers about eutrophication. In your brochure include information on what it is, its causes and its impacts.
14 Examine the information contained in the Spotlight box on the Gulf of Mexico Dead Zone and complete the following activities.
   a Explain the relationship between the Mississippi River and the dead zone.
   b Explain why the dead zone is worse in spring.
   c Examine Figure 7.4.7. Describe the scale of the dead zone and outline where it is most prevalent.
15 Prepare a short report to summarise the key information contained in Figure 7.4.8.
16 Refer to the information contained in the Spotlight box, 'Illegal gold mining in Venezuela'. Write a short report outlining the problems associated with illegal gold mining in Venezuela.

UNIT 7.5

River ecology

Rivers have a complex ecology consisting of a wide variety of fauna and flora. Many factors determine the exact plants and animals found in river systems, and a high variability of ecology exists across the world's river systems. For example, fast flowing alpine rivers have a very different ecology to the meandering slow-moving rivers of Australia.

Like all ecosystems, plants form the basis of the river food chain and large predators, such as large fish or crocodiles, sit at the top. These species are known as apex species (see Figure 7.5.1).

7.5.1 Crocodiles are an apex species of the coastal areas of northern Australia.

Aquatic flora

Phytoplankton

The word phytoplankton is derived from 'phyte', which means 'a plant' or 'growth', and 'plankton', which means 'floating'. Phytoplankton are small single-celled algae. They are part of the producers, or autotrophs, of the food web. In this sense they are similar to the grasses that grow on the great plains of Africa or North America. While they are plants, some have the ability to propel themselves through the water. Others, by changing their buoyancy, can float at different levels.

The most notorious of the phytoplankton are the blue-green algae. They cover the water in a thick film and, as they die off, release a toxin that can kill livestock that drink the affected water. While humans may also die if they drink the water, a more common problem is skin irritation from contact with the water or the algae themselves. The blue-green algae are very sensitive to their surrounding conditions, particularly sunlight, water temperature and quality (including, of course, turbidity) and the availability of nutrients. They are also sensitive to variations in river flow resulting from seasonal variations and localised rainfall.

Aquatic plants

Aquatic plants such as those seen in Figure 7.5.2 fulfil a variety of roles within a river system. They protect the riverbanks and beds, reducing the velocity of the flows and causing sediment to collect. As with the phytoplankton, they add oxygen to the water, play a role in the recycling of nutrients and are a food source.

They also provide shelter for insects and fish and even protection from fast-flowing currents; many smaller river organisms attach themselves to the aquatic plants. They also offer important protective sites for some hatching macroinvertebrates. Without them, species diversity in the river would be significantly reduced. Being at the base of the food web, their absence would reduce or even eliminate some animal populations, from the smaller zooplankton to the larger fish.

7.5.2 Aquatic plants provide important habitat and contribute oxygen to river systems.

Zooplankton

Zooplankton are tiny, single-celled animals, generally less than 0.2 millimetres in diameter. They play an important role in the aquatic food web. As a group, they eat phytoplankton, other plants and other zooplankton. Some are parasites. Many are detritivores—animals that recycle nutrients within the ecosystem by feeding on dead organisms and the cast-off fragments and wastes of living organisms.

In addition, the zooplankton are food for other, generally larger, animals within the aquatic ecosystem. Thus, a change in the aquatic environment that reduces the amount of zooplankton may have repercussions for the whole ecosystem; at least in the short term until a new population can be established. Some species are particularly sensitive to changes in water temperature and quality.

Macroinvertebrates

Macroinvertebrates are animals without backbones. In freshwater aquatic systems, such as the Murray River, insects, snails, worms, molluscs (such as mussels) and crustaceans (such as yabbies and crayfish) are all common. Macroinvertebrates fill a variety of niches in the food web because they include omnivores, carnivores, detritivores and herbivores, and represent the major food source for animals higher up the food chain, including fish and birds.

Both food supply and habitat are important for the wellbeing of these animals. They cover a wide range of life forms and their habitats include the benthos (or bottom sediment), rocks, aquatic plants and algae colonies, tree roots and old logs, branches and debris that have fallen or been washed into the river. Others are mainly free-swimming, but require suitable sites for laying their eggs. In some instances, particularly where a stretch of river is used for recreation purposes, well-meaning individuals 'clean up' all the old logs and snags to ensure the safety of those in the water. While limited removal may be appropriate, this material is part of an important habitat for many species of macroinvertebrates.

7.5.3 The Okavango Delta in Botswana is a vast wetland teeming with life.

Wetlands

Wetlands occur in areas where the water table is at or above the land surface for prolonged periods, providing some waterlogged conditions for truly aquatic plants. Wetlands are classified according to their location. They include montane (that is, found in mountains), riverine or floodplain, and coastal wetlands. See Figure 7.5.3.

Like many alpine regions around the world, Australia's Snowy Mountains have numerous small peatlands. Here the snowmelt drains into low-lying areas, keeping it saturated for much of the year. These areas are important because they tend to distribute run-off over prolonged periods. They also support unique communities of plants and animals.

Riverine wetlands fulfil several important roles. For example, they provide:

- a filter for the river, which reduces or moderates river flow and allows sediments to settle
- a habitat for fish, birds, reptiles and many vegetation types
- a resting spot for migratory birdlife
- a resource area for fish, timber and recreation.

Depending on the nature of the riverine area, the role of a particular wetland may vary. A delta-based wetland, through which the river runs, will play the role of water filter and flow moderator. Water bodies cut off from the river channel fulfil their role as sheltered habitats.

Billabongs

A billabong (oxbow or cut-off lake) is one category of wetland. For most of the time, a billabong remains isolated from the river itself. During floods, however, the billabong may become part of the river channel.

Billabongs are of particular interest for their biological rather than hydrological characteristics; that is, they are generally characterised by the plants and animals contained within them. Isolated from the river flow for most seasons, they are still bodies of water. The still waters of a billabong are the ideal habitat for amphibians, particularly frogs. Billabongs are also a favoured habitat of many species of wading birds (see Figure 7.5.4).

The water of billabongs is thermally stratified, meaning that water temperatures vary considerably with depth. Due to decaying organic matter, they are often of darkish colour but are not turbid. As an ecosystem, the aquatic community of a billabong is subject to a wide range of extremes in terms of temperature and water quality due to both seasonal and flood regimes. Thus, the organisms present must adapt to changing conditions, leave if they are mobile or suffer the consequences.

7.5.4 The calmer waters of billabongs are an ideal habitat for wading birds.

Activities

Understanding the text

1. Explain the concept of a producer in a food chain.
2. Describe the role of water plants in protecting river environments.
3. State what zooplankton is. Explain its importance to river systems.
4. Describe the role macroinvertebrates play in the ecology of rivers.
5. Outline the nature of wetland environments.
6. Explain how thermal stratification impacts on billabong ecology.

Working geographically

7. Write a short report describing the importance and function of riverine wetlands.
8. Using the internet and library resources conduct research into the ecology of billabongs in the Murray River basin. Prepare a visual aid, such as a poster or a digital presentation, on the main species that live in billabongs.
9. As a class, discuss the main threats to river ecology. Prepare a mind map that summarises the main points of the discussion.

UNIT 7.6

River regulation

Most of the world's major river systems have been regulated to provide a more consistent supply where and when it is needed. Some of the main forms of regulation are outlined in Figure 7.6.1.

Forms of river regulation		
Form of regulation	**Description and purpose**	
Dams	This involves building a structure across the river out of concrete, rocks and/or earth. Water then builds up behind the dam that can be used for human use. Dams are also used to reduce flooding by storing water during peak periods and releasing it gradually; they also store water for hydroelectric generation.	A
Channelisation	This involves lining riverbanks (and sometimes the bed) to restrict the movement of a river. It is more common along rivers in urban areas.	B
Weirs	Similar to a dam, a weir is built across the river but is much lower and creates a much smaller lake. Its main purpose is to slow down the flow of a river.	C
Locks	Locks are used to help make a river navigable to vessels. They usually replace or bypass rapids or small waterfalls that would otherwise block a boat.	D
Levee	Levees naturally form on top of riverbanks where sediment is deposited during floods. However, humans often extend these levees in order to raise the height of the banks and thus reduce the risk of floods.	E
De-snagging	Snags are submerged or partially submerged tree branches and trunks that wash down in floods. They form habitats for aquatic animals but are a hazard to boats and are often removed from rivers.	F

7.6.1 Forms of river regulation: **A** Egypt's Aswan Dam, one of the world's largest, spans the Nile River. **B** The Moyka River in St Petersburg, Russia. **C** A weir on the River Avon in Bath, England. **D** A lock on the Main River in Germany. **E** Levee bank on the Murrumbidgee River in Wagga Wagga, NSW. **F** Snags create habitat in rivers but are often removed to reduce boating hazards.

Impacts of river regulation

Virtually all of Australia's rivers are regulated to some degree. The Paroo River in the far west of New South Wales is the only major river in the state considered to be free of regulation (see Figure 7.6.2). The regulation of rivers causes many significant changes to the river ecosystem. These include the impact of dams on the flushing of the river system and the various water extractions that reduce river flows.

As the term suggests, humans regulate rivers in order to control them. Rivers are highly dynamic systems. They migrate across their floodplains and they go through periods of flood and alternatively periods of low flow. This unpredictability is disadvantageous to human activities. For example, the lack of stability in flow makes agriculture less certain and flooding impacts on human settlements.

Dams are the most significant form of river regulation as they dramatically alter the flow, direction and ecosystem of a river. Dams impact on both the upstream area that is submerged and the downstream reaches of the river. As with any large-scale human activity there are both benefits and costs associated with dams. Figure 7.6.3 summarises the negative and positive impacts of dams.

As Australia continues to seek ways to manage its water resources there have been calls for as many as 30 additional dams to be built around the country. One of these proposed dams is the Hells Gate Dam on the Clarke River west of Townsville. The dam would feed water into the Upper Burdekin River Catchment which feeds a large irrigation area.

Plans to dam the Belubula River to provide water for agriculture near Orange in the central west of New South Wales were abandoned after critics argued that the money allocated to dam construction would be better used to help farmers improve water management and efficiency on their properties. A new dam has since been proposed near Canowindra, upstream of Cranky Rock.

7.6.2 The Paroo River in far western NSW is the only major river free of regulation in the state.

Activities

Understanding the text

1. Explain why humans regulate rivers.
2. Outline the construction of dams.
3. Describe the purpose of dams.

Working geographically

4. Examine Figure 7.6.1. Select one of the forms of regulation shown. Research this regulation and prepare a digital presentation on the nature of the regulation, its purpose and its impacts.
5. Using the information contained in Figure 7.6.3, prepare a report on how dams impact on river systems.
6. Using the internet, research one of the dam projects proposed to be built in Australia. Outline the project including location and scale.

Impact of dams

	Costs	Benefits
Area submerged	■ Riverine scenery is submerged ■ Agricultural land is submerged ■ Recreation areas are lost ■ Riverine and wildlife habitats are destroyed ■ Transported sediment is trapped ■ Water temperature is modified ■ Water chemistry, particularly at depth (in the hypolimnion), is altered ■ Water quality is changed ■ Food webs are restructured and biota composition is altered ■ The migration of biota is restricted by the dam wall ■ The climate in the vicinity of the reservoir is affected ■ Water levels fluctuate as water is discharged	■ A major water body is created for recreation, such as sailing, swimming and fishing ■ Aquatic environment is enlarged ■ Aesthetic amenity could be enhanced ■ There is some degree of control over the impounded water
Downstream reaches	■ Major changes are made to the natural hydrological regime ■ Peak flows are reduced ■ There is the possibility of increased minimum flows; although, due to associated water extraction, even more serious low flows are possible ■ The viability of species that are dependent on seasonal flows is threatened ■ Floodplains that are deprived of periodic inundation are threatened ■ The replenishment of riverbeds and banks below the dam is reduced ■ A major adjustment is made to the river ecosystem	■ Flow is regulated for long periods ■ Water quality may be improved ■ There is some flood reduction

7.6.3 Impact of dams on the area submerged and downstream reaches

UNIT 7.7

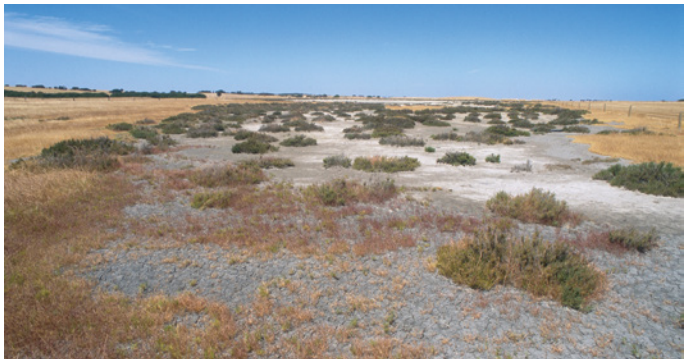
Regulation of the Murray River

7.7.1 The Murray River is Australia's most significant river system.

Major river systems of the world

River	Length	Catchment (1000 km²)	Discharge (m³/sec)
Murray (Australia)	3750	1072	470
Amazon (South America)	6516	7180	180000
Congo (Africa)	4700	3822	42000
Yangtze (China)	5800	1970	35000
Mississippi (USA)	6019	3221	17545
Nile (Africa)	4180	2881	1584

7.7.2 Major river systems of the world compared with the Murray River



7.7.3 Salinity, such as this on farmland in South Australia, is a problem throughout the Murray River catchment.

The Murray is the most significant river in Australia (see Figure 7.7.1). It is Australia's largest river and, together with its tributaries, drains an area covering about one-seventh of the continent. Compared with other major river systems around the world the Murray is relatively small. It takes the Amazon River less than one day to discharge water equivalent to the Murray's total annual flow. That said, the Murray holds enormous economic importance to Australia. Often referred to as the food bowl of Australia, the Murray–Darling Basin generates billions of dollars worth of produce annually and is home to several significant inland centres. More than two million people live within the catchment.

Catchment

The river's catchment extends from relatively dry inland areas (the Darling River) to high-rainfall areas (Australian Alps). Its course takes it through a relatively dry inland area where it supports a variety of urban, stock, industrial, irrigation and recreational activities. The dryness of the total catchment is demonstrated in Figure 7.7.2 by comparing it with other large systems around the world.

The Murray River drains an area of land that has inherently high levels of salinity, a high level of salts dissolved in the water (see Figure 7.7.3). This condition predates the European occupation of the area. In 1829–30, the explorer Charles Sturt and his party noted that the waters of the Murray were quite saline.

Over the past century, there has been a major increase in the area of the Murray's catchment that shows obvious signs of salinity. Algal blooms in the Murray and its tributary, the Darling River, have periodically reached alarming proportions. These phenomena were obviously present at the time of Sturt's exploration; what has changed is the scale and severity of the problems.

To appreciate the characteristics of the river, it is necessary to understand the factors that predispose the river to the major threats within the system. This understanding will also provide insight into the problems that have been exacerbated by river regulation and the land use in the catchment since colonial settlement.

History of the Murray catchment

Throughout geological time, the Murray catchment (see Figure 7.7.4) was inundated by a shallow sea, which provided a legacy of saline conditions. As the most recent inland sea retreated, it deposited an extensive sand sheet that persists over much of the western basin. While the ocean waters retreated, a water body covering about 30000 square kilometres remained. This body was called Lake Bungunnia. Lake Bungunnia was a megalake and was initially filled with fresh water but was brackish for most of its history. Until its disappearance, around 600000 years ago, the annual rainfall must have been significantly higher than it is today because it exceeded evaporation from the lake.

This period enabled much of the salt from the inland sea to be removed from the catchment. Little of the original salt water remains today. The majority of the present salt has been brought in via the atmosphere, largely through rainfall over the last 500 000 years.

As a consequence of its geological legacy of a shallow catchment that does not drain to the sea, the groundwaters of the Murray catchment are trapped in the sedimentary soil that has filled the catchment. Over the years, much of the water has been removed by evaporation in lower areas, where the groundwater is exposed in lakes. The salts have remained, only to find their way back into the groundwater aquifers. If there is a period of extended rainfall, the groundwater level rises, the soil may become salinised and saline water will find its way into the river system. There is, therefore, little wonder that Sturt and his party found the water salty to taste.

In the context of agriculture, the problems of salinity have been recognised for a century, although the extent of the affected area was initially limited. Since then, the extent and degree of salinisation have increased considerably and the welfare of many agricultural communities is now threatened.

River regulation: historical aspects

Apart from the watering of livestock, the first commercial use of the Murray River centred on its role as a major transport artery. The river was used extensively by paddle-steamers. These vessels were used to transport export produce, mainly wool, to Goolwa at the mouth of the Murray. From there it was shipped overseas via Port Elliot and Victor Harbour.

7.7.4 The Murray River catchment covers a huge area of south-east Australia. This map also shows the location of key human modifications to the rivers of the catchment.

Nineteenth century

There were up to 240 paddle-steamers operating on the Murray in the 1870s. While the river was used extensively for transport, the South Australian Government resisted proposals to regulate and divert water from the river. The 1870s saw increased irrigation development in Victoria and a decline in river transport due to competition from the railways.

Diversion of water from the unregulated Murray and its tributaries continued for two decades. Then, frequent dry years (during 1896–98 and 1901) prompted calls for the development of reservoirs and weirs to regulate the river's flow. The major problem was that the annual thaw of the highland snows sent a spring flush of water downstream several months before the peak demand for crops growing through the hot summer months. In addition, in some years, the spring flush yielded reduced flows.

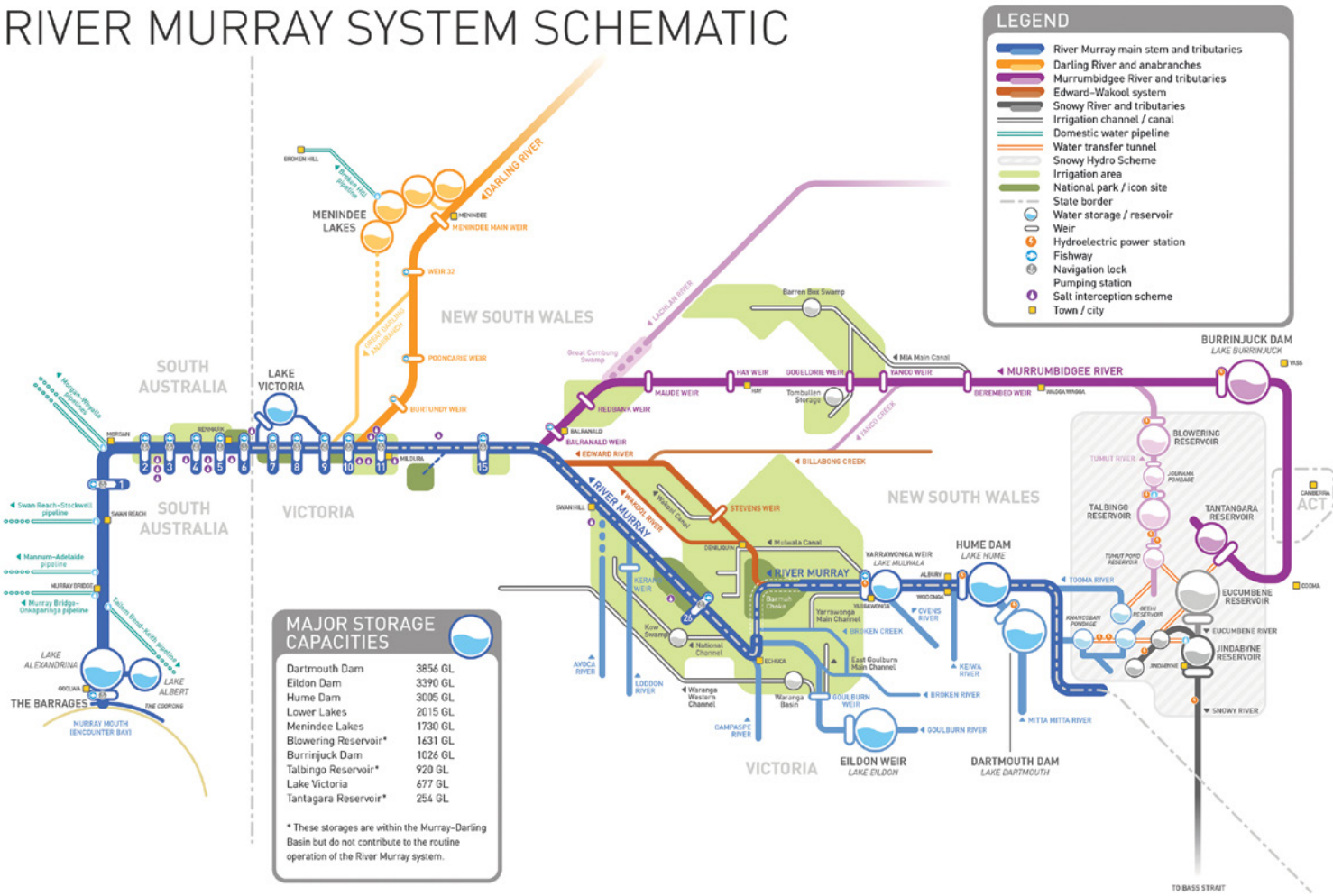
1900–1940

An Interstate Royal Commission on the River Murray was established in 1902. As if to highlight the problem of reduced flows, there was no flow passing through the mouth of the Murray for a period of at least six months during the commission's hearings.

Thirteen years of negotiation eventually produced the River Murray Waters Act (1915) which created the powerful River Murray Commission. There were three key points of the act:

- First, the flow at Albury was to be shared equally between New South Wales and Victoria.
- Second, Victoria and New South Wales were to retain control of their tributaries below Albury.
- Third, Victoria and New South Wales were to supply South Australia with a guaranteed minimum quantity of water, or 'entitlement'.

Under this arrangement, two major projects were proposed: the Hume Dam, upstream of Albury; and Lake Victoria, between Wentworth and Renmark. In addition, many locks and weirs were planned downstream from Echuca. Thus, a major transformation of the river system was instigated, ensuring a reasonably secure irrigation supply. Other schemes were developed on virtually every major tributary of the Murray, effectively providing at least some regulation on all branches of the river system.



7.7.5 River regulation along the Murray River and its tributaries

1940s

Despite this high level of supply management, and again following dry years in the early 1940s, there was a new proposal to further augment the waters of the Murray and Murrumbidgee rivers. This was the Snowy Mountains Scheme, which diverted the upper, high-rainfall portion of the Snowy River catchment into the headwaters of these rivers. This diversion was carried out via a system of hydro-electric power stations. The scheme was a marvel of technology, planning and project management and allowed the further development of irrigation works in these rivers. A consequence of this development has been the unfortunate increase in soil and river salinity.

The impact of regulation and changing land use

The construction of reservoirs has brought about major changes in the river system. They have:

- enabled more water to be diverted for irrigation by impounding high spring/early summer flows
- increased the area being irrigated
- changed the seasonality of the flows (that is, the pattern of flow by season)
- reduced the frequency and intensity of floods
- tended to reduce the volume of minimum flows; although this is really only a by-product of the river management
- caused dramatic changes to the river ecosystem.

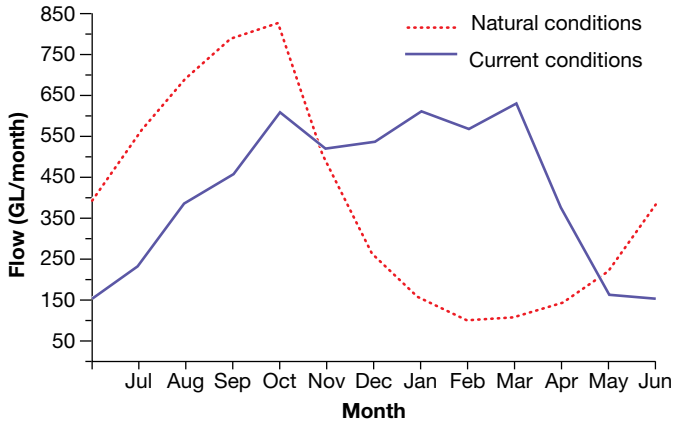
The extensive network of regulatory structures along the Murray is represented diagrammatically in Figure 7.7.5. The altered seasonal flows at Albury can be seen by comparing current or actual flow with simulated natural flows, as indicated in Figure 7.7.6.

Murray–Darling Basin Plan

In 2017, the Basin Plan was announced. The plan, although controversial, aims to balance the competing demands on water throughout the Murray River catchment. These demands include the needs of agricultural users (the biggest users of water), people living in the towns and cities of the catchment area and the riverine ecosystems in the system. Adequate flows are vital in enabling the natural environment of the river to continue to function and include the need for simulated natural floods to enhance wetland health. As part of this plan, authorities are seeking to improve water efficiency across the basin.

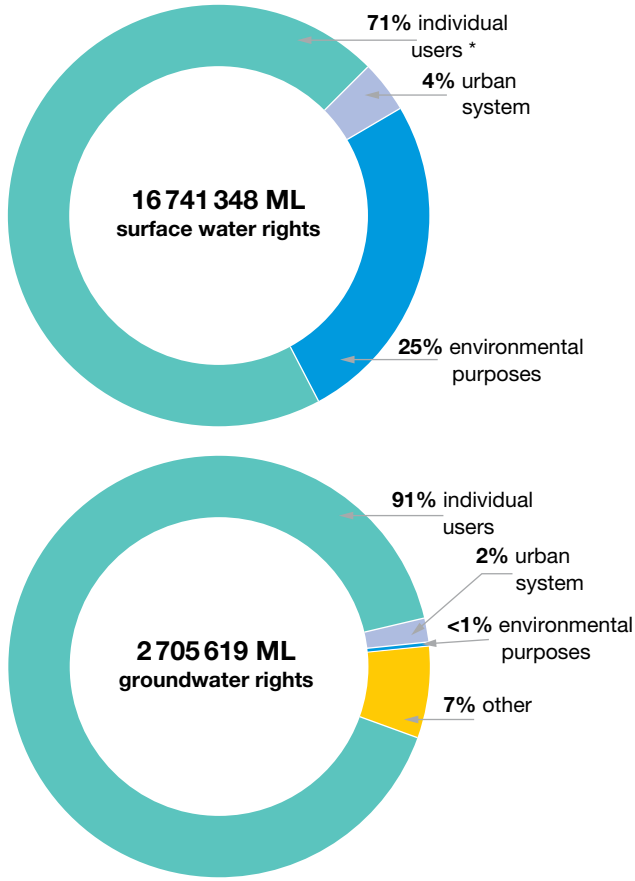
Figure 7.7.7 shows the way that water was used in the Murray Darling Basin in 2016. As can be seen, the largest users are individual rights owners. These are mostly farmers who have irrigation water rights.

In 2016 the data revealed that around one quarter of water in the system was left for environmental purposes. Under the 2017 plan, the goal is to increase this but at the same time improve efficiencies so that farmers use less water but with no impact on their crops.



7.7.6 Murray River flows at Albury

Approximately 71% of the region's water rights was for individual users, primarily for irrigation supply; less then 4% of the region's water rights was for the urban water system. Surface water use decreased from the previous year due to predominantly dry conditions across the region, reducing water availability.



* A small portion of this volume is made up of combined surface water and groundwater rights

Source: Bureau of Meteorology

7.7.7 Water rights in the Murray–Darling Basin Authority for 2016

Activities

Understanding the text

1. Describe the nature of the Murray catchment.
2. Outline the geological history of the catchment.
3. Explain how geology has impacted on salinity across the catchment.
4. Explain how reservoirs have changed seasonal flow patterns.
5. Outline the purpose of the Basin Plan that was announced in 2017.

Working geographically

6. Using Figure 7.7.2 describe the nature of the Murray catchment compared to others around the world.
7. Prepare a short report outlining the historical development of river regulation along the Murray.
8. Examine Figure 7.7.6. Compare the river flows under natural conditions to the flows under regulated conditions.
9. Review Figure 7.7.7. In a short report, outline the data shown on the graph.

Research conducted by the Murray–Darling Basin Authority in the late twentieth century found that the basin's river systems are in a state of drought for 61 in every 100 years. Under unregulated conditions, the river systems were in a state of drought for five years in every 100 years.

The reduction in flows is highly controversial, and severe droughts in recent years have made the situation even more problematic. In 2007, due to very significant drought, farmers were informed that there would be no water allocated to them. By then large irrigation dams, especially in the north of the basin, such as Burrendong, Keepit and Split Rock, were below 6 per cent of their normal capacity.

Impacts of river regulation on the hydrosphere, lithosphere and biosphere

River regulation has had a substantial and enduring impact on the hydrosphere, lithosphere and biosphere of the Murray–Darling Basin.

Salinity

Salinity is one of the key issues currently facing the Murray system. Salinity is essentially a function of rainfall, the release of salt from groundwater storages and its discharge into the river system. It also results from changes in land use, especially land clearing and overwatering of irrigated crops. Throughout the basin there is an upward trend in salinity levels.

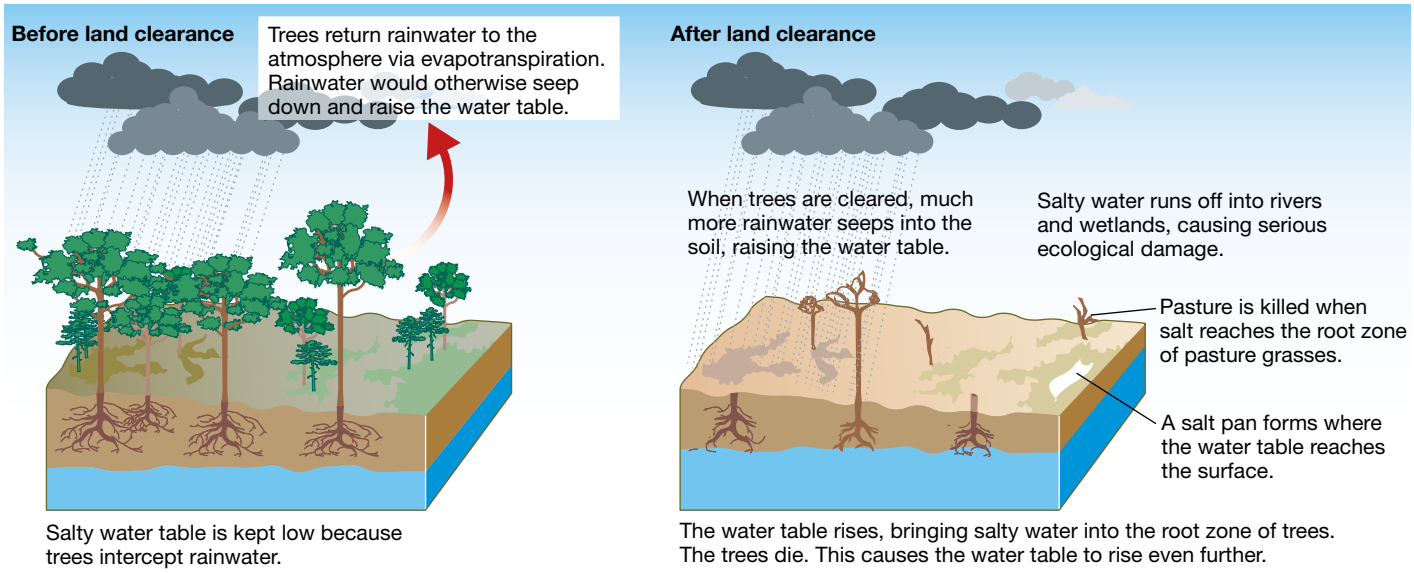
Salinity affects not only water quality but also the soil and plants that grow in it. Rising salt levels also affect aquatic life. To some extent, land-based animals are also affected due to the loss of vegetation that cannot survive in saline soils. A salinity audit conducted by the MDBA found that by the second half of the twenty-first century, salinity levels in the basin's river systems will become so great that water will no longer be suitable for human consumption.

There are two major causes of salinity within the system:

- dryland salinity
- irrigation-induced salinity.

Dryland salinity

Dryland salinity results from the removal of deep-rooted trees. These trees act as pumps by drawing on the groundwater. They evaporate the groundwater, thus keeping it well below the surface. Once the trees have been removed and replaced with shallow-rooted plants, such as cereal crops or pasture, the groundwater rises and brings dissolved salts with it. Figure 7.7.8 demonstrates how land clearing significantly increases salinity rates.



7.7.8 Land clearing is a major cause of dryland salinity.

Irrigation land salinity

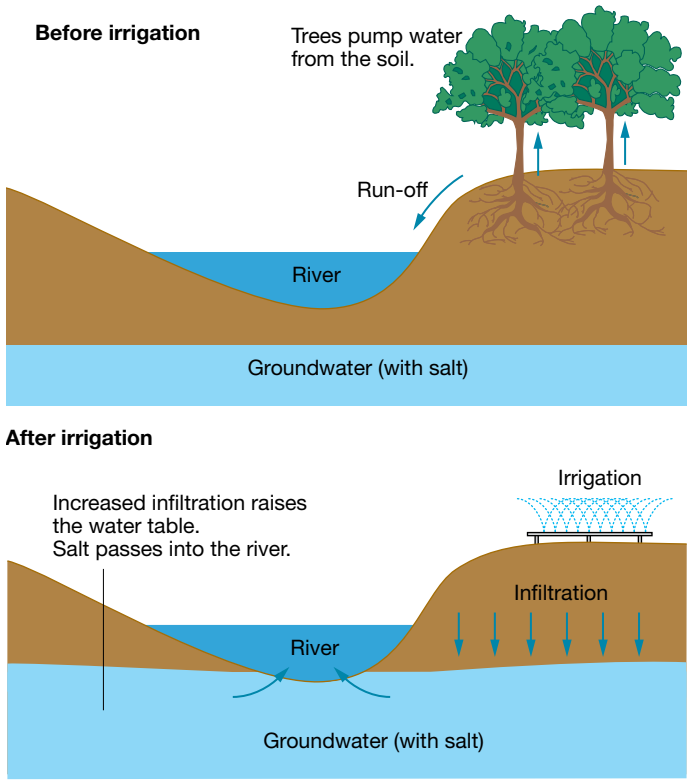
Areas that are subject to irrigation face the same problems associated with dryland salinity. However, the problem is made worse by the addition of excess water on the surface. As irrigation water is added, the water table rises further as shown in Figure 7.7.9.

Once the salt reaches the surface, it forms a scar of white salt on the landscape. Very few plants can survive in such saline soils. The water that flows over the soils and into rivers also becomes saline, creating both a land-based and riverine problem.

Strategies to reduce salinity

Throughout the basin, many strategies are currently in place to reduce the problem of salinity. One common strategy, shown in Figure 7.7.10, involves sinking bores into the underground aquifer and drawing out the saline water. However, this process is expensive and creates the problem of disposing of the salt once the water has been evaporated.

Widescale replanting of deep-rooted trees is also taking place in many parts of the basin. In most cases this involves farmers giving over part of their land to tree planting. This has had some success in reducing water levels. The number of trees that have been planted is a tiny proportion of the original number lost.



7.7.9 Impact of irrigation on salinity

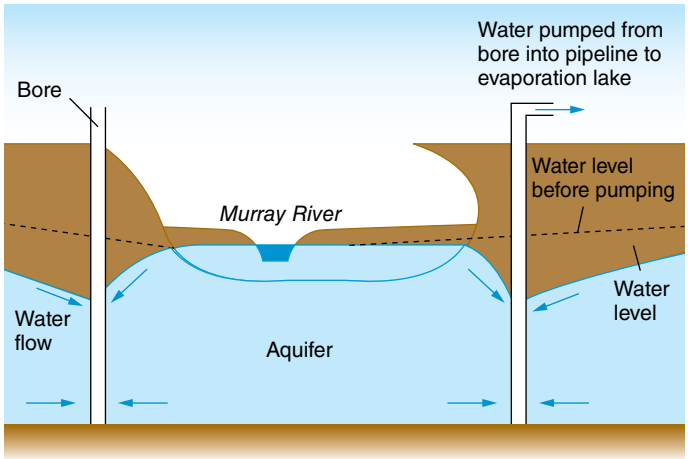
Turbidity and nutrient run-off

Turbidity is a measure of opaqueness or cloudiness of water (see Figure 7.7.11). The natural processes of weathering and erosion contribute clay and silt to rivers. These particles are the major cause of turbidity: the effect of scattered light passing through water.

In addition to suspended sediment, organic matter may also contribute to turbidity. Turbidity is not a direct measure of the volume of suspended sediment in a river because different particles have different reflective characteristics. Nevertheless, it is often used as an indication of the load of suspended sediment. Many of the tributaries to the Murray and especially the Darling contribute high sediment loads to the river.

Levels of turbidity

The level of turbidity is an important factor in any river ecosystem. The cloudiness of the water results in reduced photosynthesis. The more turbid the water, the less chance for light to penetrate the water and allow the phytoplankton, attached algae and macrophytes to grow. (Macrophytes are large, vascular aquatic plants that grow in shallow water along the shorelines of lakes or in the slow-moving reaches of rivers.)



7.7.10 Complex engineering structures are used in parts of the basin to draw saline water to the surface to evaporate.

7.7.11 Turbidity increases during periods of heavy rain. Here, a very turbid Murray River is shown during a flood in 2010.

7.7.12 Revegetation of riverbanks is a simple but important strategy in reducing erosion.

As these are the primary producers at the bottom of the food chain, turbidity can have a major influence on the quantity and diversity of life forms in the river ecosystem. Unsustainable farming practices that expose soil to erosion are the main cause of increased turbidity. Simple strategies for dealing with the problem include improved agricultural techniques, such as minimal tilling that leaves soil relatively undisturbed, and tree planting. WaterNSW is the government department responsible for managing rivers in the state. Since 2000 it has been undertaking work along more 720 kilometres of the Murray catchment—revegetating banks, fencing them off to keep stock away and working to stabilise banks and reduce erosion. See Figure 7.7.12.

Levels of nutrients

The major nutrients of importance in the river are phosphorus and nitrogen. While these nutrients occur naturally and are essential for the normal functioning of the riverine ecosystem, excessive amounts can result in deterioration in water quality. These excess nutrients are the result of fertilisers, which are used extensively in the basin, and sewage from urban areas and animals. High levels of nutrients encourage algae to bloom, which can poison the water.

Impacts to wetlands

There are more than 7000 wetlands throughout the Murray system, covering over 200 000 hectares. These wetlands are critically important habitats for many species of aquatic life as well as waterbirds and land-based animals. The wetlands are also important natural water storage areas for river systems and provide refuges for animals during times of drought.

River regulation has had a major impact on the functioning of wetlands. Regulation has reduced the frequency and severity of flood events. This has reduced the amount of water making its way across floodplains and into the wetlands on their edges. Additionally, many wetlands have become water sources for irrigation and other activities. Farmers in the northern part of the catchment have been accused of illegally diverting water out of the internationally protected Macquarie Marshes in the north-west of New South Wales, causing damage to these important waterbird habitats.

River red gums (*Eucalyptus camaldulensis*) are one of the most important plants in the Murray system. Seen in Figure 7.7.13, they form the basis of many of the wetland areas. They have suffered stresses due to grazing by livestock, logging, insect attack and localised recreational activity. The most significant threat to their existence is a reduction in flooding. This occurs when rivers are regulated and when the natural channels that reticulate the water are modified or obstructed. Often flood barrages and levees have been constructed to prevent localised flooding, but they also have an impact on flooding for many kilometres downstream.

7.7.13 River red gum forests have evolved to deal with periodic flooding, which river regulation has now reduced.

Human impacts on the ecology of the river

The features of river regulation, such as dams and weirs, have major impacts on the habitats of many different aquatic animals. Dams create large areas of deep, still or slow-moving water. Such water has different temperatures, chemistry and flow characteristics than rivers. Dam and weir walls also impede the movement of fish and other species.

Fish life

The native fish of the River Murray have not fared well as a result of river regulation. Many of the species, such as golden perch, have evolved to move up and down the river. However, barriers have significantly reduced their ability to do this. Figure 7.7.14 summarises the main impacts of human activities on native fish species across the river basin.

Strategies to improve fish habitats

Several strategies have been adopted to improve the situation of native fish within the basin.

RE-SNAGGING

The re-snagging program sees logs and other debris replaced in the main river to recreate the in-stream habitats on which many species rely (see Figure 7.7.15). A project led by the Victorian Department of Environment and Primary Industries saw 194 kilometres of the Murray River re-snagged with 4450 snags to create habitat within the river. Scientists estimate that in areas that have been re-snagged, there has been a three-fold increase in the number of Murray cod.

FISHWAYS

The installation of fishways, sometimes called fish ladders, is another important strategy for helping to manage fish ecology in the system. In-stream structures, such as weirs and dams, impede the movement of fish in the channel, disrupting normal breeding patterns as fish are unable to return to their breeding grounds. Seen in Figure 7.7.16, fishways are structures that allow fish to bypass the human-built structures and re-join the main stream. Research by the Murray–Darling Basin Authority found that golden perch travel hundreds of kilometres down the river systems of the basin. One tagged fish travelled 401 kilometres in 24 days on her way to breeding grounds. Along her journey she navigated through eight fishways, which highlights their importance.

RESTORATION OF WETLANDS

Restoration of wetland and billabong habitats has also occurred in different locations along the river, as well as the removal of alien species, such as European carp. European carp is one of the most invasive fish species in the world and was introduced to Australian river systems by humans in the nineteenth century. A single female can lay more than one million eggs. The fish live on the bottom of the river where they feed on small animals living in the sediment. They stir up the mud creating turbidity, increasing bank erosion and take food from native species. One company, Charlie Carp, has developed an organic fertiliser out of the carcasses of carp. In so doing they have turned the pest into a useful resource.

Threats to the native fish species in the Murray River

Threat	Threatening process
Flow regulation	Loss of water to other uses, critical low flows, loss of flow variation, loss of flow seasonality, loss of low to medium floods, permanent flooding and high water, increased periods of no flow
Habitat degradation	Damage to riparian zones, removal of in-stream habitats (e.g. snags), sedimentation
Lowered water quality	Increased nutrients, turbidity, sedimentation, salinity, artificial changes in water temperature, pesticides and other contaminants
Barriers	Impediments to fish passage resulting from the construction and operation of dams, weirs, levees, culverts (drainage pipes under roads) etc., and non-physical barriers (such as increased velocities, reduced habitats, reduced water quality and thermal pollution, i.e. changes in water temperature)
Alien species	Competition with and/or predation by carp, gambusia, oriental weatherloach, redfin perch and trout
Exploitation	Recreational and commercial fishing of depleted stocks and illegal fishing
Diseases	Outbreak and spread of Epizootic Haematopoietic Necrosis Virus (EHNV) and other viruses and parasites
Translocation and stocking	The loss of genetic integrity caused by inappropriate relocations and stocking of native species

Source: Adapted from *Native fish strategy for the Murray Darling Basin 2003–2013*, Murray–Darling Basin Commission, May 2003

7.7.14 Threats to the native fish species in the Murray River

7.7.15 Re-snagging of rivers helps to restore habitat in the river channel.

7.7.16 Fishways, such as this one, allow fish to bypass human obstructions, such as locks and weirs.

7.7.17 Murray crayfish

The decline of the Murray crayfish

The Murray crayfish, seen in Figure 7.7.17, is the largest macroinvertebrate in the Murray River system. They are slow-growing creatures that do not reach sexual maturity until they are six to nine years old. When fully grown (around 25 to 30 years of age) they can weigh up to 3 kilograms. They were once commercially fished in the lower reaches of the river.

The number of Murray crayfish has been declining rapidly since the 1950s. Since present river-water salinity levels and temperatures are within the range tolerated by the crayfish, it is believed other factors are responsible for this decline. These factors include increased nutrient levels and decaying algal blooms. The crayfish are also sensitive to pesticides, which are common in many parts of the basin.

Activities

Understanding the text

1. Describe the impact of human activities on drought flows within the river.
2. Outline the impact of salinity on the Murray River catchment.
3. Differentiate between dryland salinity and that caused by irrigation.
4. Outline strategies for resolving the problems created by salinity.
5. Explain what turbidity is and why it is a problem.
6. Outline how human activities increase turbidity.
7. Describe the impact of European carp on the ecology of the Murray River.
8. Explain the concept of re-snagging. How is it useful to river ecology?
9. State what a fishway is. Explain why they are beneficial.
10. Explain how waterbirds are impacted by human actions.

Working geographically

11. Using Figure 7.7.8, describe the nature and cause of dryland salinity.
12. Prepare a factsheet that could be used by farmers on salinity. In your factsheet, outline the causes and impacts of salinity and outline the actions farmers can take to reduce these impacts.
13. Prepare a report on the impact of human activities on wetlands.
14. Examine Figure 7.7.14. Using this information, explain the main threats to fish species within the basin.
15. Select a species that is found within the Murray River catchment. Using the internet, conduct research into this species and outline the way that human activities impact on the species.

Waterbirds

Many of the changes listed above also affect the waterbird population of the Murray River system. The most important threats to their continued survival is the loss of suitable habitat and the loss of stimulus (in the form of suitable flooding) for annual breeding. Of particular concern is the condition of the wetlands, as discussed earlier. Changes brought about through modification of the natural cycle of inundation of wetlands (either too little or permanent flooding), reduction of small to medium floods and the altered seasonality of flow have threatened many species that depend on the natural hydrological cycles for their survival. While the obvious solution is to return the flow patterns to normal, this is unlikely to be an acceptable option as it would jeopardise much of the agricultural activity in the region. Other approaches are necessary, but further research and understanding are still required in several areas.

Mussels in the Murray

Mussels are shellfish with two shells up to 10–14 cm long, seen in Figure 7.7.18. They live up to 15 years, and are filter feeders, burrowing through the sediment to search for food. Two species are present in the Murray: the floodplain mussel, which lives in lentic environments; and the river mussel, which inhabits the flowing waters of the river channels.

Since the development of water impoundments along the river there has been an increase in the floodplain habitat and a reduction in the river habitat. Of the two species of mussel, the floodplain mussel is more tolerant of being out of water; it can survive for a year or more in such conditions. In common with crayfish, the mussels are sensitive to changes in the amount of oxygen. This is especially the case for the river mussel, which would normally be well-oxygenated under reasonable flow conditions. Thus, human-induced changes have had a much stronger influence on the river mussel. The floodplain species, which is normally accustomed to considerable environmental change, has suffered relatively little.

7.7.18 Some species of mussels have suffered as a result of river regulation.

Exam-style questions

Extended responses

- Describe the factors that determine the nature of rivers and explain the functions of river systems.
- Evaluate the sensitivity of river ecosystems to human-induced and natural change.
- Analyse the importance of an understanding of key biophysical processes for the effective management of catchments.
- With reference to a river you have studied, discuss the advantages and disadvantages of river regulation.
- 'The environmental costs of river regulation outweigh any economic benefit derived from the exploitation of water resources.' Assess the accuracy of this statement with reference to the Murray River system or another river system you have studied.
- Salinity is one of the most important environmental issues confronting Australia. Write an extended response outlining the causes of salinity in the Murray River system and explain how the problem is being addressed.
- Identify and explain the key biophysical processes that relate to river regulation.

Glossary

algae a group of relatively simple plants that generally live in an aquatic or moist environment

aquifer a layer of rock or gravel that holds water and allows it to move through

artesian a term applied to a body of water confined in an aquifer

benthic relating to those plants and animals that inhabit the floor of lakes, rivers and oceans

biochemical oxygen demand (BOD) the amount of oxygen used when organic matter undergoes decomposition by microorganisms

biota all living organisms, including plants and animals

drainage texture the channel type, density and pattern of a drainage network

environmental flow a proportion of a river's flow considered necessary to maintain its riverine ecosystem

epilimnion the surface layer, or stratum, of water in a water body

horizon (soil) an identifiable layer in a soil profile, distinguished as a result of soil-forming processes

hypolimnion the bottom layer in a water body

impermeable rock a layer of rock through which groundwater cannot pass

infiltration the movement of water through the soil surface

lentic referring to still or slow-moving water bodies

lotic referring to fast-moving water bodies

morphology the study of shape (of the ground or landscape)

organic living material and its by-products

permeable rocks or soils that allow water to pass into them

porosity the degree to which water may pass through matter

regulated relating to streams and rivers that have their flow controlled by dams or weirs

riverine relating to a river

run-off the proportion of rainfall that does not infiltrate the soil and flows into river channels

stratification appearing to be layered

tectonic relating to the processes of the earth's crust

topography the detailed surface of an area

transpiration the loss of water vapour from plants via the leaves and, to a lesser extent, the stems

turbidity the clouding of water by the suspended sediment

unregulated relating to streams and rivers that have not had their flow controlled by dams or weirs

SECTION

2 Global challenges

Today, 7.6 billion people inhabit planet earth. This is well up on the earth's population at the beginning of the last century when there were just 1.6 billion people. This rapid rise in population is unprecedented and threatens the very wellbeing of the planetary systems on which all life depends. Clearly, we are failing to adequately feed, house, educate and employ many of the earth's people. Billions live in intolerable conditions. Demographers predict that the earth's population will grow to more than 9 billion before a fall in fertility rates initiates a gradual decline in population.

The problem lies not just in the explosion of human numbers. It also rests in the material demands of the population, especially those living in the developed world. Over 1 billion people enjoy lifestyles that impose grossly disproportionate demands on our planetary ecosystems. Our insatiable demand for the energy sourced from fossil fuels, for example, is altering the composition of the earth's atmosphere. The resulting climate change endangers whole ecosystems and perhaps humanity itself.

Humanity has confronted such challenges before. For example, it has successfully addressed the issue of acid rain. Collectively, we can reduce our environmental footprint by limiting our consumption of fossil fuels and by developing alternative (renewable) sources of energy. Humanity also has the ability to address the issues of global inequality and geopolitical instability.

This section focuses on some of the great social, cultural, political, economic and environmental challenges facing humanity.

8.0.1 Diamond mining, Angola

Outcomes

Students:

P1 differentiate between spatial and ecological dimensions in the study of geography

P4 analyse changing demographic patterns and processes

P5 examine the geographical nature of global challenges confronting humanity

P6 identify the vocational relevance of a geographical perspective

P7 formulate a plan for active geographical inquiry

P8 select, organise and analyse relevant geographical information from a variety of sources

P9 use maps, graphs and statistics, photographs and fieldwork to conduct geographical inquiries

P10 apply mathematical ideas and techniques to analyse geographical data

P12 communicate geographical information, ideas and issues using appropriate written and/or oral, cartographic and graphic forms

Overview

This section undertakes a geographical investigation of the challenges facing humanity at a global scale.

Chapter 8	Population geography
Chapter 9	Natural resource use
Chapter 10	Cultural integration
Chapter 11	Political geography
Chapter 12	Geographies of development

Note to teachers and students:
Students in New South Wales are required to study population geography plus TWO of the following FOUR options: natural resource use, cultural integration, political geography and geographies of development.

CHAPTER

8 Population geography

The increase in the human population in the last half-century is unprecedented; and nearly all the growth is occurring in developing countries. Currently, 89.8 million people are being added every year in developing countries worldwide, compared with about 1.1 million in developed countries. While developing countries will keep growing (some quite rapidly), the more developed countries may grow slowly or not at all.

The study of population (demography) is important because there is a clear connection between population growth and virtually every challenge facing humanity. Population change is linked to economic development, education, the environment, the status of women, epidemics and other health threats, and access to family planning information and services. All these factors interact with every aspect of our lives, regardless of where we live.

In this chapter, we focus on the changing nature, rate and distribution of the world's population; the factors that affect fertility and mortality; population movements; and issues arising from the changing size and distribution of the population.

> **Instead of controlling the environment for the benefit of the population, maybe we should control the population to ensure the survival of our environment.**
>
> **Sir David Attenborough, Naturalist**

8.0.1 People crowd at a beach in Dalian, Liaoning Province of China.

Budweiser

UNIT 8.1

World population: changing nature, rate and distribution

During the twentieth century the world's population grew at a rate never before experienced. At the end of the century (2000) there were 6 billion people. In mid-2018 there were 7.6 billion people living on earth (see Figure 8.1.1). By 2050, world population is projected to reach 9.8 billion. This is a dramatic rise from 1900 when there were only 1.6 billion people on earth, and 1950 when there were only 2.5 billion.

Every year the world's total population grows by more than 90 million. A continuation of this growth is inevitable because a relatively large proportion (25.4 per cent) of the world's population is under the age of 15. This provides a built-in momentum for further growth, even as fertility rates continue to decline.

8.1.1 The world grows ever more crowded. Hundreds of thousands of Hindu devotees crowd the banks of the Ganges river during the Kumbh Mela festival.

Years taken to add each additional billion people		
World population	**When reached**	**How long did it take?**
1 billion	1804	All of human history (2 million years)
2 billion	1927	123 years
3 billion	1960	33 years
4 billion	1974	14 years
5 billion	1987	13 years
6 billion	1999	12 years
7 billion	2011	12 years

8.1.2 Adding billions to the world population

World population growth

One way of appreciating the rapid rate of population increase is to calculate the number of years required to add each additional billion people to the world's population. Figure 8.1.2 shows that it took 2 million years to add the first billion, 123 years for the second billion and only 12 years for the sixth billion. Figure 8.1.3 shows the growth of the world's population since 1000 CE. The use of a semi-logarithmic graph, shown in Figure 8.1.4, allows us to see the period during which the rate of growth was greatest.

Growth in human population	
Year (CE)	**Population (millions)**
1000	275
1100	306
1300	384
1400	373
1500	429
1600	486
1700	635
1800	919
1900	1571
2000	6073
2025	8142*
2050	9800*
2100	11200*
	*UN estimates

8.1.3 The growth in human population, actual and projected, 1000–2050 CE

There are now signs that the explosive growth in human numbers during the twentieth century is beginning to slow and that the world's population may actually stabilise late in the twenty-first century. Even if the rate of growth stabilises or declines in the years to come, there still may be 11.2 billion human inhabitants on the planet before by the end of century; that is, 2100.

DID YOU KNOW?

In Pakistan, two-thirds (66 per cent) of the population is under the age of 30. In India, 58 per cent of the population is under 30 years of age. In Africa, 70 per cent of the population is under the age of 30.

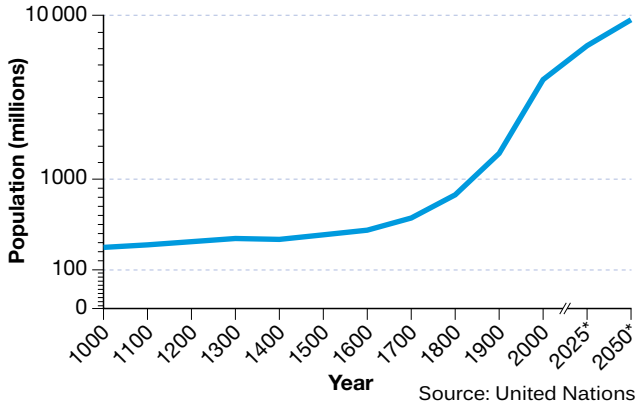
SKILLS BUILDER

Log-log and semi-logarithmic graphs

At times we need to graph data that have a range of values that are difficult to fit on a standard graph. Log-log and semi-logarithmic graphs are designed to meet this need. They can accommodate data with a huge range of values. They also allow judgements to be made about the rate of change. The steeper the line, the greater the rate of change.

Semi-logarithmic graphs have a vertical scale that is graduated in a logarithmic progression, seen in Figure 8.1.4. This means that equal intervals, or cycles, on the vertical scale increase geometrically, for example 1, 10, 100, 1000 and 10 000. The horizontal scale has a normal arithmetical progression.

Log-log graphs have both the vertical and horizontal axes graduated in a logarithmic progression.

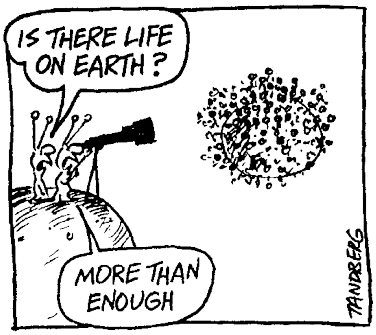


Source: United Nations

8.1.4 A semi-logarithmic graph showing the growth in the world's population since 1000 CE

Many experts are concerned about the size of this increase (see Figure 8.1.5). They fear that the addition of another 3 billion people will degrade and even overwhelm the earth's biophysical environment: the land's food-producing capacity and the other natural resources on which all life depends. They are also concerned that meeting the energy needs of the growing population will simply accelerate the rate of climate change. This will especially be the case if alternatives to the burning of fossil fuels are not widely (and quickly) embraced. The Paris Climate Agreement signed in early 2016 offers some hope that global temperature increases can be kept below 2°C.

Others believe that the earth's population should be seen as a valuable resource. They claim that technology will enable humans to cope with the problems that result from the increase in population.



8.1.5 Tandberg cartoon

How many people have ever lived on earth

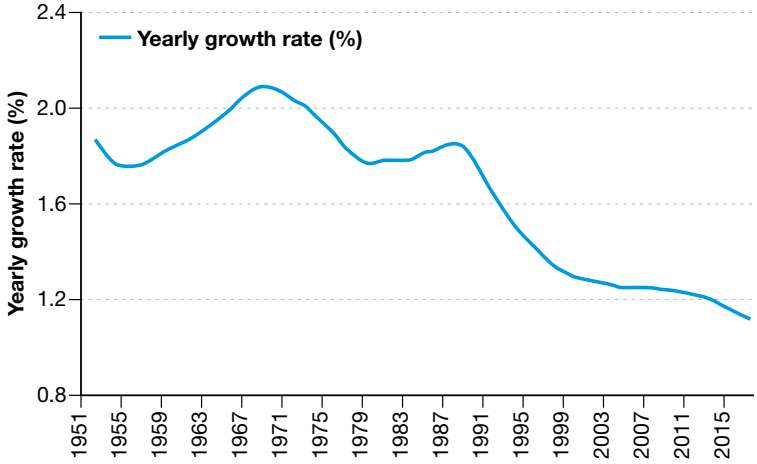
Assuming that the count starts from about 50 000 BCE, the time when modern Homo sapiens appeared on the earth, and assuming a constant growth rate applied to each period up to modern times, it has been estimated that approximately 106 billion people have been born since the dawn of the human species, making the population currently alive roughly 6 per cent of all people who have ever lived on planet earth.

Declining rates of growth

In 2017, the world's population was growing at an annual rate of 1.11 per cent (down from 1.13 per cent in 2016) as seen in Figure 8.1.6. Annual growth rate reached its peak in the 1960s, when it was above 2 per cent. Since then, the rate of increase has almost halved.

The annual growth rate is declining and is projected to continue to decline in coming years. Currently, it is estimated that it will become less than 1.0 per cent by 2020 and less than 0.5 per cent by 2050.

This means that world population will continue to grow in the twenty-first century, but at a slower rate compared to the recent past. The latest UN projections indicate that world population will reach 10 billion in 2056.



Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.6 The annual increase in world population peaked in the late 1960s. Since then, the rate of annual increase has declined steadily.

SPOTLIGHT

Exponential growth

The rapid increase in the human population is an example of exponential growth. Exponential growth occurs when a factor, such as population, grows by a constant proportion (such as doubling) during each unit of time.

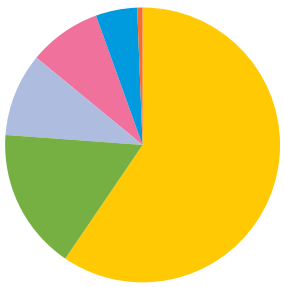
Exponential growth starts off slowly, but a few doublings quickly produce very high numbers. This is because after the second doubling each additional doubling amounts to more than the total of all preceding growth. Compare these examples of exponential growth with arithmetic growth:

Arithmetic growth	1	2	3	4	5	6	7	8	9	10	11	12
Exponential growth	1	2	4	8	16	32	64	128	256	512	1024	2048

For the first several million years of human history the world's population grew exponentially at the very slow rate of just 0.002 per cent a year. Since then the average annual exponential growth rate has increased sharply. It reached a peak of 2.06 per cent in the 1960s, before dropping to 1.68 per cent in the mid-1990s.

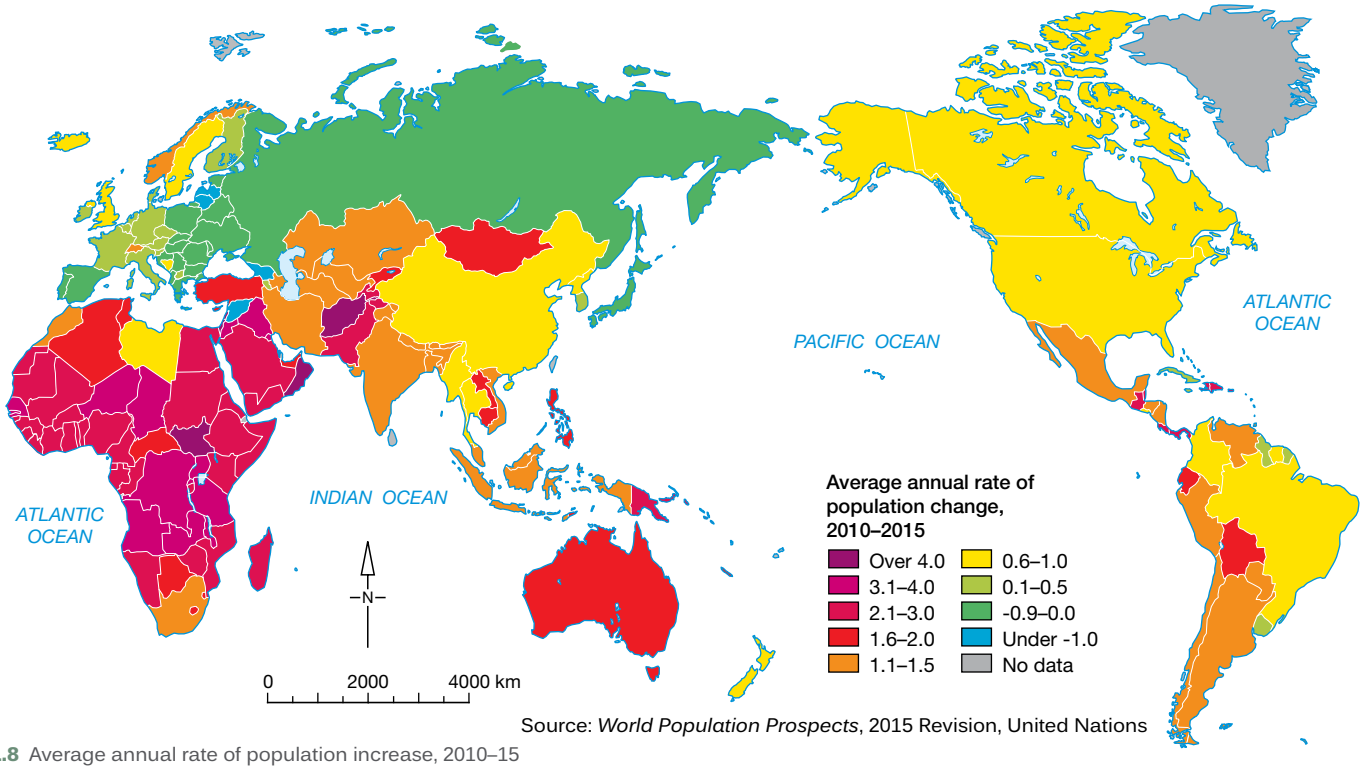
The global pattern of population increase

Figure 8.1.7 shows the distribution of the world's population by continents and regions. The world map of population growth (see Figure 8.1.8) reveals the wide range of growth rates in different regions. Population growth rates are highest in those parts of the world that are least able to cope. The countries of the developing world have 83 per cent of the world's population yet they account for 98.5 per cent of the world's annual population increase. Of the 7.5 billion people who inhabited the earth in 2017, 6.3 billion lived in countries of the developing world. The population of the developed world, now 1.2 billion, will increase to only 1.4 billion by 2050, with virtually all this growth occurring in the United States. Due mainly to immigration, the US population will continue to grow; from 326 million in 2017 to 398 million in 2050.



Region	Population
Asia	4 478 315 164
Africa	1 246 504 865
Europe	739 207 742
Latin America and the Caribbean	647 565 336
North America	363 224 006
Oceania	40 467 040

8.1.7 Distribution of the world's population, 2016



Source: *World Population Prospects*, 2015 Revision, United Nations

8.1.8 Average annual rate of population increase, 2010–15

The rate of population increase is linked to the fertility rate. The replacement fertility rate is approximately 2.1 per cent. If the fertility rate is below this level for an extended period of time, and there is no net increase due to migration, a country's population will decline.

In countries of the developed world the rate of population growth has slowed dramatically. Europe's fertility rate is now only 1.58; too few to replenish the population. Europe's population is expected to shrink by 1.6 per cent by 2050, down from 739 million in 2017 to 728 million.

The greatest proportional increase in population is happening in the developing world.

Demographic trends

Demographic statistics such as fertility rate, life expectancy and the percentage of the population under the age of 15 (see Figure 8.1.9) are used to predict future population growth. The statistics show different projections for world regions.

In Africa, the population is expected to double between 2018 and 2050 (increasing from 1.2 billion to 2.5 million in 2050). With fertility rates of up to 6.62 children per woman and 41 per cent of its population under the age of 15, the source of this growth in Africa is already in place.

In South America, population growth is relatively high but uneven. Women in French Guiana, for example, on average have almost twice as many children (3.5) as those in Chile and Brazil (1.8).

In Asia, growth rates vary significantly. China, the world's most populous country, has experienced a dramatic decline in its fertility rate: from 6.5 in 1968 to just 1.6 in 2017. Even so, China's population, which is 1.387 billion, is greater than that of the entire developed world. India's population of 1.353 billion continues to grow, with an annual rate of just 1.2 per cent.

More than 50 per cent of India's population is under the age of 25 and more than 65 per cent below 35 years of age. The Philippines, which had only 21 million people in 1950, is expected to grow to 148 million by 2050; more than either Russia or Japan. Russia's population is expected to shrink by 20 per cent between 2007 and 2050: from 143 million down to 111 million. The population of Japan is expected to decline from 126 million in 2017 to 107 million in 2050.

DID YOU KNOW?

- By 2050, Africa will be home to two in five of the world's children.
- By 2050, Africa's under-18 population will increase by two thirds, reaching almost 1 billion by the middle of the century.
- Africa's population will reach 4.2 billion by 2100 (40 per cent of the world total).

World demographic trends by region, 2016

Region	Population mid-2016 (million)	Projected population mid-2050 (million)	Projected population change 2016–50 (%)	Total fertility rate	Percentage of population <15 years	Percentage of population >65 years	Life expectancy M/F
World	7 418	9 869	33	2.5	26	8	70/74
Developed	1 254	1 322	5	1.7	16	18	76/82
Less developed	6 164	8 548	39	2.6	28	7	68/72
Africa	1 203	2 527	110	4.7	41	4	59/62
North America	360	445	24	1.8	19	15	74/80
Latin America and Caribbean	637	775	22	2.1	26	8	72/79
Asia	4 437	5 327	20	2.1	25	8	71/74
Europe	740	728	–1.6	1.6	16	17	75/81
Oceania	40	66	65	2.3	24	12	75/80

Source: *2016 World Population Data Sheet*, Population Reference Bureau

8.1.9 World demographic trends by region, 2016

Activities

Understanding the text

1 State by how much the world's population increased during the twentieth century. By how much had it grown in the first seventeen years of the twenty-first century?

2 State the number of people that are added to the world's population each year. Why is continued population inevitable in the foreseeable future?

3 Explain why people are concerned about the extent of the projected population increase. Outline the argument used to dismiss these fears.

4 Explain why the world's population is projected to grow at a slower rate over the course of this century.

5 State where most of the population growth is occurring.

6 Identify the continent that will experience the greatest proportional increase in population. Cite the reasons for this.

Working geographically

7 Study Figure 8.1.2. State what has happened to the time it takes to add a billion to the world's population since 1804.

8 Study Figure 8.1.4.

- **a** State when the world's population first exceeded 1 billion.
- **b** Identify the time period in which the world's population expanded most quickly.

9 Study Figure 8.1.7. Calculate the population living in:

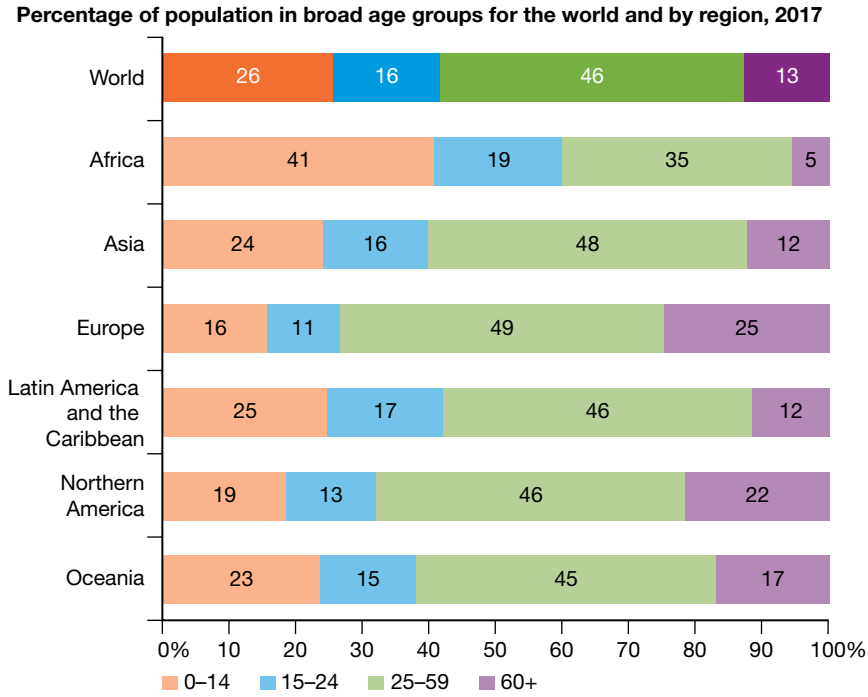
- **a** Asia
- **b** Africa
- **c** North America
- **d** Europe

10 Study Figure 8.1.8. With the aid of an atlas, identify those parts of the world with population growth rates greater than 2.1 per cent. Identify those countries experiencing negative population growth rates.

11 Using the data in Figure 8.1.9, write a report outlining the demographic trends for different parts of the world.

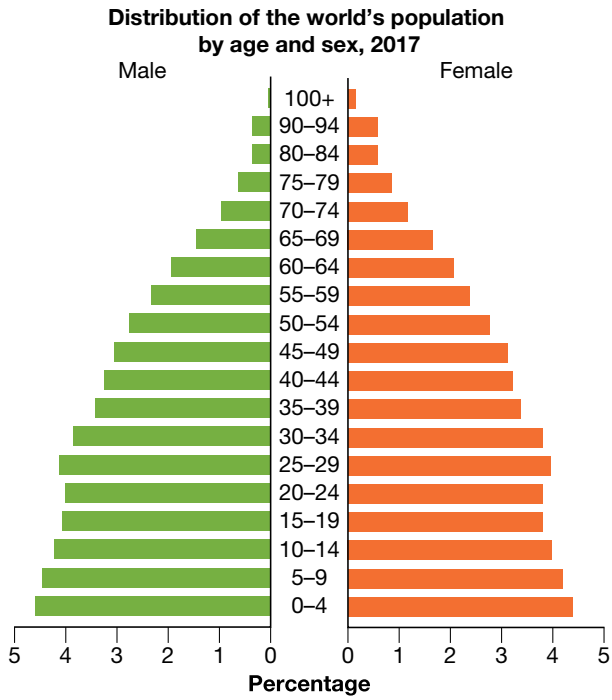
12 Study Figure 8.1.13. With the aid of an atlas, identify those parts of the world that are projected to have the greatest percentage change in their population in the period 2017–50.

To better predict population increases, population data can be presented in a variety of ways, as seen in Figure 8.1.10 which shows the percentage of the world's population in broad age groups and region; and Figure 8.1.11 which shows the age/sex structure of the world's population, 2017. Both these statistics are used to predict population change, as seen in Figures 8.1.12, 8.1.13 and 8.1.14.



Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.10 Percentage of the world's population in broad age groups and region, 2017



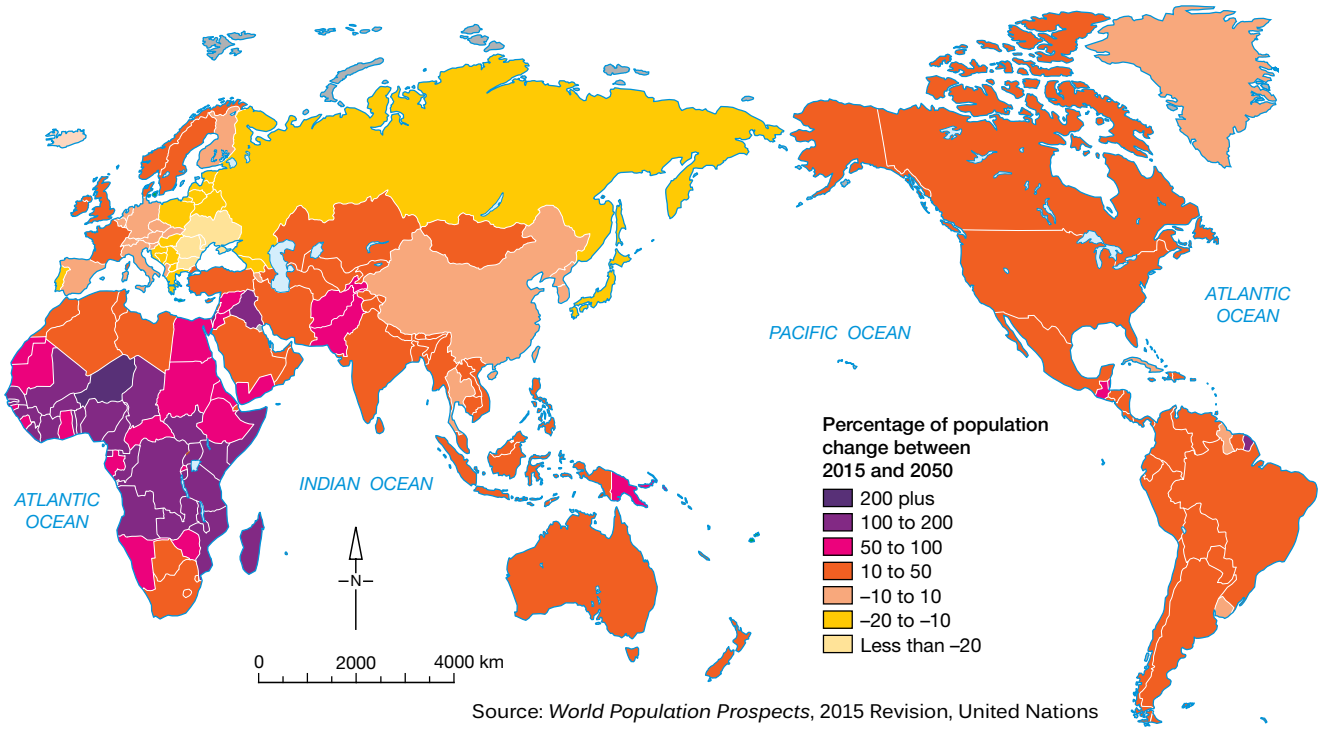
Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.11 Population pyramid showing the age/sex structure of the world's population

World's 10 largest countries by population, 2017 and 2050			
2017		**2050**	
Country	**Population (millions)**	**Country**	**Population (millions)**
China	1 387	India	1 676
India	1 353	China	1 343
USA	325	Nigeria	411
Indonesia	264	USA	397
Brazil	208	Indonesia	322
Pakistan	199	Pakistan	311
Nigeria	191	Brazil	231
Bangladesh	165	Dem. Rep. of the Congo	216
Russia	147	Bangladesh	202
Mexico	129	Ethiopia	191

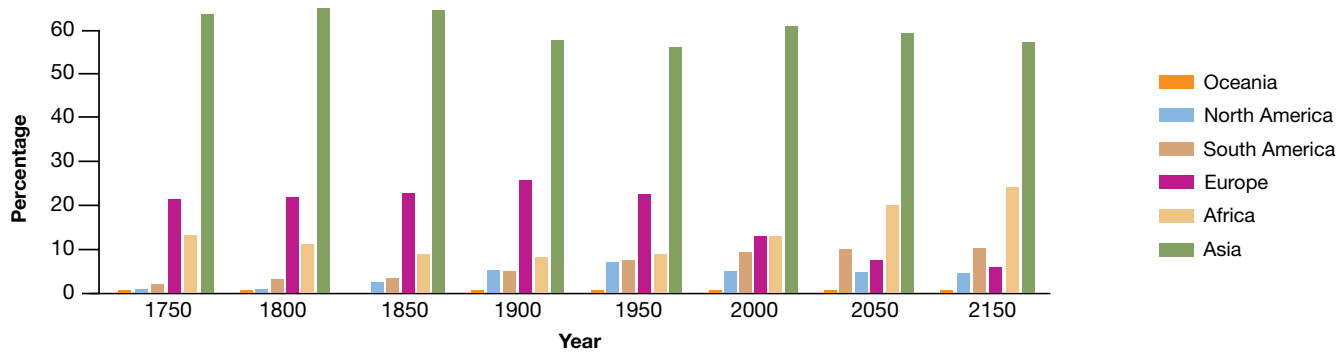
Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.12 World's 10 largest countries by population, 2017 and 2050 (predicted)



Source: *World Population Prospects*, 2015 Revision, United Nations

8.1.13 Projected population change, 2015–50



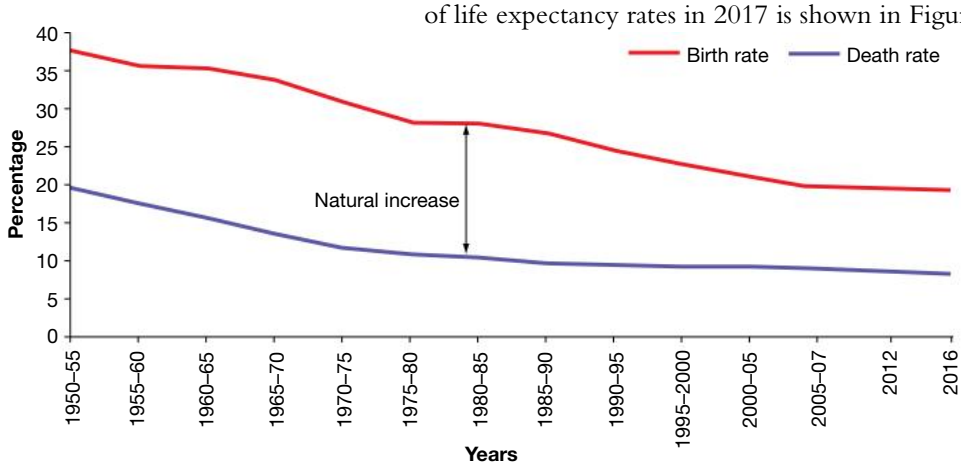
8.1.14 Changing distribution of the world's population

The cause of rapid growth in human numbers

A number of changes have combined to slash child mortality rates and increase life expectancy. These include advances in medical science and public health, nutritional improvements and greater access to education. This has meant that many more young people have survived to their reproductive years than was the case in the past.

The decline in mortality rates (see Figure 8.1.15) is often hailed as one of the great accomplishments of human civilisation. Since the early 1950s, the death rate for the world has more than halved: from 19.7 to 7.8 deaths per 1000 population. The mortality rates for the developed and developing worlds are now 10 and 7 per 1000, respectively. Infant mortality rates have declined from 198 per 1000 live births in 1960 to 32 in 2017. (The rate is five per 1000 in developed countries and 35 in developing countries.)

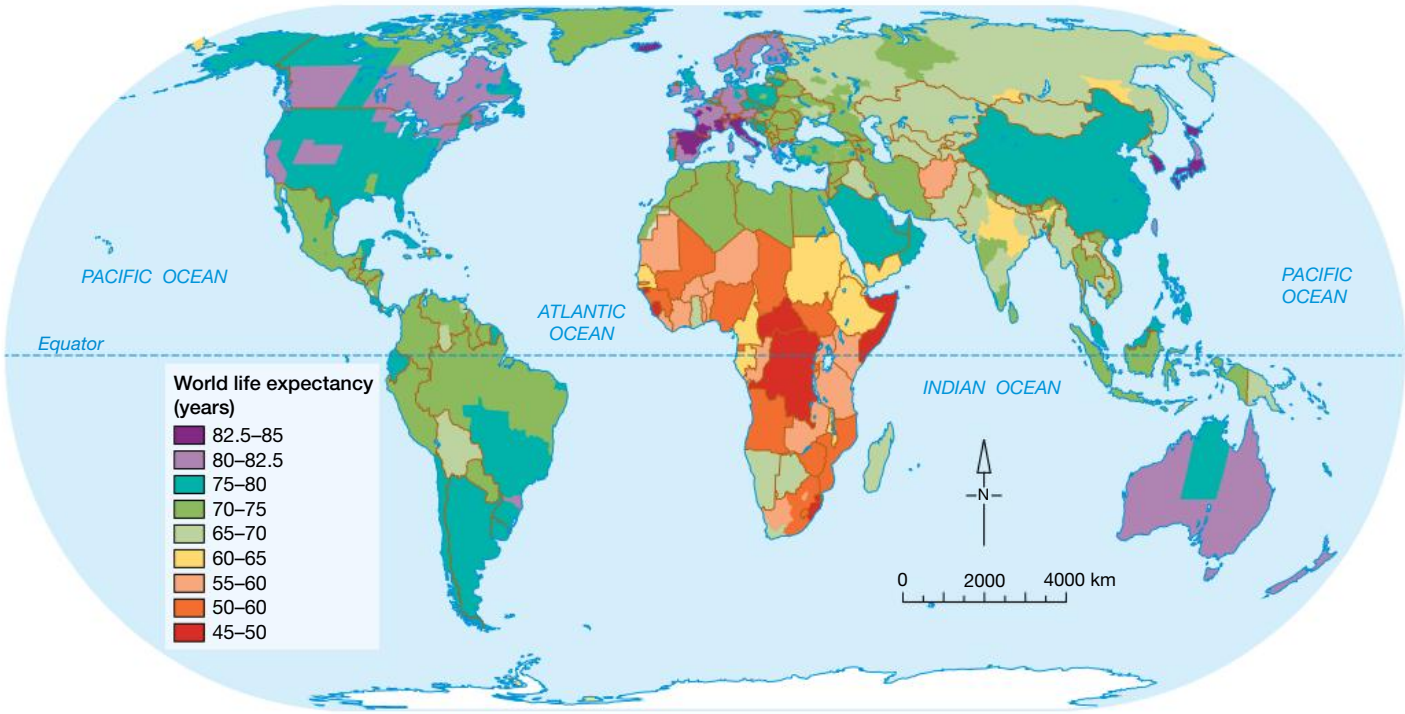
In developed countries, improvements in medical science and public health came about quite slowly and life expectancy increased only gradually. In 1800, life expectancy at birth was about 35 years; by 1900 it had increased to 50 years; by 1950 it had reached 66 years; and today it stands at 76 for males and 82 years for females. The global pattern of life expectancy rates in 2017 is shown in Figure 8.1.16.



Source: *2016 World Population Data Sheet*, Population Reference Bureau

8.1.15 Trends in birth and death rates worldwide, 1950–55 to 2016

In countries of the developing world, the rate of increase began much later but has been more rapid. By 1950 life expectancy had increased to about 50 years. Today it stands at 68 years for males and 72 years for females; an increase of more than half a year every 12 months. Most of this increase came about because of the rapid adoption of medical technologies that originated in countries of the developed world.



8.1.16 Life expectancy, 2017

As a result of these medical and public health improvements, fewer children die in infancy and people live longer. Countries with the highest and lowest life expectancy are outlined in Figure 8.1.17.

Spatial patterns of fertility and mortality

The birth rate is the number of births during a specific period. The crude death rate is the number of deaths during a specific period. These two measures are usually expressed in terms of the number of births or deaths per 1000 people in a population per year. The rate of natural increase of a population is determined by calculating the difference between the crude birth rate and the crude death rate.

The birth rate

There are significant variations in birth rates around the world. The highest birth rates are found in Africa and south-west Asia. For many years, the countries of Africa have had the highest birth rates in the world (see Figure 8.1.18). During the 1980s, Kenya, Tanzania and Uganda all had rates of 50 or more. Demographers regard rates above 30 as high. Many Central American, African and Asian countries are in this category.

Countries with the highest and lowest life expectancy, 2015

Highest		Lowest	
Country	Life expectancy (years)	Country	Life expectancy (years)
Japan	83.7	Sierra Leone	50.1
Switzerland	83.4	Angola	52.4
Singapore	83.1	Central African Rep.	52.5
Australia	82.8	Chad	53.1
Spain	82.8	Cote d'Ivoire	53.3
Iceland	82.7	Lesotho	53.7
Italy	82.7	Nigeria	54.5
Israel	82.5	Somalia	55.0
Sweden	82.4	South Sudan	57.3
France	82.4	Cameroon	57.3
South Korea	82.3	Mozambique	57.6
Canada	82.2	Mali	58.2
Luxembourg	82.0	Equatorial Guinea	58.2
Netherlands	81.9	Malawi	58.3
Norway	81.8	Guinea-Bissau	58.9
Malta	81.7	Swaziland	58.9

Source: *2016 World Population Data Sheet*, Population Reference Bureau

8.1.17 Countries with the highest and lowest life expectancy

The total fertility rate

The total fertility rate (TFR) is a measure of the average number of children born to a woman of childbearing age. The TFR is a particularly revealing statistic because it provides us with an insight into future demographic trends. For example, at the height of Kenya's population explosion in the 1980s, the average number of children born per woman was 8.1. In 2017, it was still high at 3.9. Forty years ago China's TFR was 6.0. Today it is just 1.8.

In recent years, many countries have experienced a steady decline in the TFR. Not only China but also India, Egypt, Brazil and Mexico have lower fertility rates today than they did one generation ago. In a single generation, India's TFR has declined from 5.8 to 2.9, Egypt's from 7.2 to 3.3, Brazil's from 6.3 to 1.6, and Mexico's from 7.7 to 2.2.

Nigeria's TFR (5.5) still exceeds the rate for Africa as a whole (4.6) and, on average, Afghan women still have 5.3 children each. In Timor-Leste the TFR is 5.6, which is only marginally less than Mali (6.0) and Niger in western Africa (7.3).

The lowest fertility rates are in Western Europe, where a number of countries (including Austria, Germany, Liechtenstein, Luxembourg, Monaco, Italy, Greece and Switzerland) have rates at or below 1.5. Other areas with relatively low fertility rates are Australia (1.8), New Zealand (1.9), Japan (1.5), Canada (1.6), the United States (1.8) and China (1.8).

8.1.18 A midwife discusses birth control options with a patient at a reproductive health clinic in Yaounde, Cameroon, West Africa.

It is clear that low birth rates are associated with higher standards of living. As people's material wellbeing increases they tend to have fewer children. China is the exception to this; it achieved its low birth rate by implementing strict population-control measures.

A number of countries that are moderately wealthy have intermediate birth rates. This would suggest that there is a relationship between a country's birth rate and its level of economic development. Economic development is not the only factor. Cultural traditions and the status of women also play a role. In some male-dominated cultures, women may be prevented from exercising control over their own fertility.

The overall decline in fertility has been occurring for several decades. This is why the growth rate of the world's population has declined from its peak in 1970 (2.1 per cent) to 1.1 per cent in 2017. If these reductions are sustained there is some hope that the world's rate of population growth can be slowed. The world pattern of fertility is shown in Figure 8.1.19.

The death rate

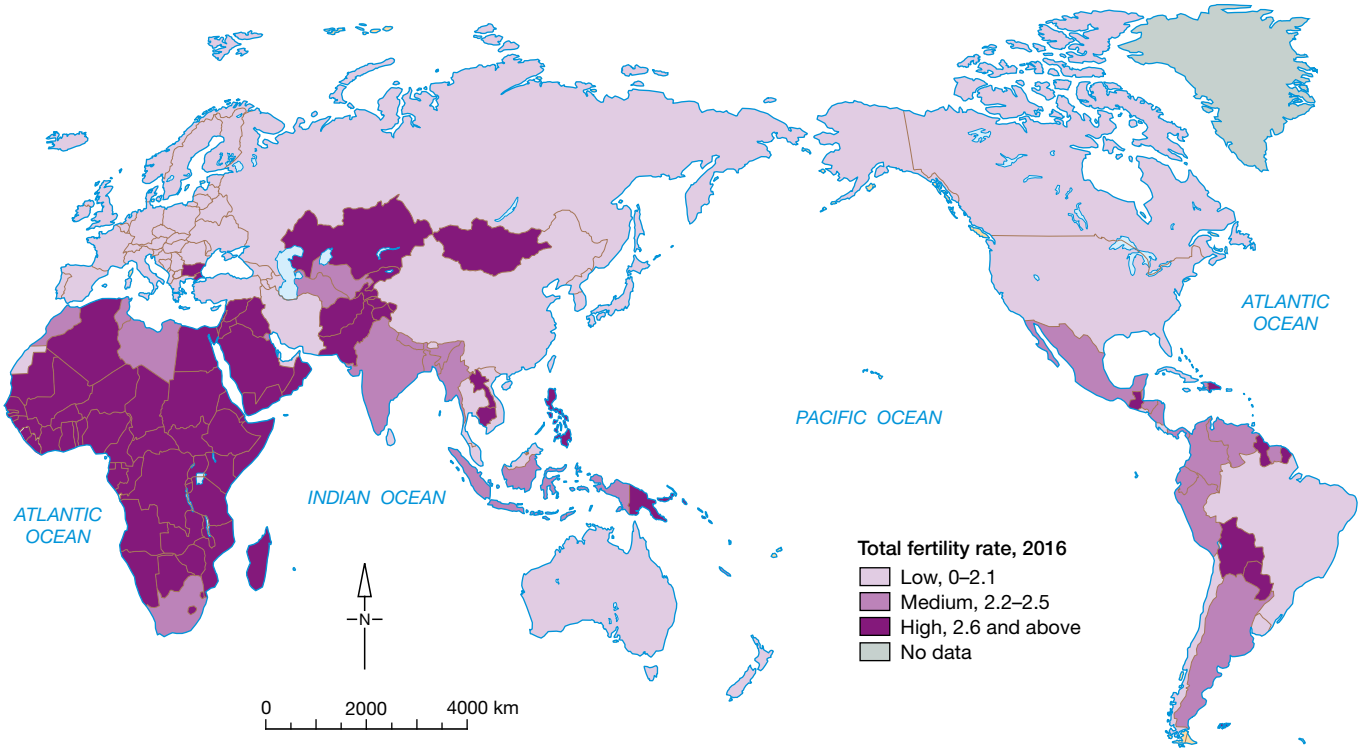
The death (or mortality) rate (MR) is a measure of the number of deaths per 1000 people in a given year. Worldwide the MR is 8, but Africa as a whole has an MR of 9 and some African countries have an MR in excess of 10. These countries include Sierra Leone (13) and Lesotho (13).

A high MR usually indicates that infant mortality is high. Infant mortality rates are highest in Sierra Leone—where 92 out of every 1000 children born die before their first birthday—and the Central African Republic (87).

This is well above the whole of Africa rate of 51 and the worldwide rate of 26. Australia's infant mortality rate, by way of comparison, is only 3.2. The global pattern of infant mortality is shown in Figure 8.1.20.

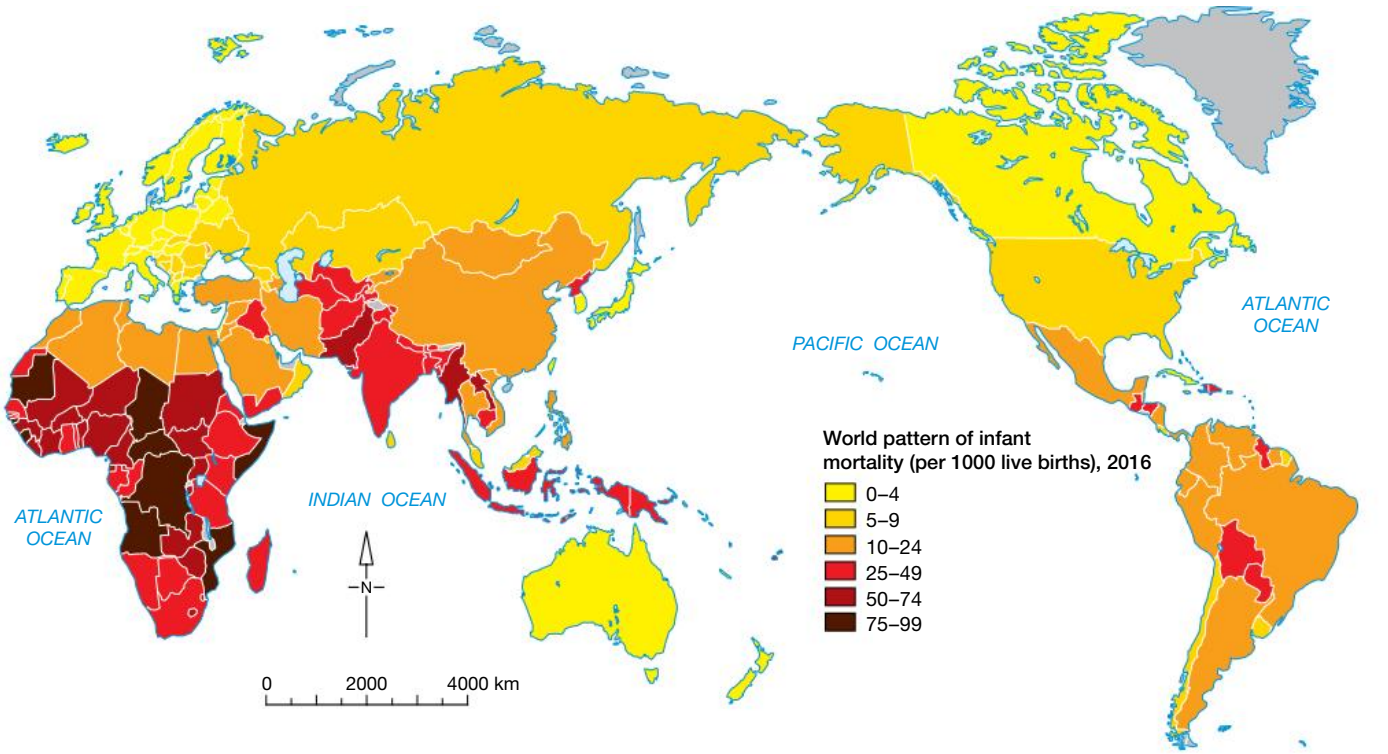
DID YOU KNOW?

Egypt has the most highly concentrated population on earth. Ninety-nine per cent of the country's 95.7 million people live on just 4 per cent of the total land area, which is 1 001 449 km².



8.1.19 Total fertility rate (children per woman), 2010–2015

Source: *2016 World Population Data Sheet*, Population Reference Bureau



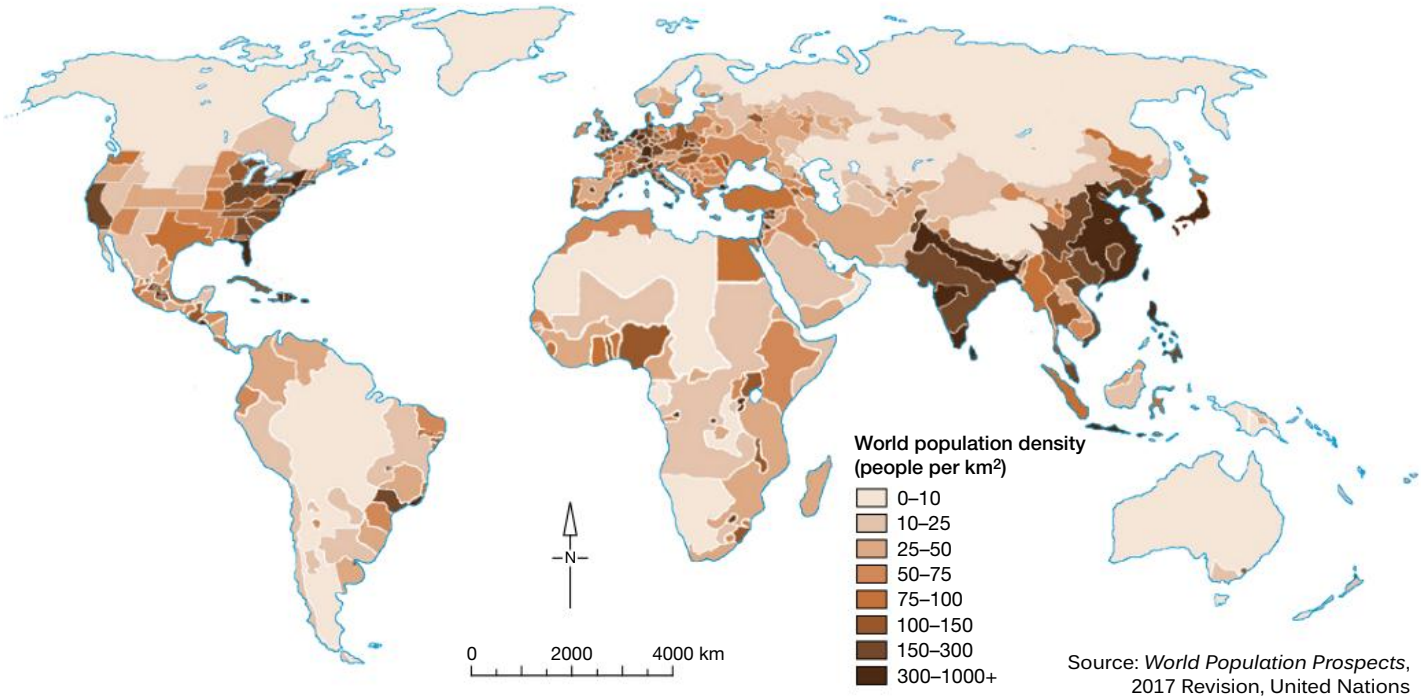
8.1.20 World pattern of infant mortality, 2016

Source: *2016 World Population Data Sheet*, Population Reference Bureau

Population distribution

The distribution or spread of the earth's population is uneven and there are substantial differences in population density; that is, the number of people per unit area.

Population distribution is often shown by using dot maps while population density is, by convention, normally shown using choropleth maps, seen in Figure 8.1.21. Both types of maps reveal those parts of the earth's surface that are sparsely settled and those that are densely settled.



Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.21 Population density map of the world showing countries as well as many subdivisions (regions, states, provinces)

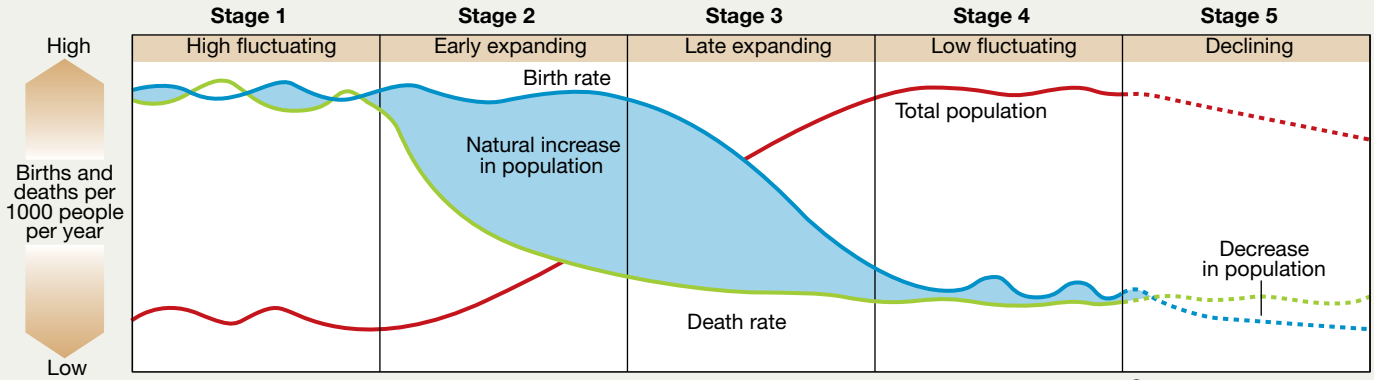
At a global scale, population distribution and density are determined largely by biophysical opportunities and constraints. Land makes up just 30 per cent of the earth's surface. Of this amount, 28 per cent is seriously deficient in water, 22 per cent has soils that are too thin for cultivation, 10 per cent is waterlogged and 6 per cent is affected by permafrost. Only 11 per cent of land offers no serious limitation to settlement and agricultural land use. At a local or regional scale, economic, political and social factors are likely to influence the nature of land use.

SPOTLIGHT

The demographic transition model

In an attempt to explain the nature of population change experienced by countries, demographers have developed the demographic transition model. This model is based on the experiences of several European countries, Canada and the United States. It attempts to identify the different stages of demographic change and to look at their impact on total population. Figure 8.1.22 illustrates these stages.

Future population projections are based on the assumption that developed countries have entered Stage 4 of the demographic transition. Demographers assume, for example, that eventually the birth rate and death rate will reach equilibrium. When the fertility rate (the average number of children women are having) is at replacement (or 2.1 children per family), the two children born essentially replace the parents when they die. (The decimal value accounts for child mortality.)



Stage 1
Birth rates and death rates fluctuate at high levels, resulting in low population growth rates.

Stage 2
Birth rates remain high but death rates fall rapidly. The result is a rapidly growing population.

Stage 3
Birth rates now fall rapidly while death rates also continue to fall but at a slower rate. The net result is a slowly increasing population.

Stage 4
Birth rates and death rates remain low, fluctuating slightly to give a steady population.

Stage 5
Birth rates fall below death rates to give a declining population. There is evidence of this in some countries in Western Europe.

8.1.22 Demographic transition model

Activities

Understanding the text

1 Identify the demographic trend now apparent throughout the countries of the developed world.
2 Describe the impact of this trend on Europe's population.
3 Identify the demographic pattern that is apparent in Asia.
4 Outline the causes of the rapid growth in the human population.
5 Define the term natural increase.
6 Identify where birth rates are the highest and lowest.
7 Explain what is meant by the term total fertility rate (TFR). What trends are apparent in the TFR?
8 Describe the relationship between fertility rates and economic development. What other factors are important?
9 State where death rates are the highest and lowest.
10 Identify the assumptions on which projections about population growth are based.
11 Explain what is meant by the term replacement level.
12 Identify the factors that determine the distribution and density of a population.

Working geographically

13 Study Figure 8.1.10. Which region has:
   a the largest proportion of its population in the 0–14 years age group?
   b the smallest proportion of its population in the 0–14 years age group?
   c the largest proportion of its population in the 25–59 years age group?
   d the highest proportion of the population in the 60+ years age group?
14 Study Figure 8.1.11. Describe the world population structure.
15 Study Figure 8.1.12. Outline how the ranking of the world's most populous countries will change in the period 2017–2050.
16 Study Figure 8.1.14.
   a Identify those regions of the world that are increasing their share of the world's population.
   b Which regions have a declining share of the world's population?
   c How has Asia's share of the world's population changed since 1750?
17 Study Figure 8.1.15. Write a paragraph outlining the trends in birth and death rates since 1950–55.
18 Study Figure 8.1.16. With the aid of an atlas, write a report outlining the spatial pattern of life expectancy.
19 Study Figure 8.1.19. With the aid of an atlas, identify the parts of the world with the:
   a highest fertility rate
   b lowest fertility rate.
20 Write an explanation of the demographic transition model. Include references to the processes responsible for the trends apparent at each stage of the transition.
21 Study Figure 8.1.20. With the aid of an atlas, identify those regions of the world where infant mortality rates are the:
   a highest
   b lowest
22 Study Figures 8.1.13, 8.1.19, 8.1.20 and 12.2.2. Outline the relationship between the rate of population increase, fertility rates, infant mortality rates and gross national income (GNI) per capita.
23 Study Figure 8.1.21, then complete the following tasks. Use an atlas to assist you.
   a Identify the regions of the world that are the most densely settled.
   b Identify the countries with the highest population density.
   c Which regions are the most sparsely settled?
   d Name 10 countries that have low population densities.
   e State the range of population density in each of the following countries: Iceland, New Zealand, Moldova, Belarus, Latvia, France, Cuba, India, Pakistan, Afghanistan and Japan.
   f Compare Figure 8.1.21 with a physical map of the world. Describe the relationship between the nature of the biophysical environment and population densities.
24 Using the US Census Bureau website, complete the following tasks.
   a Access the World POPClock. What is the population of the world today?
   b Access the International Data Base (IDB). Select a group of countries representative of different stages of the demographic transition.
      i Print out the population pyramids for the current year, 2010, 2017 and 2020 for each of the countries selected. Compare the graphs and write a report describing the trends evident.
      ii Use a world map as the basis for a wall display illustrating the demographic trends of the countries selected.
   c Access the IDB Country Summaries. For each of the countries selected in part c of this task, find the estimated population for the current year and 2030.

CASE STUDY

Population projections

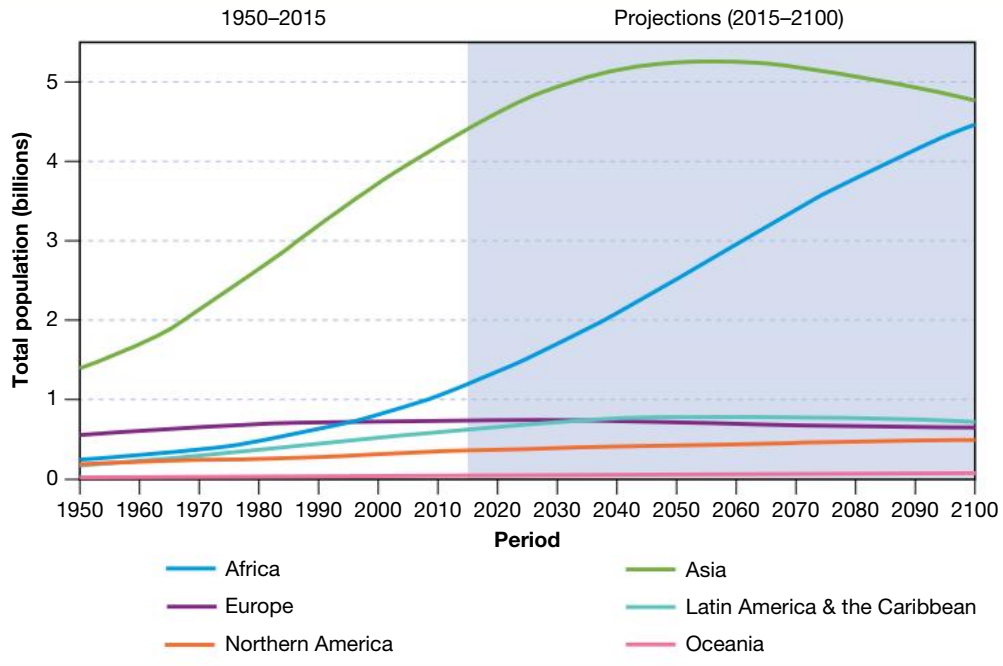
Current population projections are based on the assumption that the Total Fertility Rate (TFR) will decline in those countries where they are high today and that life expectancy will rise where rates are low. They are also based on the assumption that the demographic trends of all countries will duplicate the demographic transition experienced by the countries of the developed world.

An important variable in estimating future population levels is the point at which a country's TFR drops to the replacement level of 2.1 children per woman. In most developed countries the TFR is now below replacement level. The situation in the developing countries is not so clear-cut. In newly industrialised countries, such as South Korea (TFR 1.2), Singapore (TFR 1.2), Brazil (TFR 1.6), China (TFR 1.8), the TFR has already dropped below replacement level. In another group of countries that includes Argentina (TFR 2.3), Bangladesh (TFR 2.3), Indonesia (TFR 2.4), and the Philippines (TFR 2.8) the rate has dropped to less than 3.0. A final group that includes most of the countries in sub-Saharan Africa has experienced only modest declines in fertility.

At a global scale, population projections have proved to be quite accurate. At a national level or regional level, projections tend to be less reliable. The UN projects that the world's population will increase by slightly more than one billion people in the 13 years from 2017, reaching 8.6 billion in 2030, and will increase further to 9.8 billion in 2050 and 11.2 billion by 2100. These outcomes are based on the medium projections.

There is always some inherent uncertainty in population projections, which depend on assumptions about future trends in specific demographic variables. The results presented for future years are based on the medium-variant projection of the 2017 Revision of the UN's World Population Prospects, which assumes a decline of fertility for countries where large families are still prevalent. Survival rates are projected to increase in all countries as death rates continue to decline throughout all age groups.

More than half of the anticipated growth in world population between 2017 and 2050 will occur in Africa, shown in Figure 8.1.23. Of the additional 2.2 billion people who may be added between 2017 and 2050, 1.3 billion will be added in Africa. Asia is expected to be the second largest contributor to this future growth, adding just over 750 million people between 2017 and 2050. Africa and Asia will be followed by Latin America and the Caribbean, Northern America, and Oceania, where growth is projected to be much more modest. In the medium-variant projection, Europe is the only region with a smaller population in 2050 than in 2017. Beyond 2050, Africa will be the main contributor to global population growth. In the medium variant, the fertility rate is assumed to converge eventually towards a level of 1.85 children per woman.



Source: *World Population Prospects*, 2017 Revision, United Nations

8.1.23 Population by region: 1950–2015, and medium-variant projection, 2015–2100

Activities

Working geographically

1 Outline how the projected growth in the world's population will vary from region to region.

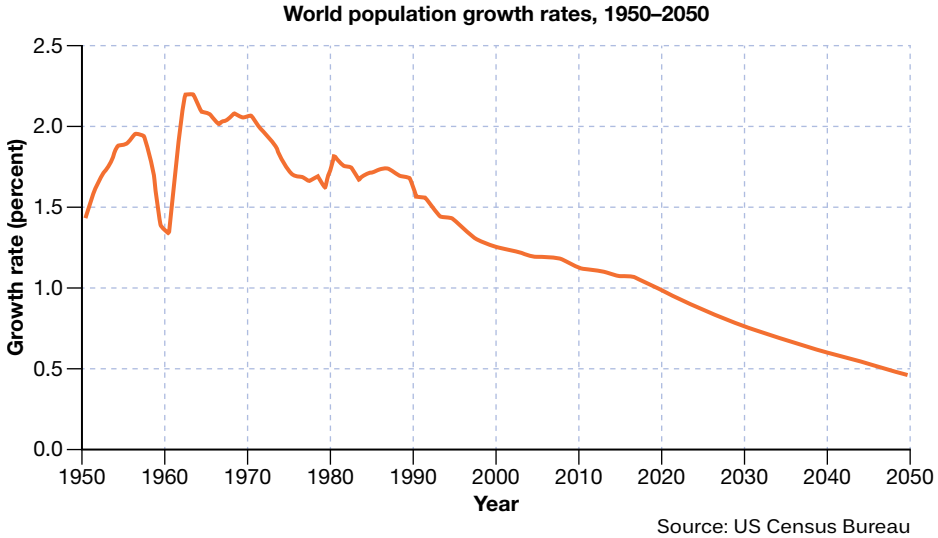
2 Study Figure 8.1.23. Using data from the graph, write a report outlining the projected changes in population of the world's regions.

UNIT 8.2

Factors affecting fertility and mortality rates

The world's annual rate of population increase is slowing, from its peak at 2.06 per cent in the 1960s, to 1.18 per cent between 2010–2015. It is projected to decline to just under 0.5 per cent in 2050 (see Figure 8.2.1) and 0.13 per cent by the year 2100.

The average annual growth rate in 2017 was 1.11 per cent. This slowing is a result of the lower fertility rates that have accompanied improvements in the quality of people's lives and the increasing use of contraceptives. As people's economic and social wellbeing improves they tend to have fewer children.

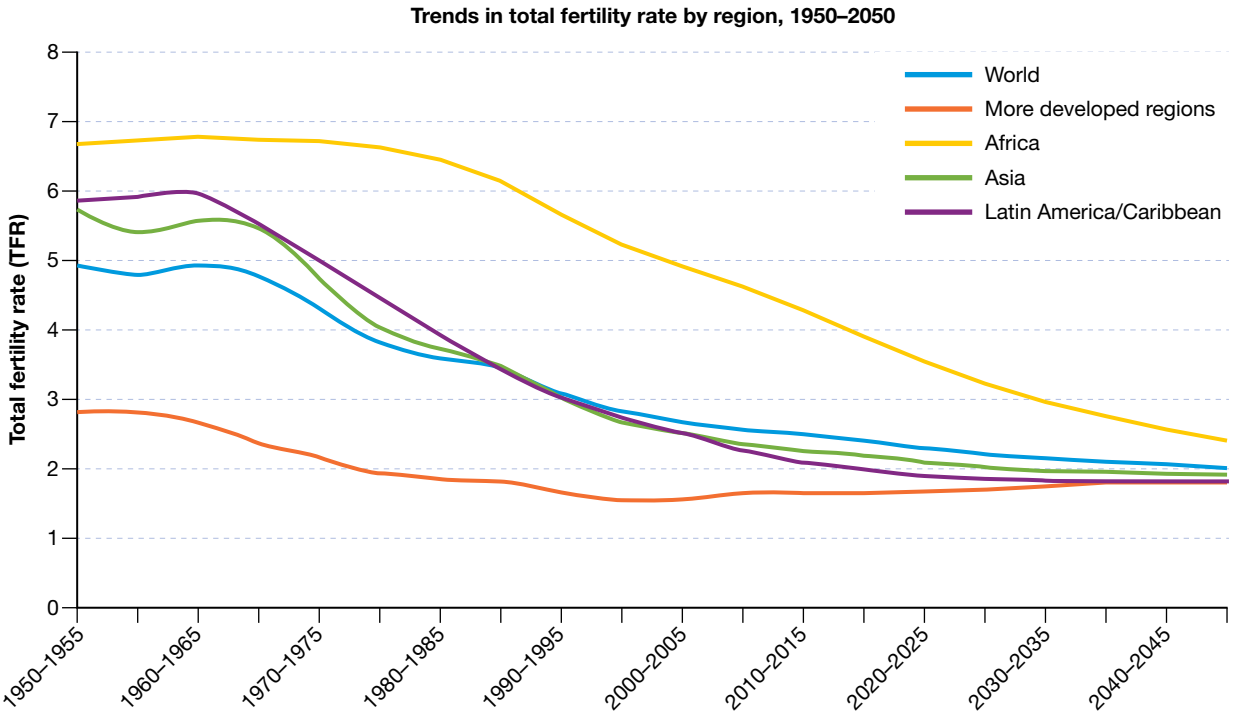


Source: US Census Bureau

8.2.1 World population growth rates (actual and projected), 1950–2050

Fertility rates plummet

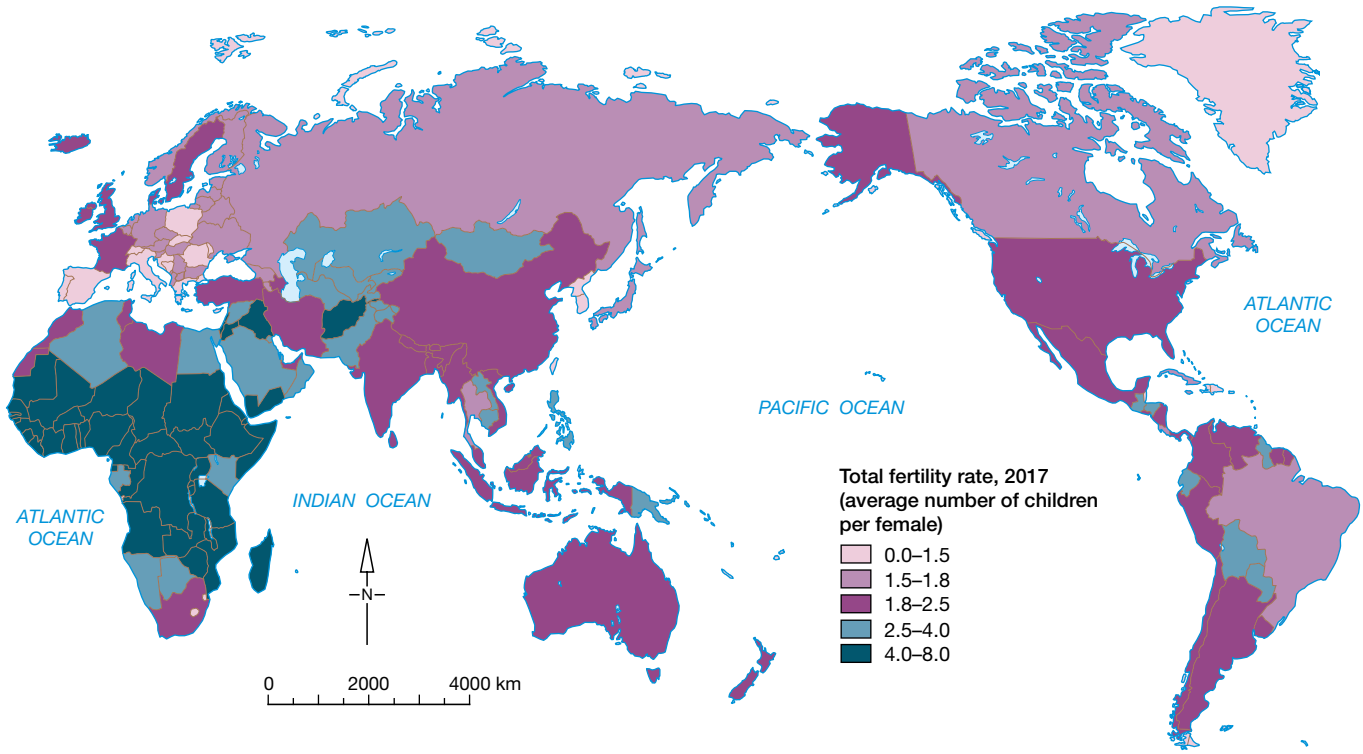
Global birth rates are now at their lowest level in recorded history, seen in Figure 8.2.2. The average woman living in the developing world is now having just 2.6 children, down from an average of nearly six babies in the 1970s. In developed countries the fertility rate has declined to 1.6. UN demographers now predict that fertility rates throughout most of the developing world will fall below the replacement level (2.1 children per woman) before the end of the twenty-first century. Factors contributing to the fall include the increased level of education for women, the use of contraceptives and the process of urbanisation.



8.2.2 Trends in total fertility rate by region, 1950–2050 (actual and projected)

Already, 78 countries have fertility rates below that required to maintain their existing population. The United Nations predicts that by 2050, 75 per cent of developing countries will have below-replacement fertility. China, which implemented a strict one-child per family policy in 1979, has had the largest drop in fertility rates: from 6 in the 1950s to 1.8 in 2017.

About 40 per cent of the world's countries now have fertility rates below replacement level. The lowest rates are found in the world's 44 most developed countries, which together account for 16.8 per cent of the world's population. All have fertility rates below replacement level. Sixteen of these countries, mostly located in southern and eastern Europe, have fertility rates below 1.5 children per woman. Japan, Italy, Spain, Germany and Russia are among the growing list of countries expected to have significantly smaller populations by 2050. The global pattern of total fertility rates is shown in Figure 8.2.3.



8.2.3 Total fertility rates, 2017

Source: 2017 Population Reference Bureau

Because of declining fertility rates, the population of developed countries is expected to remain virtually unchanged between 2017 and 2050, increasing from 1.26 billion to 1.33 billion. By contrast, the population of the world's least developed countries is expected to more than double; growing from 1.0 billion in 2017 to 1.95 billion in 2050. Some of these countries are expected to experience very rapid population growth. For instance, between 2007 and 2050, the population is projected to at least triple in Afghanistan, Burkina Faso, Burundi, Chad, Democratic Republic of the Congo, Timor-Leste, Guinea Bissau, Liberia, Mali, Niger and Uganda. The population of the developing world as a whole is expected to increase; rising from 6.3 billion in 2017 to 8.5 billion in 2050.

Fertility in countries of the developed world

Throughout countries of the developed world, rates of fertility are now falling below replacement level, with an overall figure of just 1.6. Experts expect fertility rates to remain low and possibly undergo a further decline. They attribute this trend to a range of social and economic changes taking place within developed countries.

These include the following:

- The status and role of women has changed. Women's increased level of participation in the workforce has been brought about by a number of factors, such as:
  - the changing structure of the workforce, especially the growth of employment opportunities in the service sector
  - changing social attitudes to the participation of women in the workforce, such as erosion of the once widely held view that, upon marrying, women should relinquish their position in the workforce
  - rising material expectations that have encouraged an increase in the number of two-income families.
- Attitudes to marriage and child-bearing have changed. Women are choosing to marry later, delay the start of their families and concentrate child-bearing within a shorter period of time.
- There is a growing acceptance of alternative lifestyles and family structures. It is becoming more common for women to remain single and/or childless. There is also a growing acceptance of same sex relationships in some societies.
- Methods of birth control have improved and are more acceptable and more widely available. These have enabled women to exercise greater control over their own fertility.

Fertility in countries of the developing world

In the countries of the developing world the first tentative signs of a decline in fertility rates became apparent towards the end of the 1960s. By the mid-1970s this trend had become more widespread. By 1973 the rate had fallen to 3.6 from a 1950s high of 6.2. By 2017 it had declined to 2.6. Although this decline has been substantial, it remains well above replacement level of 2.1. If it is sustained, the population of the developing world will double in just 23 years. The average fertility rate for the developing world also masks some substantial differences between regions. In sub-Saharan Africa the fertility rate is 5.0 children per woman. In western Africa it is 5.3 and eastern Africa it is 4.7; see Figure 8.2.4.

The most widespread decline has occurred in those countries experiencing the fastest rates of economic development (the newly developed countries), such as Thailand (TFR 1.5), Malaysia (2.0) and Singapore (1.2). The relatively high levels of education and well-organised, government-sponsored family planning programs in such countries have been central to their success. So successful was Singapore's 'Stop at Two' policy (in place from the mid-1960s to 1986) that the government had to reverse policy and encourage couples to have larger families. The new policy is: 'Have Three or More, if You Can Afford It.' This initiative was introduced due to the fear of future labour shortages and the restraints these would place on the country's economic growth.

In countries experiencing slower rates of economic development, some success has been achieved through the use of incentives and penalties designed to encourage couples to have smaller families. Before its current surge in economic growth, China achieved a substantial reduction in its fertility rate by just such an approach.

8.2.4 A mother with her five children in Tanzania, Africa. In parts of Africa, fertility rates remain high.

DID YOU KNOW?

UN demographers project the average life expectancy of a child born in 2050 will be 75. A child born today is expected to live, on average, until 72, while 60 years ago life expectancy at birth was 46 years. In the more developed regions, the projected increase is from 79 years today to the mid-high eighties by mid-century.

SPOTLIGHT

Fertility facts

- Twenty-six per cent of the world's population is aged under 15 years. In developing countries, the population under the age of 15 can be as high as 50 per cent (as occurs in Niger, Africa). In developed countries, the proportion can be as low as 12 per cent (Japan), 13 per cent (as in South Korea, Germany and Monaco) and 14 per cent (as in Austria, Bulgaria, Hungary, Andorra, Bosnia-Herzegovina, Greece, Italy, Portugal and San Marino).
- In 2017, Niger had the highest fertility rate, at 7.3 children per woman, while Singapore, South Korea, Taiwan, Romania, Andorra and Bosnia-Herzegovina had the lowest, at 1.12.
- In 2017, Angola, Niger, Somalia, Chad, and Democratic Republic of the Congo all had total fertility rates greater than 6.0 per woman.
- In 2017, Sierra Leone had the highest infant mortality rate, at 92 deaths per 1000 live births. Iceland (1.7 per 1000 live births), Slovenia (1.8) and Finland (1.9) had the lowest rate of infant mortality.

Factors affecting fertility rates

Factors affecting fertility rates include the following:

- **Levels of economic and social wellbeing:** Fertility rates generally decline with increasing levels of development.
- **Infant mortality rates:** High infant mortality rates result in families having larger numbers of children in the expectation that some will not survive infancy.
- **The importance of children as part of a family's labour force:** In many countries of the developing world, children are seen as an asset because of the labour they are able to contribute to subsistence farming practices. Children also assist with the collection of water and fuelwood.
- **Levels of urbanisation:** Urban dwellers tend to have a lower fertility rate than people living in rural areas.
- **Educational and employment opportunities for women:** Fertility rates tend to be high where women have little or no access to education and paid employment.
- **The average age of marriage:** As the average age of marriage increases, fertility rates tend to decrease. If marriage is delayed to the age of 25, a woman cuts her child-bearing years (typically ages 15–44) by 10 years and reduces her prime reproductive years (typically 20–29) by 50 per cent.
- **The cost of raising children:** The high cost of raising and educating children in developed countries has contributed to a reduction in fertility.
- **The availability of reliable methods of birth control:** Access to contraceptives tends to reduce fertility.
- **The availability of aged services and pensions:** These reduce parents' reliance on their children to support them in their old age.
- **Family size preferences:** In some societies, family size is influenced by a range of cultural factors, including religious beliefs and cultural traditions. These, in turn, are often linked to the status of women and the degree of control that women are able to exercise over their own fertility.

Factors affecting mortality rates

The factors affecting mortality rates include:

- nutritional standards
- standards of personal hygiene and effluent disposal (sanitation)
- access to safe drinking water and the incidence of infectious diseases
- access to medical and public health technology, including immunisation, antibiotics and insecticides.

High rates of infant mortality are usually an indication of inadequate food (under-nutrition) and poor diet (malnutrition). They often can also indicate a high incidence of infectious diseases, many of which are contracted from contaminated water.

Population policies

The countries experiencing the most substantial declines in fertility are those that have implemented population-control policies that are well-organised, government-initiated and emphasise birth control and family planning. By themselves such policies are unlikely to achieve sustained reductions in fertility unless they are associated with programs that promote economic and social development. Coercive policies are rarely successful, such as the policy implemented in India in the 1970s, where sterilisations conflicted with civil liberties as well as religious and cultural beliefs.

Family planning programs can be a highly emotive, cultural, religious and political issue in many countries. Culturally sensitive family planning programs are central to the achievement of sustained reductions in fertility and population growth rates. Such programs need to be combined with improvements in infant and maternal health care programs.

SPOTLIGHT

China's one-child policy

China's one-child policy (or Planned Birth Policy, as it is officially known) was introduced in 1979 and phased out beginning in 2015. The aim of the policy was to limit the country's population growth. Although introduced as a temporary measure, the policy stayed in place for more than three decades. Officially, couples were limited to just one child. Second or subsequent pregnancies were met with fines, economic penalties and pressure to have the pregnancies aborted.

The policy was not an all-encompassing rule. It has, in practice, only applied to ethnic Han Chinese living in urban areas. Ethnic minorities and those living in rural areas were not subject to the policy. Nevertheless, the policy proved very successful in reducing the rate of China's population growth.

There were some unplanned demographic and social impacts. Male children are often prized more highly than girls. This resulted in cases of neglect and abandonment of female children. Female babies were often aborted, and infanticide was known to occur. As a result, there is now a gender imbalance; 118 boys were born for every 100 female babies. This compares with a worldwide average of 103 to 107.

The policy proved very effective at curbing China's population growth rate. In 1979, when it was introduced, the fertility rate (TFR) was over 5.0. By 2017, the TFR had dropped to 1.8, well below the population replacement rate of 2.1. To prevent too dramatic a population decrease a special provision was introduced to allow millions of couples to have two children legally. To qualify, both partners had to be without siblings (brothers or sisters).

Activities

Understanding the text

1 Outline the trends apparent in global fertility rates. Explain why these trends are occurring.

2 Describe how the changing status and role of women has affected fertility rates in the countries of the developed world.

3 Identify the fertility trends that are now apparent in the countries of the developing world.

4 List the factors affecting fertility rates.

5 List the factors affecting mortality rates.

6 Outline what must accompany family planning policies if they are to achieve sustained reductions in fertility rates.

Working geographically

7 Write an extended response. Topic: 'Outline the factors affecting rates of fertility and mortality and account for the differences observed on a global scale.'

8 Study Figure 8.2.1.
- a When did the rate of population growth peak?
- b What trend was apparent between 1975 and 1990?
- c What has been the trend since 1990?

9 a Outline the extent of the decline in fertility.
- b Explain the consequences of this decline for the countries of both the developed and developing worlds.

10 Study Figure 8.2.2. Using data from the graph outline the trends in fertility rates for the world's regions.

11 Study Figure 8.2.3. With the aid of an atlas describe the world pattern of fertility.

12 a Outline China's one-child policy and explain how it was enforced.
- b Describe the impact of the policy on China's population growth rate.
- c Outline the unplanned demographic and social impacts of the policy.

Population structure

By studying the age and gender structure of a population we gain useful insights into the prospects for future population growth and a range of issues related to a population's economic and social needs. The demographic transition model shows only the rate of natural increase (or decrease) resulting from the difference in birth and death rates. On the other hand, population pyramids show the impact of migrations, wars, major epidemics and gender imbalances.

The ageing of the world's population

Percentage of persons aged 65 years and over			
Region	**2017**	**2025**	**2050**
World	9	10	16
■ Developed countries	18	21	26
■ Developing countries	7	9	15
Europe	18	21	28
North America	10	18	21
Oceania	12	15	19
Latin America	8	10	19
Asia	8	10	18
Africa	3	4	7

Source: *2017 World Population Data Sheet*, Population Reference Bureau

8.2.5 Percentage of persons aged 65 years and over, 2017, 2025 and 2050 (projected)

The world's population is ageing. As Figure 8.2.5 shows, almost every region is experiencing growth in both the number and proportion of older persons in their population. Population ageing is poised to become one of the most significant social transformations of the twenty-first century with implications for nearly all sectors of society, including labour and financial markets, the demand for goods and services, such as housing, transportation and social protection, as well as family structures and intergenerational ties.

In 1970, there were 291 million people over the age of 60 years. This represented 7.8 per cent of the world's population at that time. By 2017 this had grown to 962 million or 12.8 per cent. By 2050, almost 2.1 billion people (or 22 per cent of the world's total population) will be over 60 years of age.

In Europe, 25 per cent of the population is already aged 60 years or more. This is projected to reach 35 per cent in 2050 and to remain around that level in the second half of the century. Populations in other regions are also expected to age in the period to 2100.

SKILLS BUILDER

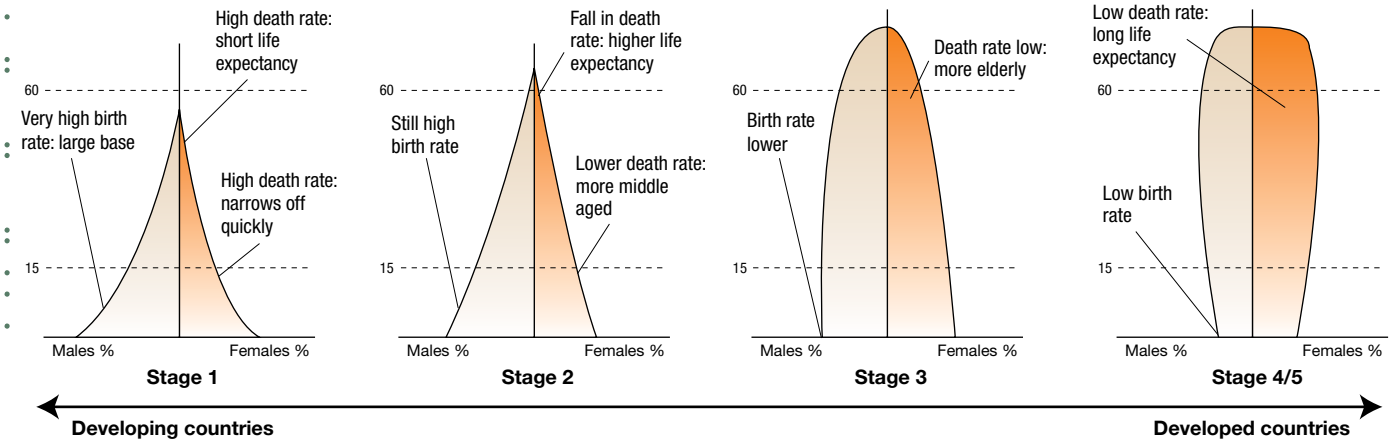
Population pyramids

Population pyramids are bar graphs used to illustrate the age and sex structure of a population. The vertical axis of the graph represents the various age groups of a population. The horizontal axis shows either the actual number or the proportion of the population for both males and females. Because each population pyramid represents 100 per cent of a particular population, comparisons can be made with the population pyramids of other populations.

Sometimes the horizontal scale shows the actual number of people in each age group. Before you try to interpret a graph, always check the units of measurement used on the horizontal axis.

Populations are often divided into broader age groups based on dependency. The dependent parts of the population are usually defined as the 0–14 age group and the 65 and over age group. The changing proportion of the population in each of the age groups provides us with valuable information about future population trends. For instance, if the proportion of the population 65 years and over is growing, the population is said to be ageing. If the proportion of the population 14 years and under is decreasing, we can conclude that the birth rate is declining, as is the rate of population increase.

Figure 8.2.6 shows some of the common population pyramid shapes and the conditions under which they develop.



8.2.6 Common population pyramid shapes and the conditions under which they develop

Africa, for example, which has the youngest age distribution of any region, is projected to experience a rapid ageing of its population. While the African population will remain relatively young for several more decades, the percentage of the population aged 60 or over is expected to rise from 5 per cent in in 2017 to around 9 per cent in 2050, and then to nearly 20 per cent by the end of the century.

Today, 237 million people are aged 80 years or older. By 2050, this number will have increased to 425 million. By 2100, this is projected to increase to 909 million, nearly seven times the number in 2017. Eighty per cent of these older people will live in low- and middle-income countries. See Figure 8.2.7.

8.2.7 Lunch being prepared for the 600 residents of a nursing home in Harbin, north-eastern China. Meeting the needs of a growing population of the aged is presenting the countries of the world with new challenges. China currently has over 128 million elderly citizens, and the figure is estimated to increase to 400 million people by 2050.

DID YOU KNOW?

Despite the surge in population growth in Africa, more than half the world's people will continue to live in Asia. At its projected growth rate, Asia's population will increase from 4494 million to 5245 million by 2050. This is an increase of 16.7%.

Median age

Another way of observing the ageing of the world's population is to focus on its median age. In 1950, the median age of the world's population was 23.9 years. By 2017 this had increased to 29.9 years, and by 2050 it is projected to increase to 36 years. However, these global figures mask significant regional differences. The population of Europe, for example, has the world's oldest median age of nearly 42.6 years and this is expected to reach 52.3 years in 2050. The least developed countries, on the other hand, tend to have young populations. Niger, Uganda, Mali, Malawi, Zambia, Burundi, Mozambique, South Sudan, Burkina Faso, Chad, Tanzania, Ethiopia and Somalia have a median age of less than 18 years of age.

Activities

Understanding the text

1 Outline the information that can be obtained about a population by examining its population pyramid.

2 Explain why the world's population is said to be ageing.

3 Outline the factors responsible for the ageing of the world's population.

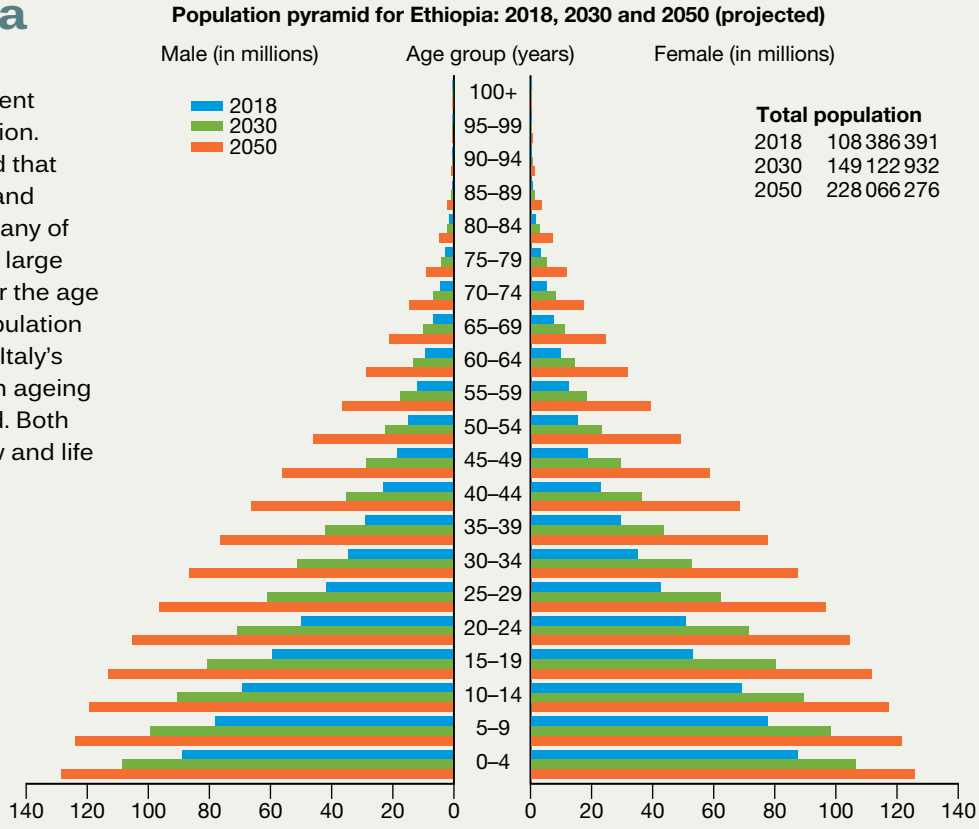
Working geographically

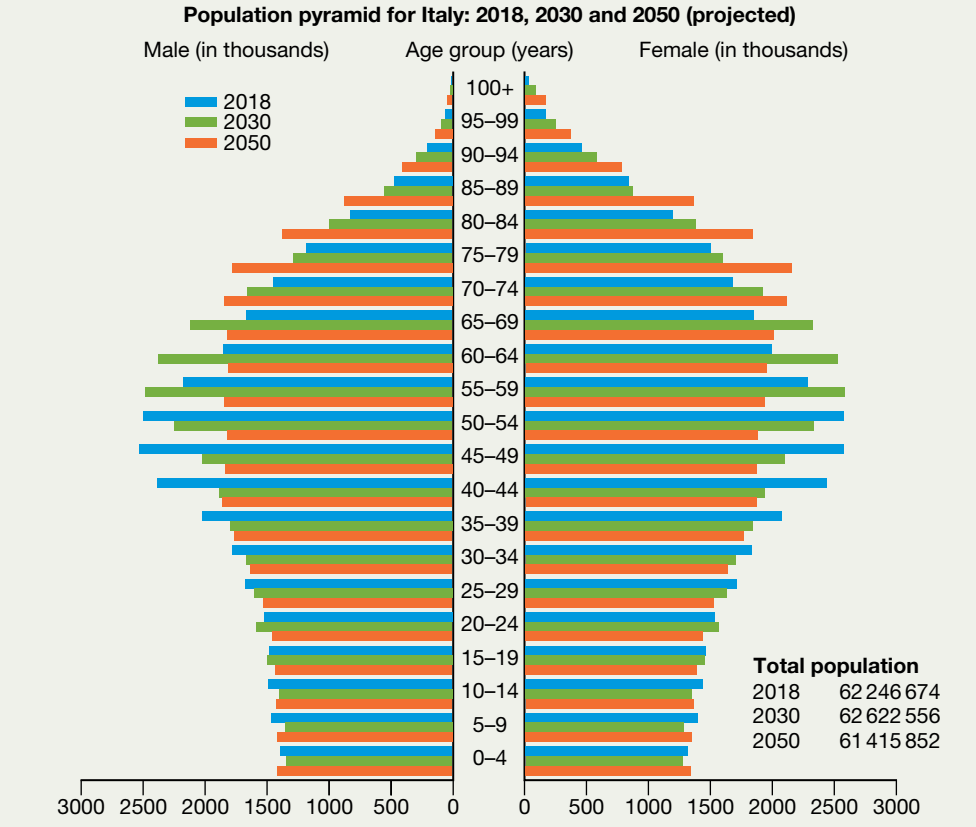
4 Study Figure 8.2.5. What does this data reveal about global inequalities in life expectancy?

SPOTLIGHT

Italy and Ethiopia

Figure 8.2.8 shows the population structure of two countries at different stages of the demographic transition. Ethiopia has a population pyramid that shows the impact of high fertility and mortality rates. This is typical of many of the world's poorest countries. The large proportion of the population under the age of 15 will ensure high levels of population growth for the foreseeable future. Italy's population pyramid is typical of an ageing population in the developed world. Both birth rates and death rates are low and life expectancy is high.





8.2.8 Population pyramids for Ethiopia and Italy: 2018, 2030 and 2050

Activities

Working geographically

1 Study Figure 8.2.8 and then answer the following questions.

- **a** Estimate the proportion of the population under the age of 15 for each of the populations in 2018.
- **b** Estimate the proportion of the population over the age of 60 for each of the populations in 2018.
- **c** Describe how the population structure of Ethiopia is typical of many other developing countries.
- **d** Describe the future trends in Italy's population.
- **e** Outline the potential for future population growth in each population.
- **f** Explain how the future social needs of Ethiopia and Italy will differ.
- **g** Explain why Italy is concerned about its future labour requirements.

UNIT 8.3

Population movements

Migration is the act or process of moving from one place to another with the intention of staying at the destination permanently or for a relatively long period of time. The movement of people out of an area is referred to as emigration while the movement of people into an area is called immigration.

Basic classification systems identify two broad types of migration: internal migration and international migration. Internal migration refers to population movements within a country, while international migration involves movement across national boundaries. Migrations can also be defined as being either forced or voluntary. Voluntary migrations occur when people move because they wish to improve their economic and social wellbeing and/or to gain personal freedom. Forced migrations are usually the result of circumstances beyond the control of the individual. Natural disasters, wars and civil unrest often initiate large-scale population movements.

The features of contemporary population movements include:

- the globalisation of migration
- an increase in the volume of migration in all regions
- a growing diversity in the type of migration—most countries with a migrant intake have a mix of immigration categories: labour, refugee, permanent settlement and family reunion
- an increasing proportion of women in all types of migration across all regions—this is particularly the case with labour migration and some refugee movements
- the increasing international mobility of highly qualified personnel
- the movements associated with economic and social change in newly industrialised countries.

International movements

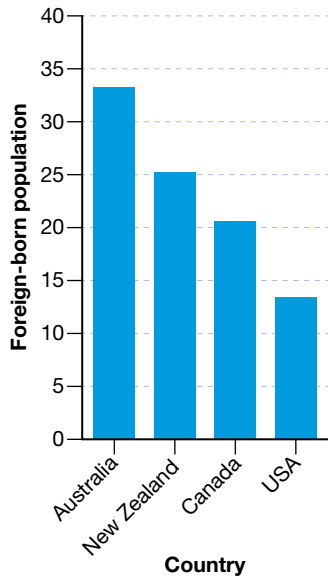
The movement of people from one continent to another and from one country to another has been a feature of human history for thousands of years. Today, such movements are part of a global process that is reshaping societies and cultures. Many contemporary migrations are closely related to the economic, political and cultural links being formed between countries due to the process of globalisation. The volume of movement is likely to increase because of this. Population movements are changing the face of the world: migration and ethnic diversity within countries are powerful forces for social and cultural change. There are now more than 244 million people living outside the country in which they were born. This is a 41 per cent increase on the figure in 2000.

International population movements have affected regions and countries in different ways. Some countries are largely the product of immigration. Examples are the United States, Canada, Australia and New Zealand (see Figure 8.3.1). Their populations consist mainly of European immigrants and their descendants. The indigenous populations have been mostly dispossessed. In the last 30 years, these four countries have experienced a change in the source of their immigrants. Many of their immigrants now come from Asia and, in the case of the United States, from Mexico, South America and the Caribbean.

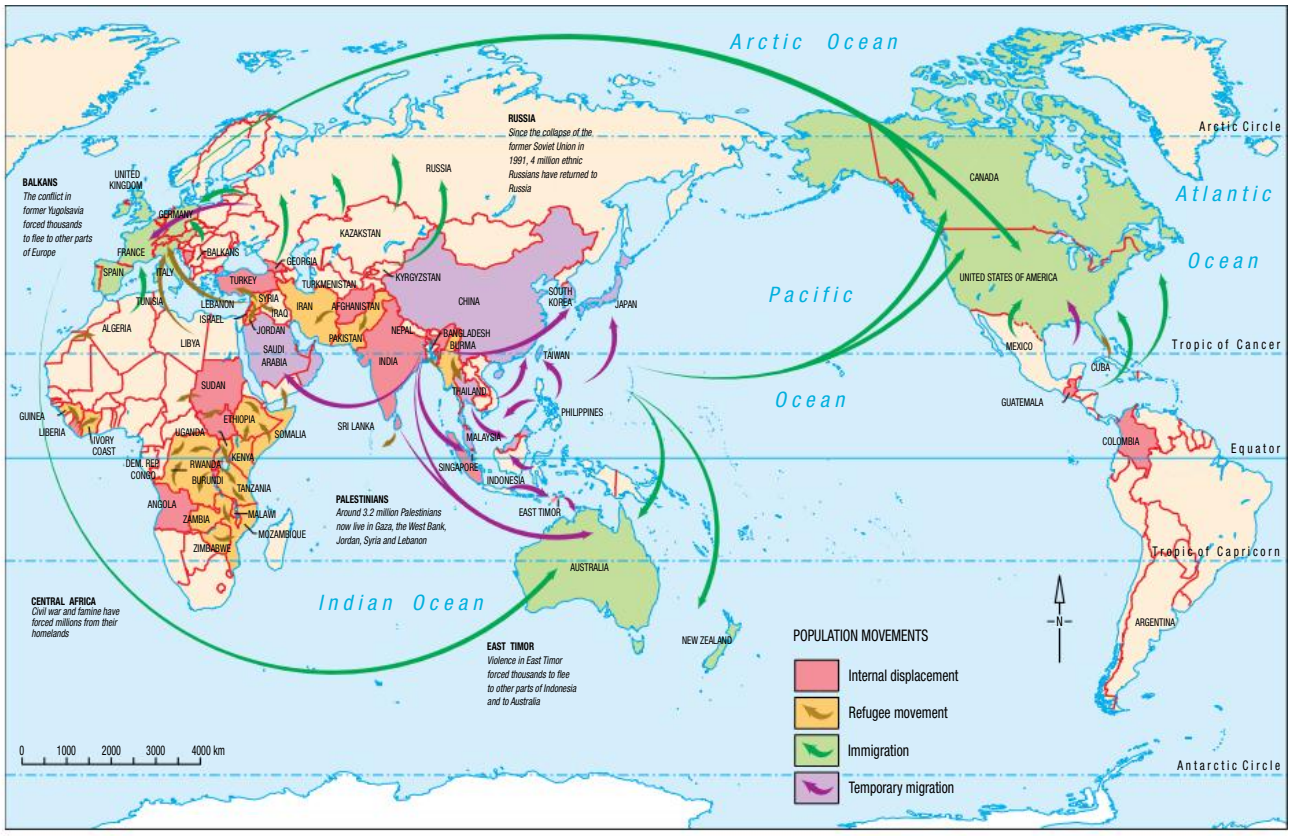
SPOTLIGHT

Diaspora

A diaspora is a spread of people from their homeland. In 2016, 16 million people from India were living outside of their country, the largest in the world, compared to 12 million from Mexico. Other countries with large diasporas include the Russian Federation, China, Bangladesh, Pakistan and Ukraine. Of the twenty countries with the largest number of international migrants living abroad, 11 were in Asia, six in Europe, and one each in Africa, Latin America and the Caribbean, and Northern America.



8.3.1 Proportion of overseas-born population for Australia, New Zealand, Canada and the United States, 2016. Australia has the most diverse population of any of the four countries, widely considered the product of immigration.



8.3.2 shows the impact that recent migration has had on specific populations.

Central and South America

Most Central and South American countries have been affected by the movement of refugees and foreign workers. There has been an exodus of refugees from Cuba and Haiti to the United States. Significant labour migrations (frequently illegal) have moved to the United States from Mexico, Jamaica and other countries of the Caribbean. Such migrations have become a major political issue in the USA, especially amongst the extreme right of US politics.

Africa

In Africa, large-scale migrations have often been initiated by climatic disasters, military conflict, civil disorder and famine. Other population movements are associated with migrant labour systems established to meet the needs of plantations and mines. These movements date from the period of colonialism and white settlement. The largest of these was an international recruitment system operated by South Africa, which continues to function in a modified form. In sub-Saharan Africa, migration has always been a tradition, although much of it is seasonal.

Asia

In Asia, large-scale international movements are common. Iran and Pakistan play host to millions of Afghan refugees. Pakistan alone is home to over 2.5 million Afghan refugees. There are also 950 000 Afghan citizens living in Iran. Most of these were born and raised in Iran during the last three and a half decades. India has, over recent decades, received thousands of immigrants from Sri Lanka, Nepal and Bangladesh. The emerging economic powers of South-East Asia have also attracted thousands of foreign workers, many of whom arrive illegally.

The Middle East

In the Middle East, oil revenues have created a demand for foreign labour. 'Guest workers' from other Arab states, India, Sri Lanka, Bangladesh and the Philippines have been recruited in large numbers. Most are employed on short-term contracts. Elsewhere in the region, population movements can be quite complex. Turkey, for example, is a country of both emigration and immigration. During the 1960s and 1970s millions emigrated, mainly to Germany, as guest workers. When recruitment of workers ceased, family reunion took over as a main motivation for Turks to migrate. Turkey, in turn, has become a favoured destination for Turks and other Muslims escaping religious persecution in Eastern Europe.

Europe

Patterns of movement within Europe have changed dramatically as a result of the collapse of communism in the late 1980s, the conflict in the former Yugoslavia throughout the 1990s, and most recently the influx of millions of asylum seekers from Syria, Libya and Northern Africa. Germany has been the country most affected by these changes.

SPOTLIGHT

European refugee crisis

Beginning in 2014, Europe has experienced a massive influx of refugees making the hazardous journey across the Mediterranean Sea (or via the safer overland through South-east Europe) seeking a new life in the European Union (see Figure 8.3.3).

8.3.4 Principal refugee migration routes to Europe

8.3.3 Turkish Coast Guard crew rescue migrants after their boat sank crossing the Aegean Sea.

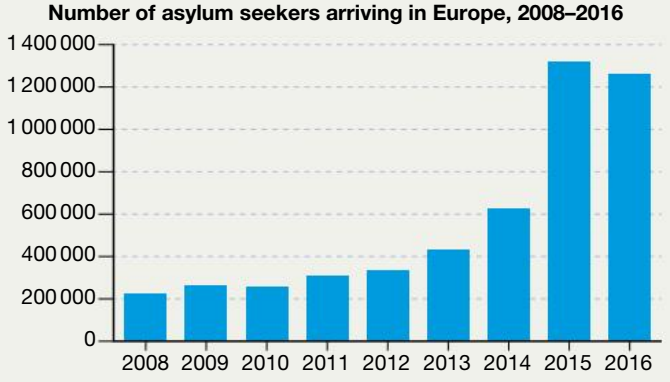
As seen in Figure 8.3.4, most of the migrants came from Muslim-majority countries of northern Africa, western Asia and south Asia. The majority of migrants are Sunni Muslim with Syria, Afghanistan and Iraq being the dominant source countries.

The movement of asylum seekers to Europe is not new, what is new is the numbers involved. Figure 8.3.5 shows the number of applications for asylum 2008 to 2016. Over this period, just over 5 million people have applied for asylum, 1.8 million of these in Germany. France is the second favoured destination with over half a million applicants, followed by Sweden with 481 000.

SKILLS BUILDER

Flowline maps

Flowline maps (such as Figure 8.3.4) show the movement of information, goods and people between places and the quantity of such movements. Movements are shown by lines or arrows that link the place of origin with the destination.



8.3.5 The number of asylum seekers arriving in Europe, 2008–2016

Activities

Understanding the text

1 Define migration. How can it be classified?

2 Outline the features of contemporary international population movements.

Working geographically

3 Study Figure 8.3.1. Identify the country with the highest proportion of overseas-born residents. What proportion of New Zealand's population was born overseas?

4 Study Figure 8.3.2.

- a List the main flows of migration shown on the map.
- b Name the parts of the world that have experienced significant levels of internal displacement.
  - i Identify the main source regions of temporary migrations.
  - ii What are the main destinations of these temporary migrations?
- c Describe the main refugee movements shown on the map.

5 Study the section of text, 'European refugee crisis'. Outline the nature and scale of the crisis. Investigate the causes of the crisis. Describe the major migration routes.

8.3.6 Sydney's Lord Mayor, Clover Moore, presents a Citizenship Certificate to a new Australian. Many people make a conscious choice to migrate and settle permanently in another country in the hope that they will achieve a better quality of life for themselves and their children.

DID YOU KNOW?

The 'skilled migration stream' consists of those who migrate permanently and who have skills and qualifications in demand in Australia. The 'family migration stream' consists of family members who migrate to Australia in order to join relatives who have already migrated here.

Types of international movements

The main types of international movements are described below.

Resettlement migration

Many people make a conscious choice to migrate and settle permanently in another country in the hope that they will achieve a better quality of life for themselves and their children (see Figure 8.3.6). Others seek to be reunited with family members who have previously undertaken the move.

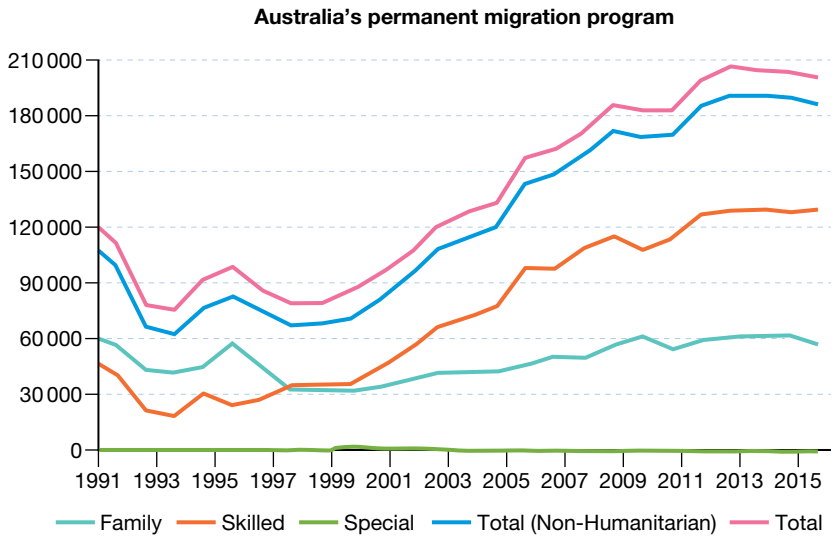
A feature of recent resettlement migration has been a growth in the number of professionals, technicians and other highly skilled personnel migrating on a permanent basis. For example, Europe, North America and Australia have accepted thousands of doctors and engineers from places such as India and Malaysia, many of whom are unable to find well-paid work in their own countries. Such migrations, however, are a drain on the resources of many poorer countries.

Meeting Australia's demand for skilled workers

Australia has a long history of planned migration. Since World War II, it has welcomed more than 7 million migrants. On a per capita basis, Australia has taken more migrants than Canada, New Zealand or the United States in the post–World War II years.

Today, one in three of Australia's current population of 24.7 million people was born overseas. This is much higher than other traditional immigration countries. Our overseas-born population originates from over 170 countries.

In 2015–16, Australia received 189 770 migrants. Of these, more than 128 550 entered via the skilled migration stream, while the family migration stream accounted for 57 400 places. Within the skilled stream, 48 250 were employer-sponsored. General skilled migration accounted for 72 840 immigrant arrivals. Those whose occupations appear on the skilled occupation list are given priority. Applicants must be over 18 and under 45 years of age; they need to have good English language ability, and recent skilled work experience or a recently completed, eligible Australian qualification. Figure 8.3.7 shows Australia's permanent migration program by category, 1991–2015.



8.3.7 Australia's permanent migration program by category, 1991–2015. 'Special' covers visas for those in special circumstances that do not fit in other streams (for example, permanent residents returning to the country after a period away).

Australian employers are permitted to employ skilled foreign workers who have recognised qualifications and skills and/or experience in particular occupations required in Australia as long as they can demonstrate that they have tried to employ a locally qualified worker.

Top destinations of new Australian settlers in 2015–16 were:

- New South Wales (32.5 per cent)
- Victoria (25.0 per cent)
- Western Australia (11.9 per cent)
- Queensland (11.5 per cent).

Contract migrations

Contract migrations are usually undertaken for a specified period and are related to contracted employment. Part of the income earned is often sent back home to the worker's family. Some 50 to 60 million of an estimated 244 million people (3.3 per cent of the world's population) living outside their country of birth are thought to be foreign workers. They are believed to remit (or return) more than US$429 billion annually (2016) to their homelands. Contract migrations fall into several categories.

Guest workers

In some parts of the world there are more jobs than there are people willing or able to work. To solve the ensuing labour shortages, governments often permit the entry of guest workers for a specified period of time. Most work within a rigid contractual framework; they are not permitted to settle or be accompanied by dependants and they are denied a range of civil and political rights. Many are required to live in barracks. Women domestic workers are often subjected to exploitation and sexual abuse. (See the Spotlight on 'Population movements: the Middle East and Northern Africa'.)

Business migrations

The globalisation of economic activity has been accompanied by the growth in the international movement of highly qualified executives and professionals. An increasing number of firms are sending personnel to work in overseas firms or joint ventures. Japanese firms, for example, have more than 110 500 personnel assigned to overseas branches. An additional 1 million Japanese people go abroad each year on short visits related to business. This type of migration is expected to increase with the growth of transnational corporations.

Student migrations

A third type of 'contract' migration is the international movement of students. Large numbers of students from both developed and developing countries now study at schools and universities throughout the world. Another type of student migration is the student-exchange program.

Forced migrations

Forced migration is a general term used to describe movements of refugees and internally displaced people (those displaced by conflicts within their country of origin) as well as people displaced by natural or environmental disasters, chemical or nuclear disasters, famine, or development projects. In other cases, people are driven from their homeland because of religious, political or ethnic persecution, as seen in Figure 8.3.8.

8.3.8 Rohingya refugees cross into Bangladesh to escape the brutality of Myanmar's security forces, September 2017.

SPOTLIGHT

Population movements: the Middle East and Northern Africa

Population movements to, from and within the Middle East and Northern Africa are reshaping the populations of the region.

In many of the oil-rich Persian Gulf states, foreigners make up the majority of the labour force and in some cases the majority of the population. For the most part, they fill the service and skilled jobs native-born workers are unwilling to do.

8.3.9 Dubai's massive construction industry depends on the labour of guest workers.

Population movements to Dubai

In the emirate of Dubai (population 2.8 million) less than 15 per cent of the population is made up of United Arab Emirate (UAE) nationals. The rest are expatriates, who together make up 96 per cent of the country's workforce. Seventy per cent of the population is of Asian background, mainly Indian (51 per cent), Pakistani (16 per cent), Bangladeshi (9 per cent) and Filipino (3 per cent). The majority of migrant workers are found in the private sector. Even in the public sector they hold 40 per cent of the jobs. Employment opportunities in the UAE attract high, medium and low-skilled workers and, in contrast to other countries in the regions, migrants often hold higher-level positions, such as managers.

Many of the medium and low-skilled workers are employed in the emirate's vast construction industry, seen in Figure 8.3.9. Women guest workers typically work as domestic staff in people's homes or service sector employment in the city's rapidly growing retailing and tourism sectors.

Tourism is an increasingly important sector of the Dubai economy. The government's strategy is to promote the flow of foreign cash into the emirate. Dubai's lure for tourists now extends beyond the city's famed shopping to include a range of attractions (including Dubai Fountains, the Burj Khalifa skyscraper and the Dubai Atlantis resort) and its lavish resort-style hotels. Dubai is now the world's seventh visited city based on the air traffic passing through its vast airport—the third busiest on earth. In 2016, Dubai hosted 14.9 million overnight visitors, and is expected to reach 20 million tourists by 2020.

8.3.10 Far from the glitz of Dubai's opulent hotels and gleaming skyscrapers, migrant workers crowd into bunk beds. Workers live and work without adequate rights.

Population movements to Saudi Arabia

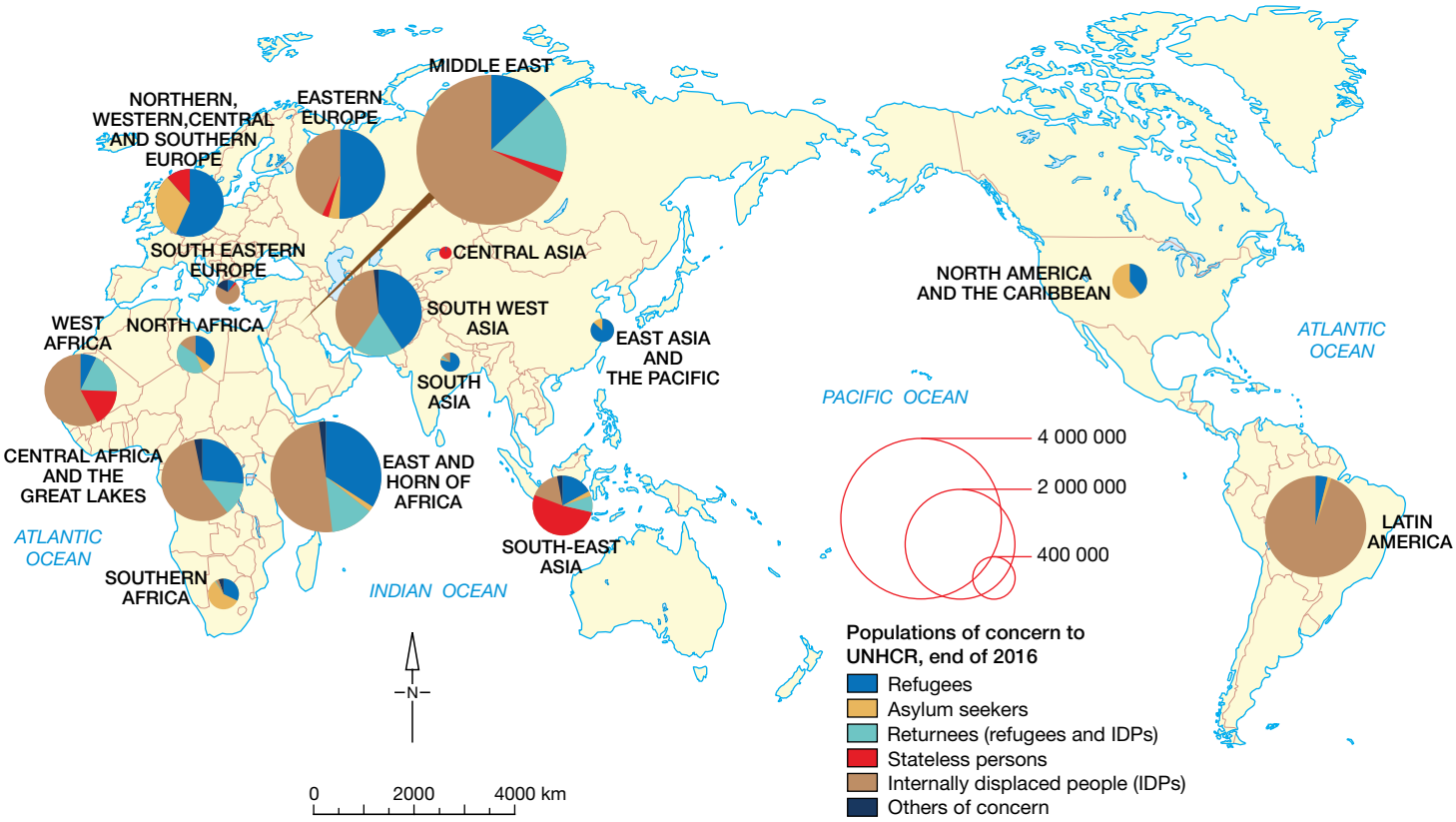
Saudi Arabia, the conservative, oil-rich state on the Arabian Peninsula, is home to a large foreign workforce. Although migrants make up only 33 per cent of the country's total population, they represent 56 per cent of all employees. Approximately 74 per cent of foreign nationals are male, and most are semi-skilled. While most work in the construction industry (26.5 per cent), many also work in the retail and wholesale (22 per cent) sectors, as well as domestic work (15 per cent).

Working conditions

These immigrants to the Middle East send home billions of dollars in remittances to their families. But they often work long hours and have limited ability to challenge their employers, some of whom fail to deliver on promised pay and benefits. The living conditions of the workers in Dubai have, for example, been described by Human Rights Watch (a human rights NGO) as being 'less than human'. (See Figure 8.3.10.)

Population movements from the Middle East and Northern Africa

In other parts of the Middle East and Northern Africa, people are leaving to seek economic opportunities or escape violence or political instability. In North Africa, a region of emigration, foreigners make up less than 1 per cent of the population. One-third of France's 5.3 million foreigners are from Morocco, Algeria, Tunisia, sub-Saharan Africa and Turkey. One-third of Germany's 9.8 million foreign-born population is from the Middle East and North Africa.

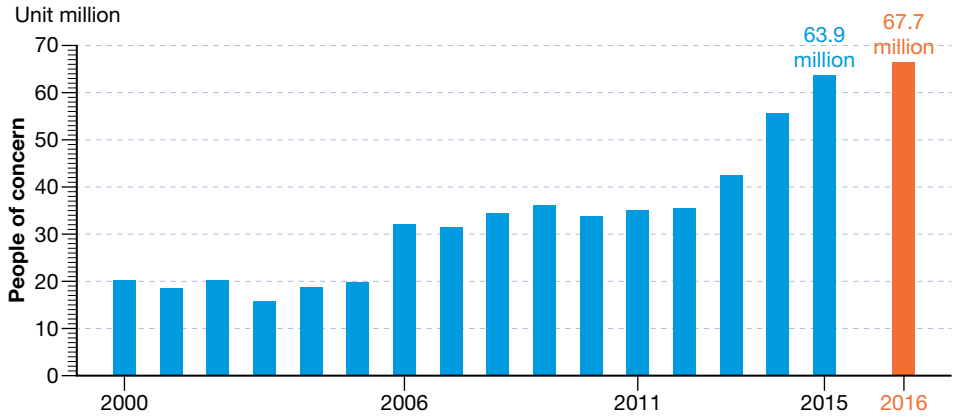


8.3.11 Populations of concern, UNHCR, end of 2016

Forced migrations have, over time, transformed entire populations. Figures 8.3.11 and 8.3.12 highlight the extent of forced migration occurring worldwide.

Refugees or 'displaced persons'

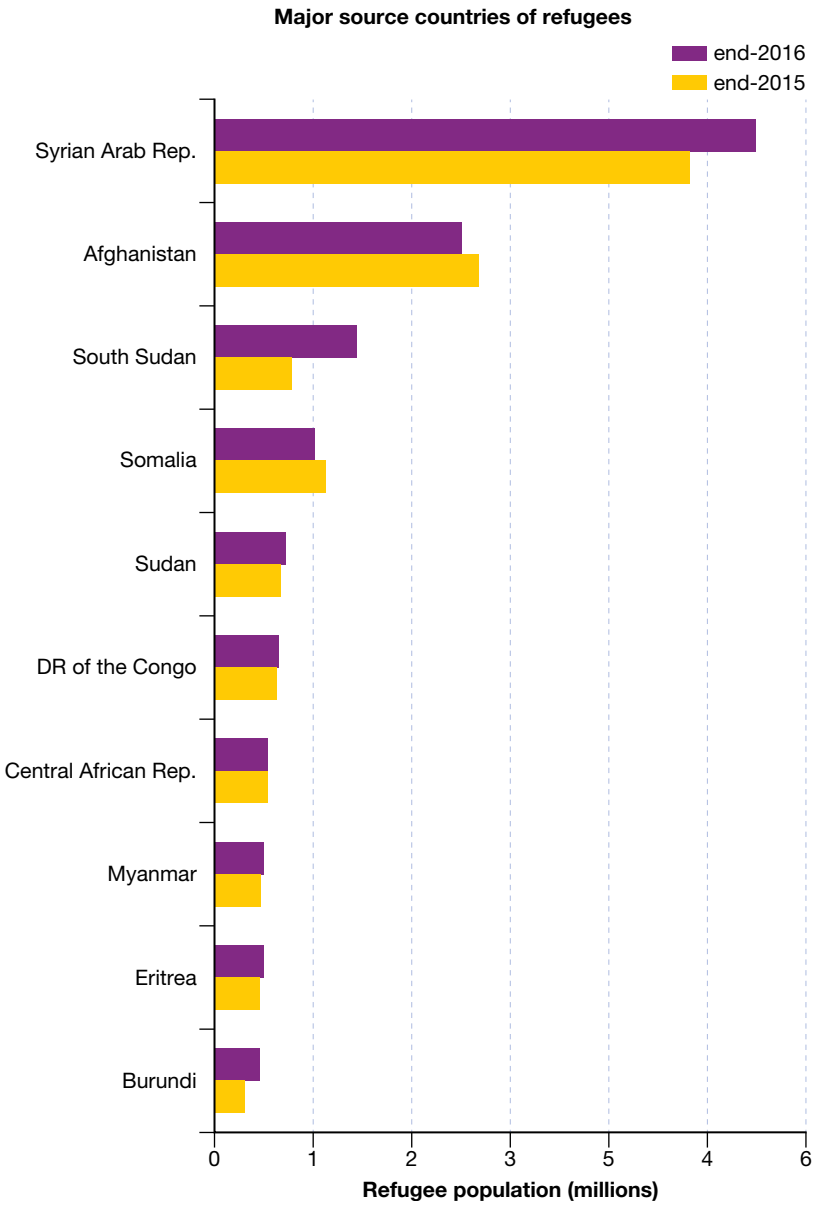
The United Nations (UN) officially defines a refugee as being a person who cannot return to their country of origin without risking serious harm because of a well-grounded fear of persecution based on their race, religion, nationality or political views. Many people disagree with this definition and argue that it excludes millions of people who have been displaced within countries. The UN definition, for example, does not take into account those millions of people who because of drought, starvation, land degradation, natural disasters, poverty and political conflict have lost their livelihood and been forced to flee their home but remain within their country of origin. The term 'internally displaced person (IDP)' is used to avoid the problems associated with the narrow UN definition of a 'refugee'.



8.3.12 People of concern, UNHCR, end of 2016

Another classification is 'economic' refugees: people who flee their homeland in search of a better standard of living. One of the difficulties that government authorities face is how to differentiate between economic refugees and genuine refugees.

The number of refugees has grown substantially since 1970s. The victory of the communist-led forces in Indo-China led to the departure of more than 2 million people from Vietnam, Cambodia and Laos. More than 1 million have been resettled in the United States. Others have found refuge in Australia, Canada and Western Europe.



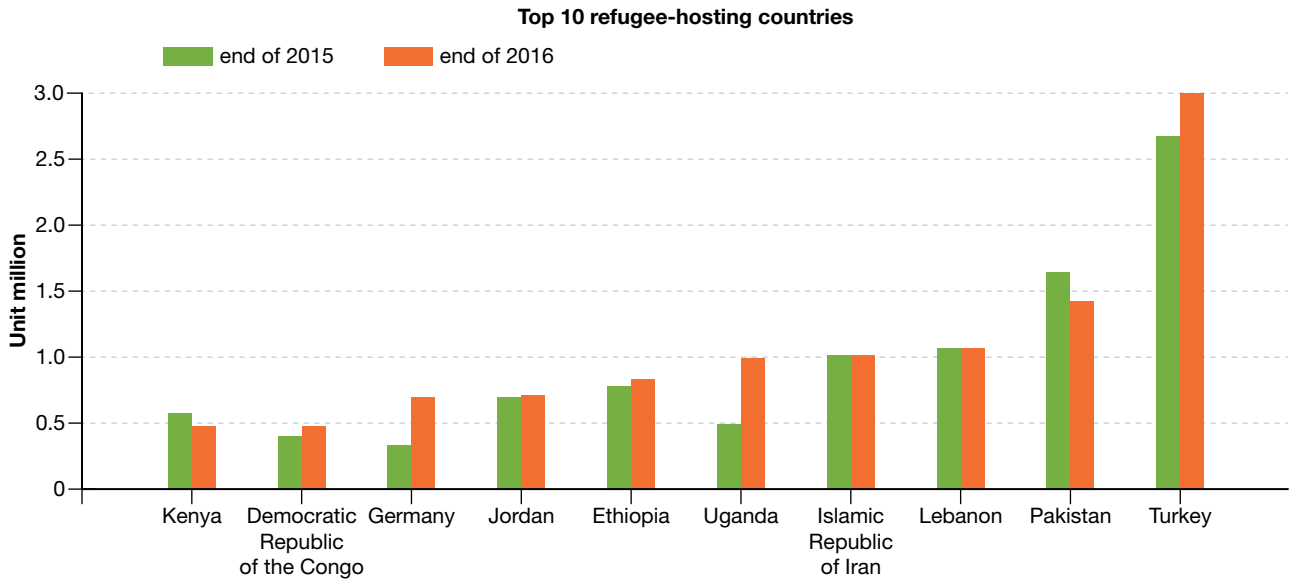
During the 1970s and 1980s large numbers also escaped conflicts in Lebanon and Afghanistan. (Since the 1970s, six million Afghans have fled to neighbouring countries.) In South America, thousands fled repressive military regimes in Argentina and Chile. In Africa, there have been mass exoduses from Zaire, Uganda, Namibia, Somalia, Rwanda, and most recently South Sudan.

The collapse of the Soviet Union and the Soviet-backed governments in Eastern Europe led to an upsurge in the number of refugees from there seeking asylum in Western Europe. The disintegration of Yugoslavia into a number of warring ethnic groups made the situation worse, as has the civil war in Syria.

The number of refugees worldwide reached 22.5 million in 2016. There were also 40.3 million internally displaced people and 2.8 million asylum seekers. Figure 8.3.13 outlines the major source countries of refugees in 2015 and 2016.

Historically, the countries of the developed world have absorbed large numbers of refugees. Since 1945, Australia, for example, has accepted more than 500 500 refugees and displaced people. This number includes 170 500 Europeans displaced by World War II and its aftermath. Australia currently accepts refugees from about 40 countries. The intake of refugees in 2016 was a modest 8284. Historically, the United States, Canada and the countries of Northern Europe have accepted large numbers of refugees. In more recent times Turkey, Pakistan and Lebanon have hosted the largest number of refugees, as shown in Figure 8.3.14.

8.3.13 Major source countries of refugees, end of 2016



8.3.14 Top 10 refugee-hosting countries, end of 2015 and 2016

SPOTLIGHT

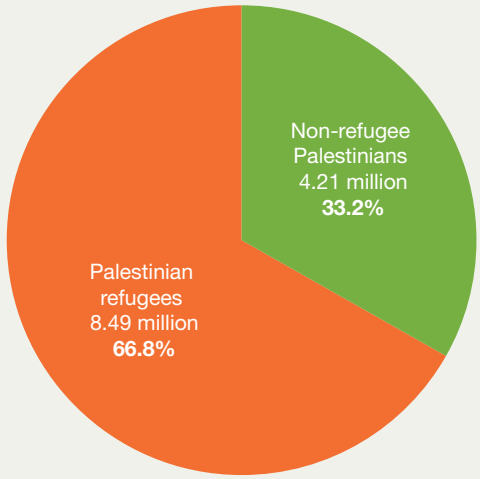
The plight of the Palestinians

The world's most enduring refugee crisis is the plight of the Palestinian people. The Palestinians were displaced as a result of the Palestinian War of 1948. Eighty-five per cent of the Palestinian population were expelled from their lands (see Figure 8.3.15).

Today, there are five million descendants of the original Palestinian refugees. About 1.5 million people live in camps operated by the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). The refugees are spread across the West Bank (774 000 refugees), the Gaza Strip (1.2 million), and the countries of Jordan (2.1 million), Lebanon (452 000) and Syria (528 000).

Until there is ongoing peace between the State of Israel and the Palestinian people, the plight of the dispossessed will continue.

The number of Palestinian refugees (8.49 million) compared to the total number of Palestinians (12.7 million), is considered the highest refugee rate worldwide (66.8%).



8.3.15 The number of Palestinian refugees compared with the total number of Palestinians

Activities

Understanding the text

1 Outline the main types of international movements. What are the drivers and consequences of these movements?

2 Distinguish between resettlement migration and contract migration.

3 Account for the expansion of business migration.

4 Outline the reasons why people are sometimes forced to flee their homeland.

5 State how the United Nations defines a refugee. Why is this definition said to be inadequate?

6 Outline some of the significant refugee movements since World War II.

Working geographically

7 Explain how Australia is addressing a shortage of skilled workers.

8 Study Figure 8.3.7. Write a stimulus-based response outlining the trends in Australia's migration program, 1991–2015.

9 Study the Spotlight box, 'Population movements: the Middle East and Northern Africa'.
- a Outline the principal population movements in the region.
- b Why is labour required in the countries of the Middle East and Northern Africa?
- c How are population movements reshaping the populations of the region? Give examples.
- d Investigate the state of Dubai. What is the basis of its economic growth? Why is there so great a demand for guest workers in Dubai? Develop a short profile of Dubai's workforce.

10 Study Figure 8.3.11 and then complete the following tasks.
- a Identify the major concentrations of internally-displaced persons.
- b Which region has the greatest proportion of displaced persons classified as:
  - i refugees?
  - ii stateless persons?
- c Estimate the number of internally-displaced persons in Latin America and the Middle East.
- d Undertake research to explain why people have been displaced in these countries.

11 Study Figure 8.3.12. Outline the trend in the number of people of concern to the UNHCR between 2000 and 2016.

12 Study Figure 8.3.13. Which regions saw a reduction in the number of refugees in the period 2015–2016? Which regions saw the greatest proportional increase?

13 Study Figure 8.3.14. Name the three biggest refugee-hosting countries.

14 Study the Spotlight box, 'The plight of the Palestinians' and Figure 8.3.15.
- a Outline the background to the Palestinian refugee crisis.
- b Using data from the graph and the text, write a report on the distribution of Palestinian refugees.

15 Undertake internet research into a contemporary refugee crisis. Investigate the reasons for the crisis, its historical context, the numbers of refugees involved, the destination of the refugees and the actions taken to meet their needs. Present your findings in an oral report to the class.

CASE STUDY

Refugee crises: Syria and South Sudan

Civil war has created two major refugee crises in Syria and South Sudan.

Syria's civil war and the flight of its population

The Syrian civil war started in March 2011 when anti-government demonstrators, part of the so-called Arab Spring, took to the streets of Syria's cities and towns. The largely peaceful protests quickly escalated into violence following a violent crackdown by Russian backed President Bashar al-Assad's government forces. Armed opposition groups began fighting back.

By July 2011, the Free Syrian Army and many armed civilians joined the opposition. Divisions between secular and religious fighters, and between ethnic groups, have complicated the politics of the conflict. There is no end in sight to the highly complex and contested civil war. Islamic State, the terrorist organisation, took advantage of the unrest to seize territory and establish what it called a caliphate. It subsequently seized territory across neighbouring Iraq. By late 2017, Islamic State had suffered a number of strategic setbacks. The Syrian city of Raqqa, the de facto capital of Islamic State, was defeated by government forces in late 2017.

After more than six years of war much of Syria lies in ruins (see Figure 8.3.17) and an estimated 470 000 people have been killed. Whole cities have been destroyed and human rights violations are widespread. Chemical weapons have been use by government forces against the civilian population.

8.3.16 The displaced people from Syria

8.3.17 Syrian women walk through the ruins of a neighbourhood in central Homs.

SKILLS BUILDER

Proportional circles and shapes

Proportional circles, when used on maps, show the relative size of the units being measured by the area of each circle. The size of each circle must be drawn in proportion to the total value it represents.

Proportional shapes are sometimes used instead of circles. They may be, for example, squares, rectangles, cubes, triangles, symbolic representations or the shape of nation-states.

Basic necessities like food and medical care are sparse.

More than 6.3 million people have been internally displaced. When you add those who have fled the country, well over half of the country's pre-war population of 22 million is in need of urgent humanitarian assistance. Of the 5 million who fled the country, many are living in refugee camps in Turkey, Jordan and Lebanon, as seen in Figures 8.3.16 and 8.3.19. Of these, 2.5 million are under the age of 18 (see Figure 8.3.18).

South Sudan refugee crisis

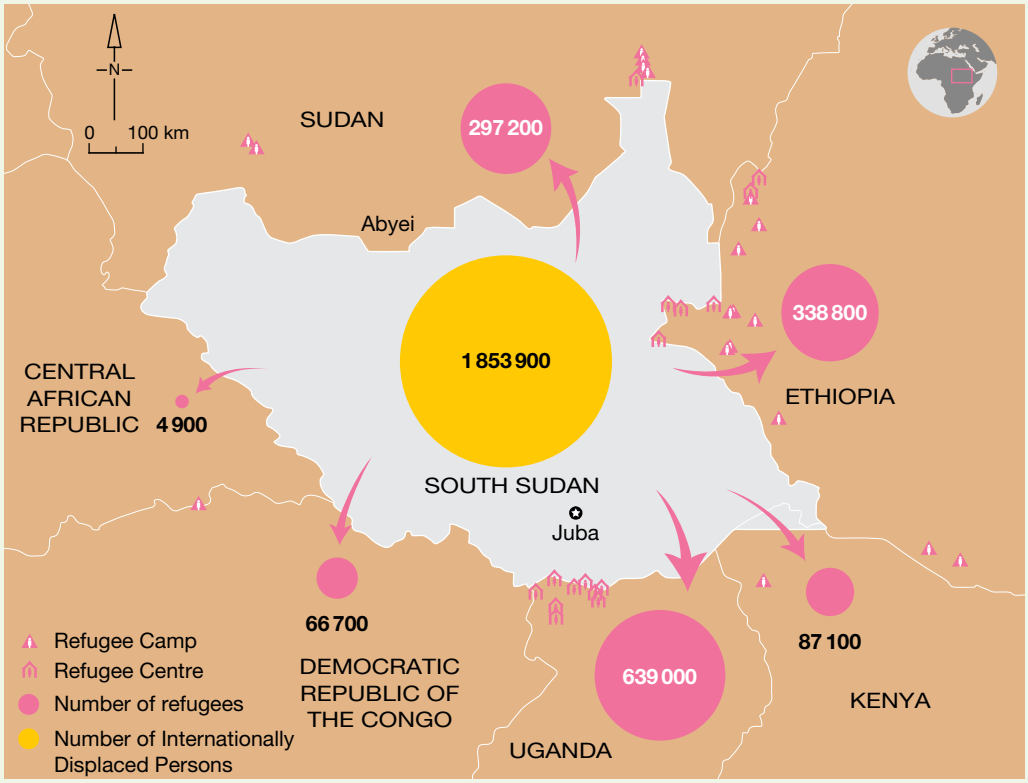
At the end of 2016, the fastest growing refugee population (seen in Figure 8.3.21) was caused by the crisis in South Sudan. Since the conflict began, one in three people have been forced from their homes (see Figure 8.3.20). Nearly 4 million people have been displaced, with some 2.1 million people internally displaced, plus more than 1.8 million people have fled to neighbouring countries.

The South Sudanese civil war broke out in late 2013 when the Sudan People's Liberation Movement-in-Opposition (SPLM-IO)—the anti-governmental forces—split from the Sudan People's Liberation Movement (SPLM) due to political tensions compounded by economic problems and drought. The conflict has caused massive displacement, raging violence and dire food shortages. Nearly half the population is in need of humanitarian assistance.

8.3.18 A family of seven takes shelter in the Zaatari refugee camp.

8.3.19 The sprawling Zaatari refugee camp—seen from the air—is home to more than 80 000 Syrian refugees.

8.3.20 A family takes refuge in a displaced persons camp, Juba, South Sudan.



8.3.21 In South Sudan 3.3 million people have been displaced by conflict.

Activities

Working geographically

1 Outline the causes, nature and scope of the displacement of people resulting from the Syrian civil war. Where are most of the refugees taking shelter?

2 Outline the causes and impacts of the crisis in South Sudan. Where are the major concentrations of refugees?

CASE STUDY

Major international migrations in the past

The past five centuries have witnessed human migrations on a vast scale. The majority of these migrations have been generated by events in Europe. The most significant of these flows are shown in Figure 8.3.22 and include these two internal migrations:

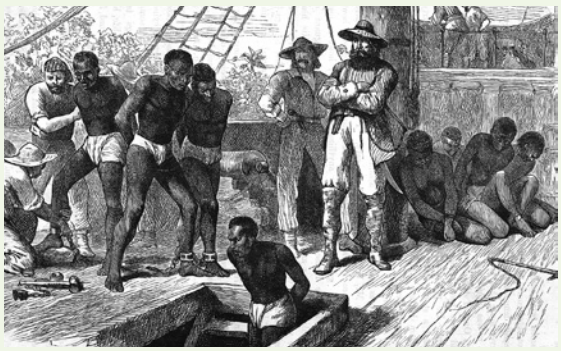
- from the eastern United States westwards
- from western Russia eastwards.

They also include flows from:

- Europe to North America
- Southern Europe to South and Central America
- the United Kingdom and Ireland to Africa, Canada, New Zealand and Australia
- Africa to the Americas (the slave trade)
- India to east Africa, South-East Asia and the Caribbean
- China to South-East Asia and the United States

The slave trade

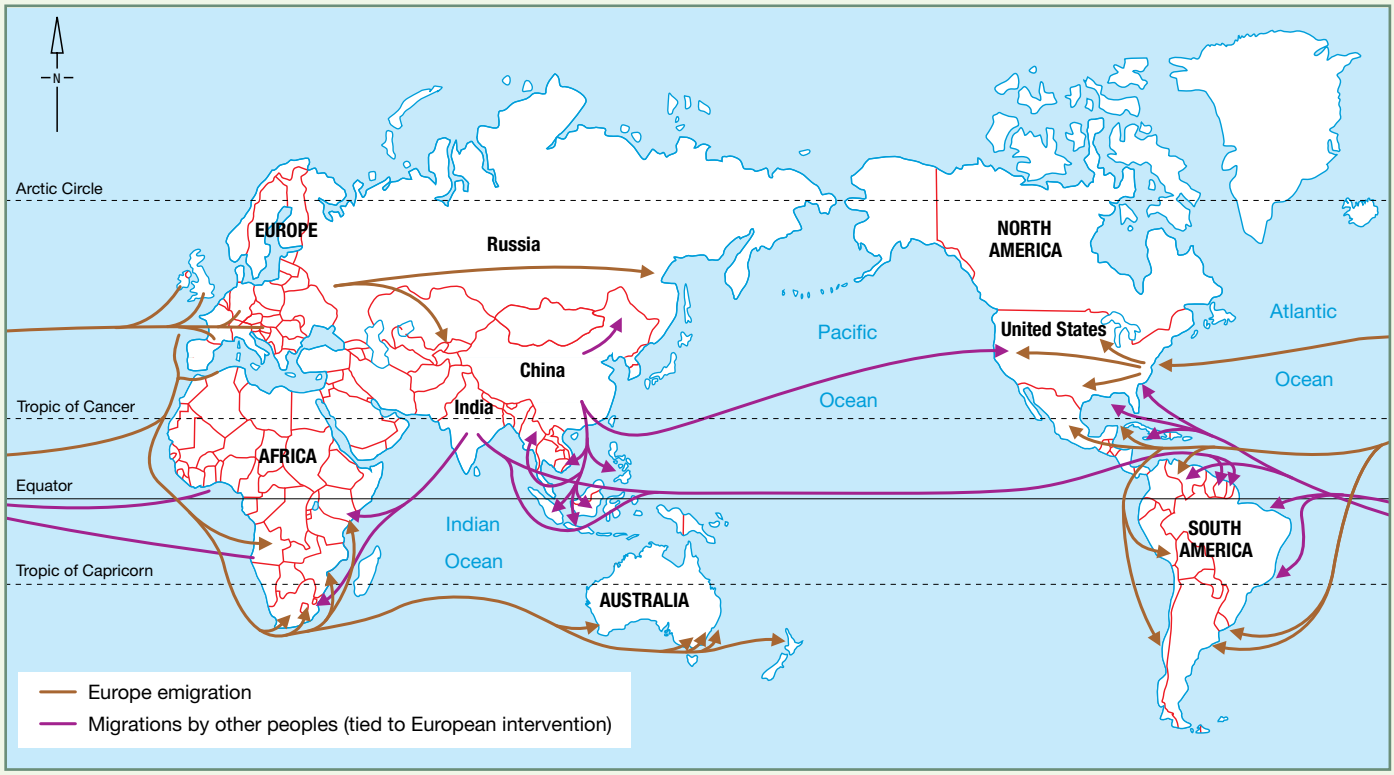
Some of the world's largest migrations have been forced migrations. By far the most significant of these was the transatlantic slave trade. Tens of millions of (mainly male) Africans were transported to the Americas against their will and at a huge loss of life. The actual number of people involved may never be known; estimates vary from 12 million to over 30 million. Most were transported to the plantations of the Caribbean and South America, where they worked as unpaid slave labour. Today the descendants of these people make up the majority of the population of several Caribbean countries.



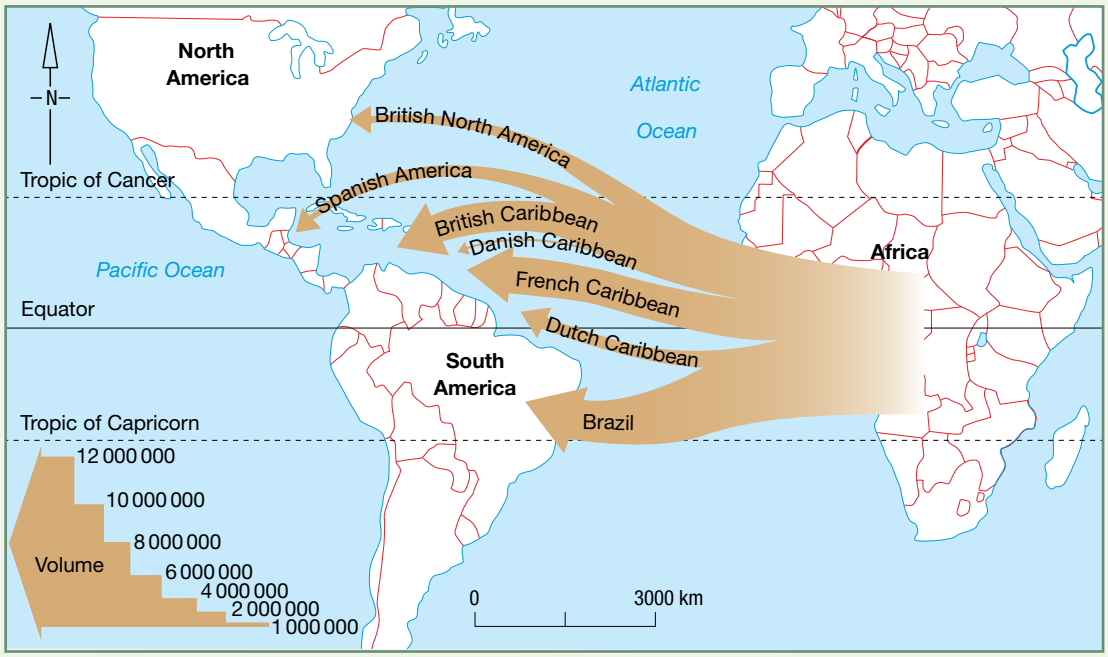
8.3.23 African slaves en route to the Americas

Despite the relatively large proportion of African-Americans in the US population, the number of slaves transported to the United States was quite small compared with the number taken to the Caribbean and South America. (See Figures 8.3.23 and 8.3.24.)

The slave trade devastated whole communities in Africa. Families were destroyed, children orphaned and community life disrupted. Communities were raided and most of the younger men seized. Generations passed before the demographic effects of the slave trade were overcome and the long-term balance of population structures in Africa and the Americas was restored.



8.3.22 Major human migrations of the past 500 years



8.3.24 The transatlantic slave trade, volume and destinations, 1701–1810

Nazi slave labour

During World War II, ten million Jews, gypsies, Poles, other Eastern Europeans and people of other nationalities and religions were forced to work under inhuman conditions in Nazi-controlled industries as slave labourers. Many did not survive, and became victims of the Nazi Holocaust (see Figure 8.3.25).

The working conditions the slave labourers endured were repressive. There was no payment of any kind, they were kept under constant surveillance, forced to perform physically demanding labour, and worked excessive hours (often 10 to 12 hours per day) with minimal nutrition. There was a general lack of hygiene, poor medical care and disease was widespread. Clothing was inadequate for the harsh winters of Europe. They were also subject to torture and physical abuse. When too weak to work they were put to death in the Nazi death camps.

Some of Germany's best known industrial conglomerates used slave labour supplied by the Nazis. They included IG Farben (83 000); BASF, Bayer and Hoechst (80 000); ThyssenKrupp (75 000); BMW (50 000); Daimler (Mercedes) (40 000); Bosch (20 000); Audi (20 000) and Volkswagen (12 000).

8.3.25 Jewish slave workers in striped uniforms work in a Nazi ammunition factory near Dachau concentration camp during World War II.

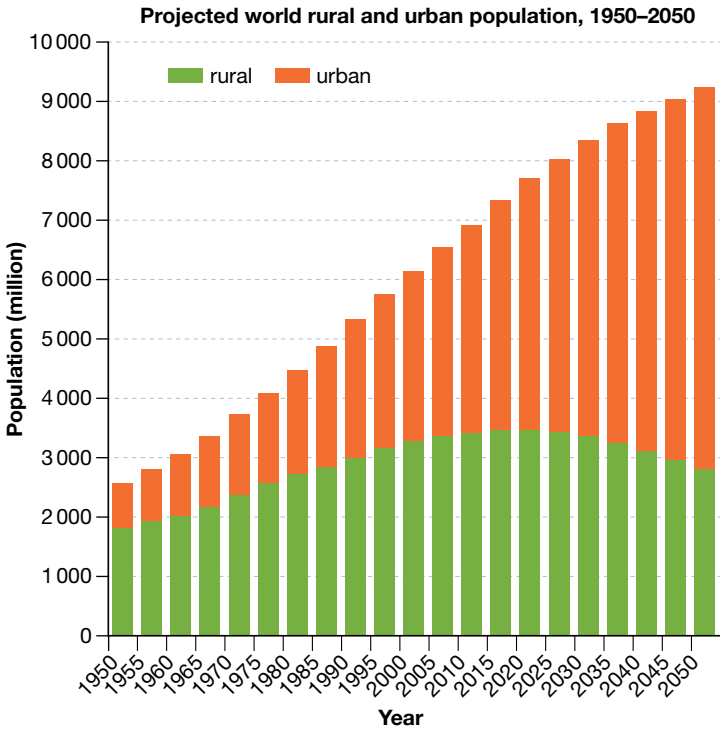
Activities

Working geographically

1. Select one of the migrations listed and investigate the reasons for the migration, the numbers of people involved and the impact on indigenous peoples. Present your findings as a PowerPoint® presentation and accompanying oral report.
2. Study the text and Figure 8.3.24.
   - **a** Why were African slaves shipped to the Americas?
   - **b** Where did the majority of slaves go to?
   - **c** What impact did the slave trade have on African communities?
3. Investigate a past large-scale population movement, such as the transportation of an estimated 15 million slaves from Africa to the Americas or the movement of up to 37 million indentured labourers from places such as India and China to east Africa, Malaysia, Sri Lanka, Fiji and the Caribbean. Present your findings as a written report. Include a map showing the movement discussed.
4. Study the text and photograph related to Nazi slave labour. Investigate the nature and scope of the Nazis' exploitation of slave labour in Europe immediately before and during World War II. Investigate the international legal instruments aimed at preventing a repeat of such actions.

UNIT 8.4

Internal migrations



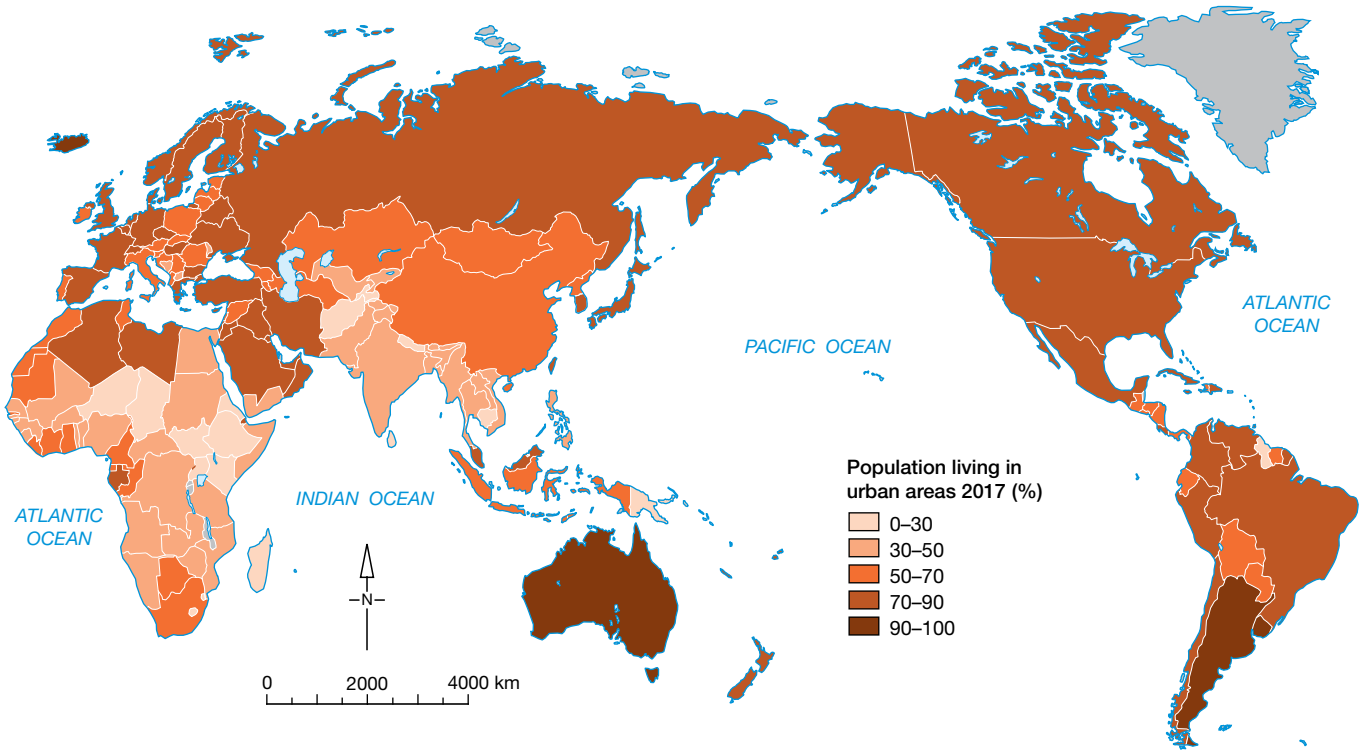
8.4.1 The urban and rural population of the world, 1950–2050

Rural–urban migrations

One of the most significant population movements of the twentieth century has been the drift to cities. This has resulted in a rapid growth in the size of cities and the proportion of the population that lives in them.

At the beginning of the twentieth century, only 14 per cent of the world's population lived in urban places (towns and cities). By 1950 this had increased to 30 per cent and by 2017 it was 54.5 per cent. By the year 2025 the proportion of the world's population living in urban places is expected to be more than 60 per cent. In actual human numbers, this represents an increase from 733 million in 1950 to an estimated 5119 million in 2025 (see Figure 8.4.1). In 1900 there were only 13 cities with more than 1 miillion people. There are now more than 488.

This important demographic change is the result of urban growth and urbanisation. Urban growth occurs when the size of a city's population increases due to both natural increase and rural–urban migration. Urbanisation is the process by which the proportion of a population living in towns and cities increases due to rural–urban migration. World urbanisation is shown in Figure 8.4.2.

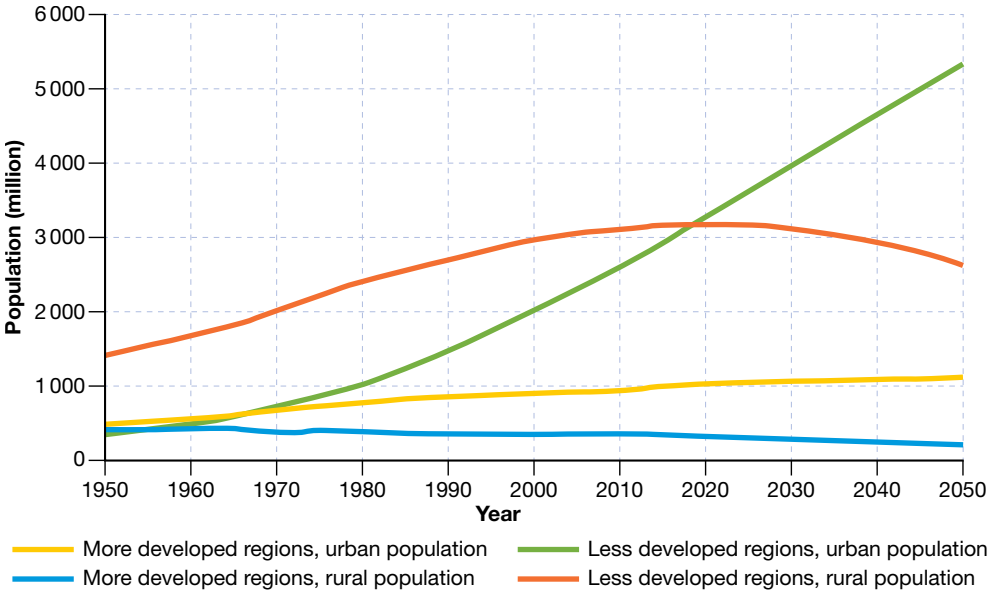


8.4.2 Percentage of the population living in urban areas, 2017

Source: *2017 World Population Data Sheet*, Population Reference Bureau

Since the 1950s, most of this growth has occurred in developing countries, as shown in Figure 8.4.3. This trend will almost certainly continue.

The reasons for rural–urban migration are often referred to as 'push' and 'pull' factors. The factors 'pushing' people include famine, war and civil unrest, rural poverty, landlessness resulting from population pressure, land degradation and mechanisation, and climatic disasters. Factors 'pulling' people towards urban centres include the hope of securing a higher standard of living through greater employment opportunities, better access to health care and education, and access to entertainment and the 'bright lights'.



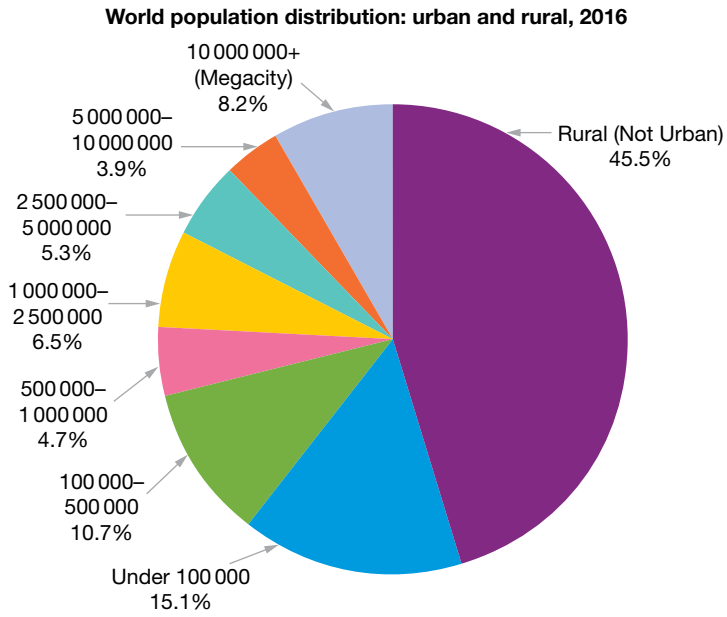
8.4.3 Rural and urban populations of the developed and developing worlds, 1950–2050 (projected)

Population distribution

People have moved to urban places ranging in size from a megacity (a city of over 10 million people), to a smaller city of just under 100 000 people. The distribution is illustrated in Figure 8.4.4

Counter-urbanisation

In the countries of the developed world, both the rate of urbanisation and the rate of urban growth have slowed. There is some evidence to suggest that there is a process of counter-urbanisation taking place—people are choosing to leave the large urban centres and move to smaller communities. They are doing so for a variety of reasons, usually associated with quality of life. This trend has been observed in the United States and in parts of Western Europe. It can be explained, in part, by the development of economic activities not tied to urban areas. These include service industries such as tourism. Advances in communication and computer technology now make it possible for some people to work from home. Improvements in transport enable others to commute to work over long distances.



8.4.4 Distribution of the world's population by size of urban area, 2016

This trend may also be related to the longer period of the life cycle now spent in retirement. With the prospect of spending 25–30 years in retirement, a growing number of retirees are opting for a change in lifestyle. This may involve a move away from large urban centres to resort communities, such as those scattered along the east coast of Australia, in Florida and along the west coast of the United States. In these communities, retirees can take advantage of a more relaxed lifestyle and a better climate.

Population movements related to changing patterns of work

Population movements within countries are also initiated by changes in the pattern of economic activity. If sustained, these movements can bring about quite significant changes in population distribution.

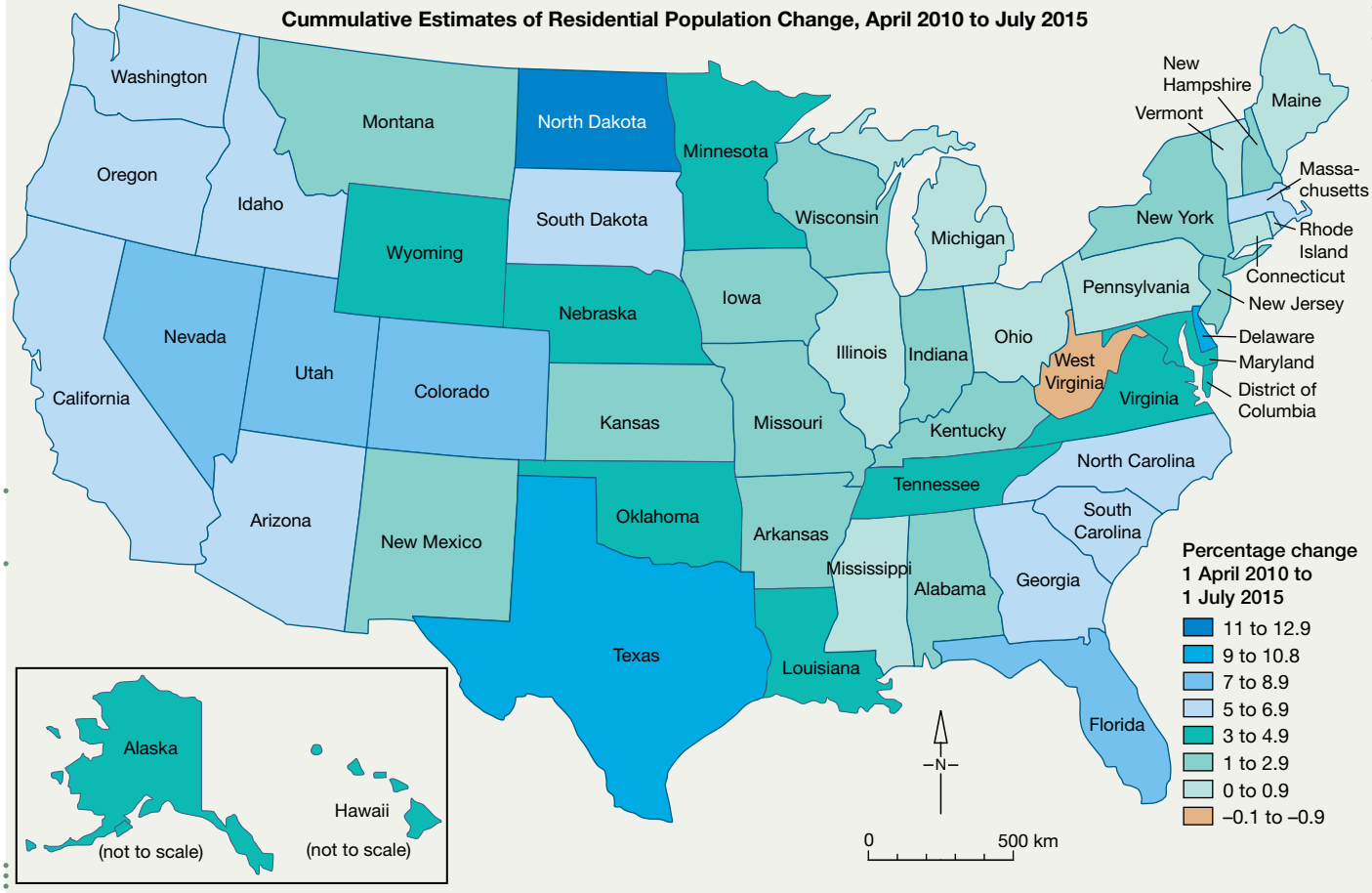
Within the developed countries, the relative decline in manufacturing employment and the growth of employment in the service sector have led to changes in the distribution of the workforce. Older industrial areas often have outmoded methods of production, ageing plant and equipment, a highly unionised workforce and congested urban infrastructure.

SPOTLIGHT

Internal migration in the United States

The people of the United States are the most mobile on earth (see Figure 8.4.5). The two most significant movements are those towards the west (and more recently the south) and the northward migration of African-Americans from the rural south to the urban north.

The westward movement of people continues to this day. People continue to leave the older industrial centres of the north-east and the farming states of the mid-west in search of employment opportunities in the rapidly growing 'sun belt', especially the states of California, Texas, Georgia and Florida. Many of the older industrial cities have experienced a decline in population. In addition, there has been a decrease in the population of states that have traditionally depended on farming and mining. There are, of course, exceptions to such generalisations. North Dakota shows the largest proportional gain of any state, due mostly to the fracking boom in oil and natural gas.



8.4.5 Population change in the USA, 2010–2015

These areas have found it increasingly difficult to compete with the newer industrial centres developing elsewhere in industrialised countries and in the rapidly growing economies of East Asia.

Areas such as the industrial north-east of the United States and the Midlands of Great Britain have experienced a sharp decline in employment as factories have either closed or been relocated to new sites, including those in the developing world. Some displaced workers have moved where work is more readily available. Usually it is the younger, more mobile workers who decide to move. In Australia there has been, over the course of the last decade, a net movement of people from New South Wales, Tasmania and South Australia to Victoria, the Australian Capital Territory and Queensland where the growth in service-sector employment has been strongest.

Movements within cities

Similar processes can also be seen to operate within cities. Manufacturing firms are abandoning the older and more congested industrial sites close to the city centre and relocating in the new industrial estates on the periphery (outer edge) of the urban area. This has resulted in a transfer of jobs from the urban centre to the outer suburbs. This is one of the factors contributing to the process of suburbanisation whereby people move from inner-urban locations to the expanding suburbs at the city's outskirts. People are now willing to commute to work over quite long distances, and many opt for lower-cost housing in areas far from the city centre.

Countering this trend are the processes of gentrification and urban consolidation. Gentrification is the process whereby rundown inner-urban homes are purchased and refurbished by young middle-income and high-income earners. The process is driven by a desire for accessibility to employment, recreation and entertainment in and near the central business district. Urban consolidation is a process that increases population densities in older inner-city areas where the existing infrastructure is under-utilised. Such policies are designed to slow the growth of urban sprawl.

Seasonal movements

Some movements that are related to work and leisure are seasonal. Fruit pickers and seasonal workers in areas dependent on tourism are obvious examples. Ski resorts take on large numbers of additional staff during the winter months; in coastal areas, hotels and resorts add to their staff in summer. People often move to take advantage of these employment opportunities. Tourism itself is often seasonal. For example, in many parts of the world large numbers of people move to coastal resorts for their summer vacations.

Activities

Understanding the text

1 Explain the difference between urban growth and urbanisation.

2 Outline the reasons for rural–urban migrations.

3 Explain what counter-urbanisation is. Why are people choosing to leave cities?

4 Outline how changes in the pattern of economic activity affected population movements. Give examples.

5 Describe the movements taking place within cities.

6 Distinguish between gentrification and urban consolidation.

Working geographically

7 Study Figure 8.4.1. Describe the trends in the world's rural and urban populations 1950–2050.

8 Study Figure 8.4.2. Describe the distribution of countries with:

- **a** high levels of urbanisation
- **b** low levels of urbanisation.

9 Study Figure 8.4.3. Outline the trends in rural and urban populations of the developed and developing worlds 1950–2050.

10 Study Figure 8.4.4. Write a paragraph outlining the distribution of the world's population by size of urban area.

11 Write a report outlining the factors responsible for the process of urbanisation.

12 Investigate the internal movements of people in Australia. Draw a sketch map to illustrate the flow of people.

13 Study the Spotlight box, 'Internal migration in the United States' and Figure 8.4.5. Outline the principal population shifts in the US population and the factors driving such changes.

14 Access the Australian Bureau of Statistics website or text-based publications. Locate information highlighting population movements within Australia. Write a report describing the trends apparent. Suggest reasons for this pattern of movement.

UNIT 8.5

Issues arising from the changing size and distribution of population

SPOTLIGHT

Population statistics

- By 2050, India will become the world's most populous country with 1.7 billion people, overtaking China in second place at 1.3 billion. Currently China is at 1.39 billion, compared with 1.35 billion in India.
- India will also register the largest numerical increase in population of any country, adding 350 million people by 2050. Nigeria is set to post the second-largest rise at 220 million, followed by Democratic Republic of the Congo at 134 million.
- Thirty-nine countries will have smaller populations in 2050 than in 2017. China will register the largest numerical population decrease of 90 million, followed by Japan at 25 million and Ukraine at 9 million.
- The population of 30 countries, nearly all in Africa, will at least double by 2050.
- The population of the United States is expected to reach 397 million, up from 325 million today.

The implications of rapid population growth are becoming increasingly apparent as the world's population exceeds 7.6 billion and heads towards 9.8 billion by 2050. How will the environment and humankind respond to this population explosion? Expert opinion is divided into two camps.

Environmentalists and ecologists regard the situation as a catastrophe in the making. They argue that in order to feed the growing population, new agricultural practices that limit serious environmental damage are required. They also contend that the earth's natural resources and the biophysical environment, already burdened by past and current resource exploitation, will simply collapse under the weight of future demand.

Many economists and some agricultural scientists argue that the earth can produce more than enough food to meet the needs of a rapidly expanding human population. They assert that technological innovations will help us meet the challenges associated with rapid population growth and deliver higher standards of living to most people.

Global inequalities

The countries of the developed world have just one-fifth of the world's population but consume 70 per cent of the world's energy, 75 per cent of its metals and 85 per cent of its wood. They also account for 80 per cent of the world output of goods and services. The poorest one-fifth of the world's population struggles to survive on just 1.4 per cent of the world's goods and services (see Figure 8.5.1).

Quality of life refers to an individual's overall sense of wellbeing and the degree of wellbeing enjoyed by a people as measured by income levels, quality of housing and food, medical care, educational opportunities, transportation, communications and other measures. The standard of living in different countries is frequently compared based on annual per capita income. Figure 8.5.2 contrasts the quality of life experienced by those living in the developed and developing worlds.

A good deal of the environmental degradation that has accompanied population growth can be traced to the environmental interactions of two groups of people:

- the affluent, who live in the developed world and who degrade the environment through their high consumption of resources and by generating vast amounts of waste
- the world's poorest people, who are forced to degrade their own resource base out of necessity and lack of alternatives.

8.5.1 Rapid urbanisation and poverty result in the development of vast squatter settlements, such as this one in Jakarta, in the cities of the developing world. The lack of urban infrastructure results in high levels of environmental degradation, especially water pollution.

SPOTLIGHT

Population data sources

Listed below are sources of up-to-date information about population.

- Population Reference Bureau
- United States Census Bureau
- Australian Bureau of Statistics
- United Nations Population Fund

World food supply

Central to any discussion about the implications of future population growth is an assessment of the earth's food-producing capacity. Historically, agricultural production has kept pace with population growth (see Figure 8.5.3). However, the increases in agricultural production required to meet the needs of an expanded population might be achieved at an unacceptably high cost to the environment. Also, the distribution of food remains an issue that must be addressed if all people are to have an adequate supply of food.

Impacts on the environment

Population growth can affect the biophysical environment in a number of ways. In societies that continue to pursue a subsistence lifestyle, population pressure contributes to an intensification of land use. This ultimately contributes to the deterioration and depletion of important natural resources. Increasing population densities and the growing demand for food have resulted in an expansion of cultivation and grazing into increasingly marginal lands and have led to shortened periods of fallow. These, in turn, have led to accelerated rates of erosion and a decline in soil fertility. The increased demand for fodder, fuelwood and land suitable for agriculture has accelerated the rate of deforestation, seen in Figure 8.5.4.

Global inequalities, 2017

Indicator	World	Developed countries	Developing countries*	(Least developed countries#)
Population mid-2017 (1000s)	7536	1263	6273	1001
Births per 1000 population	20	11	21	33
Deaths per 1000 population	8	10	7	8
Net migration rate per 1000	3	3	0	–1
Projected population 2030 (1000s)	8563	1304	7259	1340
Projected population 2050 (1000s)	9846	1325	8520	1952
Infant mortality rate	32	5	35	52
Total fertility rate	2.5	1.6	2.6	4.4
Per cent population <15 years	26	16	28	40
Per cent population 65+	9	18	7	4
Life expectancy at birth (males)	70	76	69	72
Life expectancy at birth (females)	74	82	63	66
Per cent urban	54	78	49	32
Population per square km of arable land (1000s)	532	239	707	572
GNI per capita (2016) – (US$)	16 101	41 421	10 822	2 566

*Includes data for the least developed countries

#Least developed countries (LDCs) are low-income countries confronting severe structural impediments to sustainable development. They are highly vulnerable to economic and environmental shocks and have low levels of human assets. There are currently 47 countries on the list of LDCs as determined by the UN's Committee for Development.

Source: *2017 World Population Data Sheet*, Population Reference Bureau

8.5.2 Global inequalities, 2017

8.5.3 Industrial hothouse with lettuce sorts. Investments in intensive forms of agriculture will be necessary to meet the needs of a rapidly growing population.

8.5.4 Degraded landscape resulting from deforestation

This has contributed to a range of ecological and socioeconomic problems. These include an acceleration in the rates of erosion, an intensification of seasonal flooding, an increase in the incidence of droughts, the silting of rivers and coastal waters, and the loss of countless species of plants and animals.

Attempts to make existing agricultural lands more productive have also contributed to a range of ecological problems. These include increased rates of erosion and run-off as well as problems associated with the use of irrigation and agricultural fertilisers and pesticides, such as salinity, algal blooms and chemical residues. These impacts are most apparent in the world's fragile environments: its semi-arid lands, mountains, wetlands, tropical rainforests and coral reefs.

8.5.5 Polluted waterway in Dhaka, Bangladesh

The processes of urbanisation and industrialisation have also contributed to environmental degradation. The concentration of large numbers of people in relatively small areas overwhelms the ability of biophysical processes to cope. Severe atmospheric, water and noise pollution are common to most large cities, shown in Figure 8.5.5.

SPOTLIGHT

The Philippines: impacts of rapid population growth

High annual population growth rates have resulted in the Philippines having a population that now exceeds 105 million and a population density in excess of 329 people per square kilometre, or six times the world average. (In 2017, the population growth rate in the Philippines was 1.58 per cent, which is down from 2.07 per cent in 2000.) The magnitude of the population growth experienced over time has outstripped the capacity of the land to absorb the additional rural population as well as the capacity of the economy to absorb the expanding urban-based population. The population density per unit of arable land (1878 per square kilometre) illustrates the extent of the challenge. The solution for many Filipinos has been to move to upland areas or to migrate overseas.

Internal migrations

The pressure of population growth on agricultural land has been particularly intense. While more and more land has had to be brought into production, serious land shortages still exist in many regions. The only choice for many people has been to move to less densely settled areas. The population of the less densely settled upland areas has been growing by about 4 per cent annually. This is primarily due to migration. More than one-third of the entire population now live in these areas. One of the most significant of these rural–rural migrations has been to the island of Mindanao.

SOCIAL IMPACTS

The social impacts of these migrations have been considerable. The male-dominated migration to Mindanao has, for example, disrupted the livelihood and social stability of the existing Muslim or indigenous groups and has embroiled parts of the island in an ongoing and bitter political conflict. The most recent outbreak of violence was focused on the city of Marawi. Over 500 Islamic State of Iraq and the Levant (ISIL) affiliated militants seized control of the city from Philippine government security forces. The Philippine Government responded by imposing martial law on the island of Mindanao. Australian military aircraft assisted in attempts to defeat the ISIL militants.

ENVIRONMENTAL IMPACTS

The environmental costs of population growth and the associated intensification of land use relate largely to the expansion of agriculture into areas previously forested and/or with a slope greater than 18°. Cultivated upland areas increased from 582 500 hectares in the 1960s to over 5.5 million hectares in 2015. As a result, the country lost more than one-third of its forest cover between 1990 and 2010—a loss of more than 50 000 hectares per year (see Figure 8.5.6).

Rates of water run-off and soil erosion have increased greatly as the protective forest cover has been removed. Soil erosion is estimated to remove about 122–210 tonnes per hectare annually from newly established pasture, compared with less than 2 tonnes per hectare from land under forest. Other related consequences include the loss of habitat for wildlife, microclimatic change and the siltation of downstream rice-growing areas. As a result of elevated levels of run-off there has been an increase in the incidence of flooding. This has led to the devastation

The safe disposal of industrial and domestic waste has become a major issue in urban areas in both the developed and developing worlds. It is most acute in the developing world where rapid rates of urbanisation have exceeded the ability of government authorities to provide the necessary infrastructure.

Other implications

Landlessness

Landlessness is now a major problem throughout the developing world. There is simply not enough land to go around because of population pressure, the nature of land ownership and the ownership of land by commercial agricultural interests. This has resulted in a range of socio-economic problems. Without access to land on which to grow food, people become increasingly dependent on a cash income in order to buy food. Starvation and malnutrition, therefore, become more directly linked to poverty. Another outcome of landlessness is the drift to the cities.

Employment

Because of the age structure of their populations and their high rates of urbanisation, the countries of the developing world are facing an employment crisis. On average, 30 million new jobs will need to be created annually just to prevent an increase in the present high rates of unemployment and underemployment (currently more than half a billion).

8.5.6 Philippine soldiers guard timber seized from illegal loggers.

8.5.7 This Philippine village was partially destroyed by a mudslide caused by illegal logging on a nearby hillside.

of communities and loss of life. Major mudslides are increasingly common, shown in Figure 8.5.7.

International migrations

The Philippines has 10.2 million of its citizens working temporarily in more than 160 countries. Most take up short-term contracts in the Middle East and South-East Asia. Significant numbers also go to the United States (where there are now almost 1.5 million Filipinos) and to the UK, Canada, Australia, Japan and Europe. Perhaps as many as another 100 000 leave to 'illegally' seek work or residence in Europe, the United States and East Asia.

Legally reported remittances from overseas workers to their families in the Philippines now exceed US$25 billion. Illegally transferred remittances are said to greatly exceed this amount. Approximately 80 per cent of the remittances came from only seven countries—the United States and Canada, the United Kingdom, UAE and Saudi Arabia, Singapore and Japan.

Population pressure undoubtedly plays a significant role in the escalating numbers leaving the Philippines. However, it is not the only factor to take into account. Pressure to migrate is particularly strong among well-educated Filipinos. Professionals (such as doctors, engineers, teachers and nurses) find that they can secure much higher standards of living by accepting permanent or temporary contracts overseas. Strong family ties and mutual support structures have also fostered the development of 'chain migration'. Filipinos often sponsor other family members to join them as either short-term or permanent migrants. Another contributing factor is the demand for Filipino labour. Since the 1970s there has been a demand for all types of labour in the oil-rich states of the Middle East, for domestic servants in Hong Kong and Singapore, and for service workers in Europe. Cruise ship companies also employ large numbers of Philippine workers.

Activities

Understanding the text

1 Outline the main arguments put forward by the two 'camps' in the population debate.

2 Explain why the very affluent and the very poor both contribute disproportionately to environmental degradation.

3 Outline the various ways in which rapid population growth can have an adverse effect on the environment.

4 Identify the issues that have been linked to increased landlessness.

5 Explain why countries of the developing world are facing an employment crisis.

Working geographically

6 Study Figure 8.5.2. Working in groups, brainstorm the problems faced by cities in the developing world that are experiencing rapid population growth. Share your group's points with the rest of the class.

7 Undertake research into the arguments of the two 'camps' in the population debate. Working in groups, brainstorm other arguments and supporting examples that you could use in a debate about the issue. Report your group's findings to the class.

8 Conduct a class debate. Topic: 'Technological developments will enable humankind to cope with the rapid escalation in human numbers.'

9 Undertake internet-based research into one of the implications of rapid population growth mentioned in this section of the text. Present your findings as either a written report or an oral presentation.

10 Study the Spotlight box 'The Philippines: impacts of rapid population growth'.

- **a** Use an atlas to locate the island of Mindanao. Describe its location relative to the rest of the Philippines.
- **b** Write a report outlining how population pressure in the Philippines has led to environmental degradation.
- **c** Write a paragraph describing the international migrations from the Philippines.

SPOTLIGHT

Urbanisation and the big shift

In 2008, the world reached an important milestone. For the first time in the planet's history, more than half the human population were living in urban areas. There are now 3.9 billion urban dwellers. By 2030, this number is expected to grow to almost 4.9 billion. Many of the new urban residents will be poor. Their future, the future of cities in developing countries, and the future of humanity itself, all depend on how this process is managed. How, for example, do authorities best meet people's basic needs: shelter, access to clean water, sanitation, health care, employment and affordable public transport? Can these needs be met in a way that is environmentally sustainable?

The next few decades will see an unprecedented scale of urban growth in the developing world. This will certainly be the case in Africa and Asia where the urban population will have doubled by 2030. In other words, the accumulated urban growth of these two continents during the whole span of history will be duplicated in a single generation. By 2030, the towns and cities of the developing world will make up 80 per cent of the world's urban population.

Managing the process of urbanisation is among the greatest challenges facing humankind. Cities concentrate (and often highlight) the environmental damage done by modern civilisation; yet experts and policymakers increasingly recognise the potential value of cities to long-term sustainability. If cities create environmental problems, they also contain the solutions.

Exam-style questions

Extended responses

- Outline the changing nature, rate and distribution of the world's population.
- Account for the spatial variations in the growth of the world's population.
- Explain the spatial variations in the world pattern of fertility and mortality.
- Account for the relatively high rates of urbanisation being experienced by countries in the developing world.
- Outline the types, volumes and directions of population movements.
- Analyse the environmental, economic and social issues arising from the changing size and distribution of the world's population.

Glossary

age structure percentage of the population (or number of people of each gender) at each age level in a population

birth rate the total number of live births in a year for every 1000 people in a population per year

child mortality rate the annual number of deaths of children under the age of five years per 1000 live births; also known as the under-five mortality rate

death rate the total number of deaths per 1000 people in a population per year

demographic changes changes in the size, composition, rates of growth, and density of population; changes to fertility and mortality rates; and changes to patterns of migration

demographic transition the theory that relates the process of industrialisation to declining death rates followed by declines in birth rates

demography the study of the characteristics and changes in the size and structure of human populations

infant mortality rate the annual number of deaths of infants under one year of age per 1000 live births

life expectancy the average number of years a newborn infant can expect to live

migration the act or process of moving from one place to another with the intent of staying at the destination permanently or for a relatively long period of time

overpopulation the situation where the existing population is too large to be adequately supported by available resources

population density the number of people per unit area

population distribution the variation of population density over a specified area

population doubling time the number of years required for a population to double in size given a constant rate of natural increase

population pyramid a bar graph showing the distribution by gender and age group of a country's population

population structure the age and gender composition of a population, usually depicted as a population pyramid

rate of natural increase the percentage by which a population grows in a year; this is the difference between the birth rate and the natural death rate and excludes migration

replacement-level fertility the number of children a woman and her reproductive partner must have to replace themselves; the worldwide average is usually just above two children per couple because some children die before they reach their reproductive years

total fertility rate the average number of children a woman will have during her reproductive years

urban growth the rate of growth of an urban population

urbanisation the process by which there is an increase in the proportion of a population living in places classified as urban; the movement from rural to urban areas

CHAPTER

9 Natural resource use

Our appreciation of what constitutes a natural resource is changing. Resources are used to meet a society's needs. As a society's needs change, the value of any one resource will also change.

This chapter discusses the characteristics of natural resources, as well as their distribution, management and consumption around the globe in the context of associated economic and political issues.

Environmental and social issues relating to natural resource use are also addressed, with particular attention given to resource use by developing countries. Such countries often lack natural resources or have inadequate funding and expertise to develop the resources they do have. Trade barriers may restrict their economic growth and limit their standard of living.

> **To waste ... our natural resources ... instead of using it so as to increase its usefulness, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified ...**
>
> **Theodore Roosevelt, former US president (1901–09)**

9.0.1 Mt Tom Price, open-cut iron ore mine

UNIT 9.1

The nature of natural resources

9.1.1 An appreciation of what constitutes a resource varies between cultures and individuals.

A resource is something from the natural environment (water, air, trees, mineral ores and fuels) that is used to meet one's needs and wants. The Australian economy and standard of living is largely based on the exploitation of the natural resources bestowed by nature. In addition, the discovery, extraction, transportation and processing of these resources is dependent on the country's *human* resources: the skills and abilities of its people.

The appreciation of natural resources varies from one culture to another, and even from one individual to another. People often have differing opinions about what constitutes a resource, such as farmlands and mineral deposits (see Figure 9.1.1). To a hungry family in a developing country the land on which to grow essential food crops may seem more immediately important than a possible wealth of minerals found under that land. Any value judgement about resources, including their conservation or management, must be viewed through the eyes of the people dealing with them (see Figure 9.1.2).

Definition of natural resource

For a naturally occurring item to become a resource, several conditions must be met:

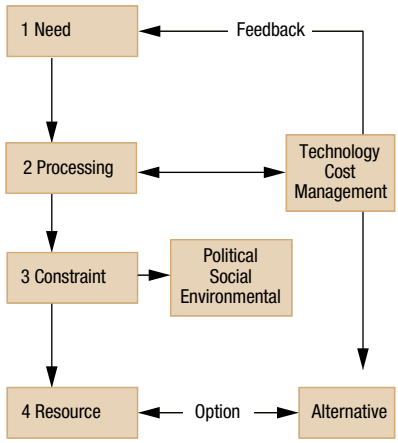
- An item must be recognised as having a use, either directly or as an input into a process that will produce a needed product or outcome.
- The skills, equipment and, in some instances, the degree of social organisation necessary must exist to transform the item from its natural state into the required product.
- The transformation of a naturally occurring item into a resource must be achieved at a cost and convenience that makes it more appealing than seeking and transforming alternatives.
- Any adverse impacts (social, environmental or economic) generated by the whole activity must be acceptable to society. This is especially the case where society has an input into the decision-making processes relating to resources, their processing and utilisation.

Figure 9.1.3 demonstrates the dynamic, or changing, nature of natural resources. Research and/or experience may lead to additional knowledge about resources and the development of new production techniques and patterns of consumption. These developments, together with society's changing needs, may cause previously unappreciated items to become valued resources. Sometimes, the same resource may have several different uses through time.

9.1.2 Bear Glacier Lake and Bear Glacier, Kenai Fjords National Park, Kenai Peninsula, Alaska. Any value judgement about resources, including their conservation or management, must be viewed through the eyes of the people dealing with them.

Economic factors

Regardless of the system in which the transfer of goods takes place, there is generally a mechanism that assigns the relative value to an item. The most common mechanism is price, either in monetary terms or some other form of currency. A trade takes place if the price offered by the seller is acceptable by the purchaser. The price of resources rarely stays constant for long and is determined largely by availability and need. Assuming that there is a demand for a particular resource, its price will largely be dependent on the level of supply. If the supply increases and the market is free to respond, the price of the resource will drop. If the demand increases and supply becomes limited, the price will rise, as shown in Figures 9.1.4 and 9.1.5.



9.1.3 Defining the nature of natural resources

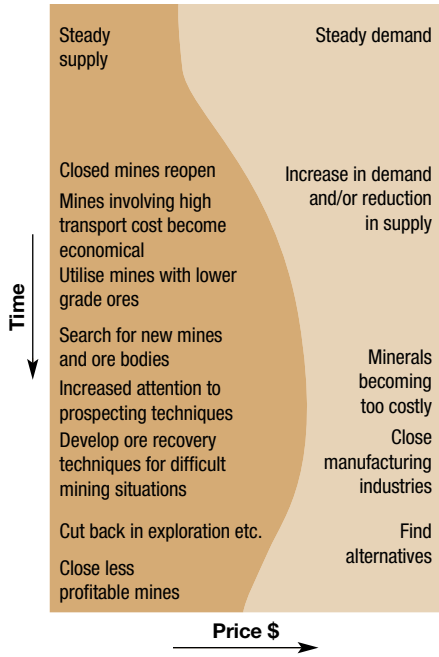
Technology

Most technology is developed by building upon prior experience and understanding. It advances through the processes of communicating, questioning and observing. It may be the latest or most recent phase of a very long line of developments dating back to the harnessing of fire, the intentional cultivation of crops and the domestication of animals.

Technology can impact on natural resources by creating or stimulating demand. In addition, it may improve the supply of materials by improving extraction and processing techniques and reducing production costs. Chilean nitrate deposits provide an example—these deposits accumulated naturally over many years and were once crucial to the global fertiliser trade. When developments in processing allowed nitrogen to be 'fixed' artificially through the use of electricity, the Chilean deposits became less valuable as a resource.

Cultural factors

As societies evolve, they develop a variety of cultural characteristics. This is even more apparent when a society evolves in isolation. Aspects of culture may range from formal religions to traditional myths and legends, and from appreciation of landscape to appreciation of the qualities of certain woods or minerals for production of an artefact. Indigenous Tasmanians, for example, ate vast amounts of shellfish; however, eating fish with scales was taboo and fish, fishnets or traps had no resource value to them. In some societies, such as those of Papua New Guinea, the eating of pork has special celebratory significance, whereas it is forbidden to Jews and Muslims.



9.1.4 Changes resulting from increased price of a mineral

Other differences between cultures are evident in the way colonists attempted to exploit land in Australia. Although directed towards meeting economic objectives, traditional farming practices can be seen as an attempt to defy natural systems, particularly in times of drought. One Western Australian wheat farmer recently questioned the culture that had been transplanted from Britain and Europe to this arid landscape:

> Why is it that I spend all my working days cutting down native trees and shrubs that proliferate, and chasing away and shooting native animals to try and, at the same time, maintain stock that do not do well for half the year and grow crops that provide little profit if any.

Australian resources that have received more immediate acceptance are our native flowers and plants. There has been increasing interest in these and they now fill an important export role.

9.1.5 The price the grower receives for wheat is determined by the price mechanism. As supply increases or demand drops, the price of wheat drops. As supply declines or demand increases, the price increases.

Environment and health

Thomas Malthus (1766–1834) was an English demographer and political economist. He is best known for his influential views on population growth. Malthus believed that population growth would mean the over consumption of natural resources. In recent decades there has been increased criticism of population growth and the mismanagement of natural resources.

9.1.6 Bayswater coal-fired power station, Hunter Valley, NSW. Will coal remain a resource if its use is judged to be a threat to the earth's atmosphere?

9.1.7 Hazard waste handling. Insecticides such as dieldrin and DDT have been banned because of the threats they pose to fauna.

9.1.8 Clear-felling old-growth forest, Tasmania

Climate change

If the atmosphere ceases to buffer us from the effects of worsening pollution and significant climate change appears imminent, a responsible society may be convinced to drastically reduce the consumption of fossil fuels. There may well be a trade-off in favour of the environment against the use of coal (see Figure 9.1.6). Similarly, unless the long-term, safe disposal of nuclear waste can be proven possible, nuclear fuel may lose its resource value. This will especially be the case if renewable sources of energy become more efficient and reliable.

Pollution

Over the last century, there has been a growing reliance on the use of pesticides, particularly in agriculture. Livestock are particularly vulnerable to various internal and external parasites, and preventative treatment is required. Crops are susceptible to insect attack, and crop production also suffers due to weeds, fungal diseases and plagues of mice and rats. The role of pesticides in maintaining production is crucial, but often it is at a cost to the environment. Insecticides such as dieldrin and DDT, seen in Figure 9.1.7, have been banned in many countries because of their impact on fauna.

Logging

Logging provides profits for the logging companies but continues to have a devastating impact on many environments. In Tasmania, each year approximately 15 000 hectares of native forest is destroyed, shown in Figure 9.1.8. Once cleared of native vegetation, most of the land is converted to plantations. This land clearing is devastating the region's biodiversity and the quality of water catchments. The value of these trees as a living resource, part of an interdependent ecosystem, compared to their value as items to be exploited and sold is an ongoing source of disagreement among companies and environmentalists.

Policy and politics

For strategic, economic and/or political reasons, governments may actively promote the exploitation of natural resources. Incentives, such as tax rebates, are often used to encourage the development of a mine or new agricultural enterprise in an unpopulated area or in an area with high levels of unemployment. For example, partly in order to reduce Australia's reliance on imported cotton, the Federal Government in the 1960s offered a bounty on locally produced cotton. This policy led to the construction of large dams and the eventual transformation of large grazing holdings into intensively irrigated cotton-farming land. Primarily, the cotton farms were established in northern New South Wales and in southern and central Queensland. During the prolonged drought of the early 2000s many people questioned the wisdom of this government intervention. In 2017, a major controversy arose when the ABC's Four Corners program exposed widespread instances of water theft and meter tampering by some NSW irrigators in the Murray–Darling Basin.

Conservation

Conservation of natural resources is a concept with a variety of meanings. Some believe that it means limited or non-use of certain resources. They may maintain that no air pollution is acceptable, and that wilderness cannot be wilderness if people change it or use it in any way. Others feel that conservation means efficient resource use. They argue that a resource should be used to produce the greatest human good. To these people, resources are beneficial only if they are used; non-use of resources is seen as a waste.

The disagreement is even more complex. The term 'efficient' also has varied definitions; few can agree on what is truly beneficial. Is profit the highest benefit? Is the spiritual renewal experienced in wilderness the best use of land? When a beautiful valley is filled with four houses per hectare, each resident has a home and a quarter hectare of land—is this a more efficient and beneficial use of the land than making the valley into a park, so that more people can enjoy it, albeit less often?

SPOTLIGHT

Asbestos

A dramatic deterioration in resource value was experienced by the mineral asbestos. With its effective insulating ability and its high strength-to-weight ratio, asbestos was used extensively to provide heat protection, and in building. It has caused numerous fatalities through mesothelioma (a lethal lung cancer) and the lung disease asbestosis. The most tragic aspect of its production and use, particularly associated with mining, was that it had been widely known for more than half a century that it was a carcinogen (cancer-causing agent). For a number of reasons, restrictions on its use and research into suitable alternatives were delayed. The delay can be attributed to industry wanting to profit from the use of asbestos; the workforce and those exposed to the end-product being ignorant of its health impacts; and governments not being prepared to tackle the problem. In Australia, the major manufacturer of asbestos sheeting ('fibro') only ceased production in 1982. Worldwide, many hundreds of thousands of people have already died and, since mesothelioma can take 20 to 40 years to develop, many more may still die.

Australia's trade union movement has campaigned on behalf of mesothelioma sufferers. In 2007 it was successful in getting James Hardie Industries (a major Australian producer of asbestos-based products) to agree to compensate the victims of the disease (see Figure 9.1.9).

9.1.9 Asbestos, because of its horrific health impacts, has experienced a dramatic deterioration in resource value.

Activities

Understanding the text

1 Explain how naturally occurring items become resources.

2 Cite examples of resources whose uses have changed over time.

3 Outline the conditions that need to be met for a naturally occurring item to become a resource.

4 Outline the economic factors that can cause the value of a resource to change.

5 Explain how technology can impact on our perception of what constitutes a natural resource.

6 State whether Indigenous Australians were technologically advanced at the time of European settlement. Give reasons for your answer.

7 Describe how people from different cultures may view resources differently.

8 Outline the environmental and health concerns associated with resource use.

9 State why governments often choose to promote the exploitation of natural resources. How might they do this? Are the consequences of such interventions always positive?

10 Cite examples of materials, other than asbestos, that have lost their resource value because of environmental concerns.

Working geographically

11 Study Figure 9.1.1.

- **a** In groups, discuss the context in which each of the features shown could be regarded as a resource.
- **b** Write a report outlining the different views of resources drawn from the scenes shown in the photographs.

12 Study Figure 9.1.3. Using the diagram as a guide, write a paragraph outlining the dynamic nature of natural resources.

13 Study Figure 9.1.4. Write a paragraph outlining the changes that take place when the price of a mineral increases.

UNIT 9.2

Natural resources: renewable, recyclable and exhaustible

9.2.1 Rainforest, Kondalilla National Park, Queensland. A forest, if used sustainably, can regenerate. It is, therefore, a renewable resource.

9.2.2 Fish stocks, if managed carefully, are a renewable resource.

9.2.3 If forestry activity causes a reduction in either plant or animal populations, especially to the point of possible extinction, the harvested timber is not a truly renewable resource. This is because the harvesting process threatens the long-term survival of other life forms.

The nature of resources varies greatly. Some appear to be continuously available, while others are in limited supply and could be exhausted. Resources are usually grouped into four categories. These are:

- renewable resources (see Figure 9.2.1)
- non-renewable, or exhaustible, resources
- recyclable resources
- continuous resources.

Renewable resources

If used, renewable resources will eventually be replenished. This group in theory includes forests, groundwater, wildlife and fish (see Figure 9.2.2).

Forests

It is assumed that after a forest is used for timber, given time, a very similar ecosystem would be reproduced in its place. The word 'ecosystem' is used here for an important reason. Timber production (see Figure 9.2.3) involves far more than harvesting a given quantity of wood per unit area on a regular basis. In the timber production process, key timber values need to be maintained. These include the quality of the timber produced (growth of good sawlogs) and the species of trees grown. If the timber cannot be reproduced at a similar or better standard than is available from old growth native forests, then the forest is not being renewed.

Forests are not only timber-producing areas; they are also ecosystems fulfilling other functions. For example, forests:

- provide a variety of habitats for native fauna
- contain complex vegetation systems, including many non-commercial species
- consume carbon dioxide, making them a key element in the global carbon cycle
- contain water catchments that are often important recreation areas.

If forestry activity causes a reduction in either plant or animal populations, especially to the point of possible extinction, the harvested timber is not a renewable resource. This is because the harvesting process threatens the long-term survival of other life forms. Also, if soil erosion caused by logging is such that natural soil-forming processes cannot balance the net loss of soil, the timber cannot always be replaced in the long term. Similarly, if water catchments and rivers are degraded as a result of logging, then the forestry cannot be correctly described as renewable.

Non-renewable resources

The quantity of non-renewable (exhaustible) resources is finite. This means that once they are used there is no possibility of reuse. Many of the world's energy sources are examples of non-renewable resources (see Figure 9.2.4).

9.2.4 Coal seam mining, Germany. Coal is an example of a non-renewable (exhaustible) resource.

Peak oil

Peak oil is the point in time when the maximum global petroleum production rate has been reached. After this time, the rate of production will enter a slow period of decline because readily available supplies will have been used and other sources will be more difficult, or more expensive, to extract. If global consumption is not reduced significantly before the peak is reached, the availability of cheap, conventional oil-based products will drop and prices will rise, perhaps dramatically.

The more optimistic predictions claim a peak in production will not occur until around the 2020s or 2030s and assume major investments in alternatives will occur before a crisis point is reached. These predictions show the oil price first escalating and then retreating as other types of fuel sources are used, and as fuel substitution in general occurs.

An unknown factor in determining the actual date of peak oil is the role of unconventional sources. These include: 'tight oil' (oil extracted from deposits of low-permeability rock, sometimes shale deposits but often other rock types, using hydraulic fracturing); 'oil shale' (a substitute for conventional crude oil) extraction; and 'oil sands' (unconsolidated sandstone deposits containing large amounts of very viscous crude bitumen or extra-heavy crude oil that can be recovered by surface mining or by in situ oil wells using steam injection or other techniques).

SPOTLIGHT

Sustainable development

The term 'sustainable development' has become a popular concept in environmental literature and in debates about the nature of economic development. Achieving sustainable development has replaced maximising economic growth as the stated goal of many development assistance agencies, such as the World Bank. Yet, it is more talked about than actually applied.

The term 'sustainable development' does not have the same meaning for all who use it. Our Common Future (commonly known as the Brundtland report) was published in 1987 by the United Nations World Commission on Environment and Development. It defines sustainable development as 'development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs'. But some regard the primary focus on meeting 'human needs' as being too anthropocentric (human-centred) and argue for 'global sustainability' that includes all the components of the biosphere.

Recyclable resources

While there is a limit to most of the world's mineral resources, many of them, as well as some plastic and rubber products, can be recycled after use. Scrap iron and steel for example can be recycled repeatedly into a wide range of metal products. Paper is often recycled (seen in Figure 9.2.5), as are aluminium cans, glass bottles, plastic bottles, copper wire, silicon, gold and lead from car batteries.

9.2.5 A paper recycling plant

Managing the waste of the technological age

Electronic waste (e-waste) consists of any broken or obsolete electrical equipment (for example, computers, TVs and mobile phones). The safe disposal of such waste is a growing concern because many components of such equipment are toxic and are not biodegradable.

In most cases, e-waste consists of electronic products that were used for data processing, telecommunications or entertainment in private households and businesses. The products are now considered obsolete, broken or irreparable.

Despite being classified as waste, discarded electronic components are best regarded as a secondary resource because many parts can be refurbished and/or reused. For example, many fully functional computers and components are discarded during upgrades. Material recycling of constituent raw materials is possible. Treating e-waste as a resource is much better than having to deal with its potentially hazardous qualities. The toxic substances typically found in electronic equipment include lead, mercury and cadmium. Carcinogenic (cancer-causing) substances in e-waste include polychlorinated biphenyls (PCBs).

As a result of lower environmental standards and working conditions in countries such as China, India and Kenya, e-waste is being sent to these countries for processing, in some cases illegally. Delhi and Bangalore in India and Guiya, Guangdong province in China have large e-waste processing areas. Uncontrolled burning, dismantling and disposal are causing environmental and health problems, including occupational safety and health impacts among those involved in the industry. The trade in e-waste is controlled by the Basel Convention.

The Basel Convention is an international treaty designed to reduce the movements of hazardous waste between countries, and specifically to prevent transfer of hazardous waste from developed countries to developing countries.

Done correctly and with the appropriate regulatory, public and commercial scrutiny, component reuse can divert e-waste from energy-intensive, down-cycling processes. These processes, which include conventional recycling, involve converting the equipment to the raw material from which they were originally made. The environmental and social benefits of reuse are:

- decreased demand for new products and the raw materials from which they are made
- increased availability of technology to more people due to greater affordability of products
- reduced amounts of waste going to landfills.

E-waste in Australia

The National Television and Computer Recycling Scheme (established in 2011) provides Australian householders and small business with access to industry-funded collection and recycling services for televisions and computers.

To date, more than 1800 collection services have been made available to the public and more than 130 000 tonnes of TV and computer e-waste has been collected and recycled under the scheme. This has diverted hazardous materials away from landfill and enabled the reuse of valuable resources contained in e-waste.

The scheme supplements state, territory and local government e-waste management, but does not entirely replace these activities.

SPOTLIGHT

Guiyu, China's e-waste capital

Guiyu in China was the largest e-waste site in the world, with an estimated 150 000 workers processing more than 100 truckloads of waste each day. Shown in Figure 9.2.6, locals dubbed the region the 'electronic graveyard'. In 2016, Chinese authorities ordered all unregulated electronic e-waste workshops to move to a new industrial park, with tighter controls and regulation. This was part of the Chinese government's 'war on pollution'.

Authorities estimate that Guiyu processed 1.5 million tonnes of e-waste each year. In thousands of simple shelters in Guiyu's villages, workers 'cooked' circuit boards to extract lead and tin and pried off microchips and dropped them into sulphuric acid to recover gold and silver. They burned wiring for the copper inside. The impact of illegal processing of e-waste remains. In 2014, a Shantou University Medical College report found the air and water in Guiyu was contaminated with heavy metals. Many children also had high lead levels in their blood, which has a negative impact on intelligence and the development of the central nervous system.

9.2.6 Electronic waste in Guiyu, China. Vast amounts of e-waste are routinely and often illegally shipped from Europe, the United States and Japan to places such as Guiyu where unprotected workers recover parts and materials.

Continuous resources

Continuous (perpetual) resources are those that will virtually always exist. They include solar energy and rainfall.

For the foreseeable future, we can be sure that solar energy will reach the earth. However, modification of the earth's atmosphere means there is no guarantee that current levels of solar energy will continue to reach the earth's surface. In addition, alterations to the landscape (for example, the shrinking of the polar ice caps) may have an impact on the albedo (reflectivity) from land surfaces, and this could alter the climate.

Factors such as changes to the landscape and atmosphere are likely to have a major impact on the pattern of precipitation around the globe. Therefore, it may not be totally accurate to describe rainfall as a continuous resource either.

Several other resources may be defined as continuous. They include wind energy, hydro-electricity, tidal power and geothermal power.

Activities

Understanding the text

1 Distinguish between renewable, non-renewable, recyclable and continuous resources. Give examples of each.

2 a Define the term conservation. Provide three examples of conservation practices.

b Define the terms anthropocentric and biocentric as they relate to people's world view.

c In your definition of conservation, did you emphasise human benefits or was your viewpoint more biocentric? Justify your answer.

Working geographically

3 Study Figures 9.2.1 and 9.2.3. Outline the role of forests. Under what circumstances are forests not considered renewable?

4 Figures 9.2.1 and 9.2.2 show two renewable resources. Is their future guaranteed because they are renewable? Write down your reasons for each case.

5 a Explain what is meant by 'peak oil'.

b When is it projected to occur?

c Explain what is meant by 'unconventional' sources of oil.

6 Study the Spotlight box, 'Sustainable development'.

a Define sustainable development.

b Outline the principal criticism of the definition of sustainable development in the report: Our Common Future.

7 a What is e-waste?

b Why is it useful to regard such e-waste as a resource?

c Outline the role of the Basel Convention.

d Outline the environmental and social benefits of reuse.

e Outline the role of Australia's National Television and Computer Recycling Scheme.

f Outline the economic value of e-waste to communities such as Guiyu. What might be some of the costs?

CASE STUDY

Renewable energy

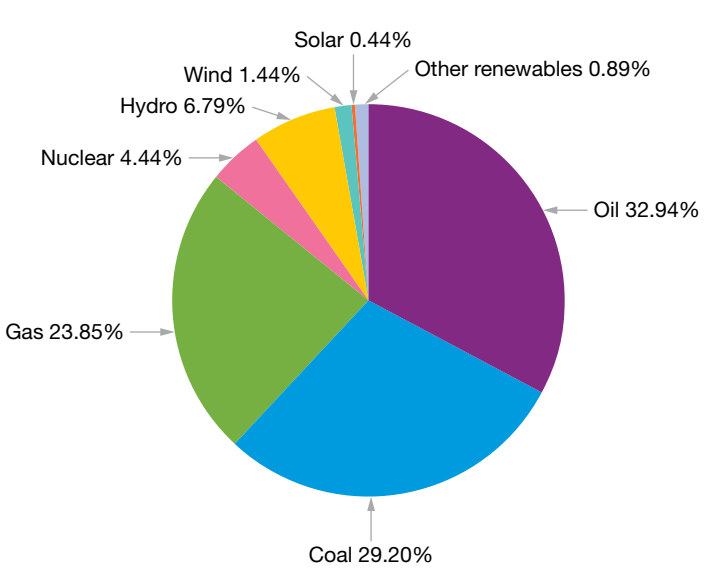
The growing interest in renewable energy is linked to the state of the world's environment, particularly the threat of global climate change. Billions of dollars are now being invested in renewable energy technologies, and building the related infrastructure is rapidly becoming more cost-effective when compared to the cost of conventional fossil fuel-based energy infrastructure.

Estimates of the future growth of continuous energy sources range from a 57 per cent to a 71 per cent share of the world's total energy consumption by the year 2050. This will be a significant increase on the 2016 level, which was approximately 9.56 per cent (not including traditional wood burning), seen in Figure 9.2.7. Australia has a renewable energy target of 23.5 per cent for the year 2020.

To promote new and renewable energy sources, governments could:

- promote research into energy-efficient technologies
- promote investment in renewable energy infrastructure (solar, wind, hydro-generators and storage) through a market mechanism such as a 'price on carbon', providing investment certainty via clean energy targets and/or providing tax breaks
- use tax incentives to reward corporations that demonstrate ecologically responsible behaviour and to establish a 'level playing field' for all energy sources
- provide incentives for households to install energy-saving technologies, such as solar panels, storage batteries, solar hot water systems, insulation and energy-efficient lighting.

Figure 9.2.8 outlines the world electricity generation by source, including the recent increase in electricity from renewables.

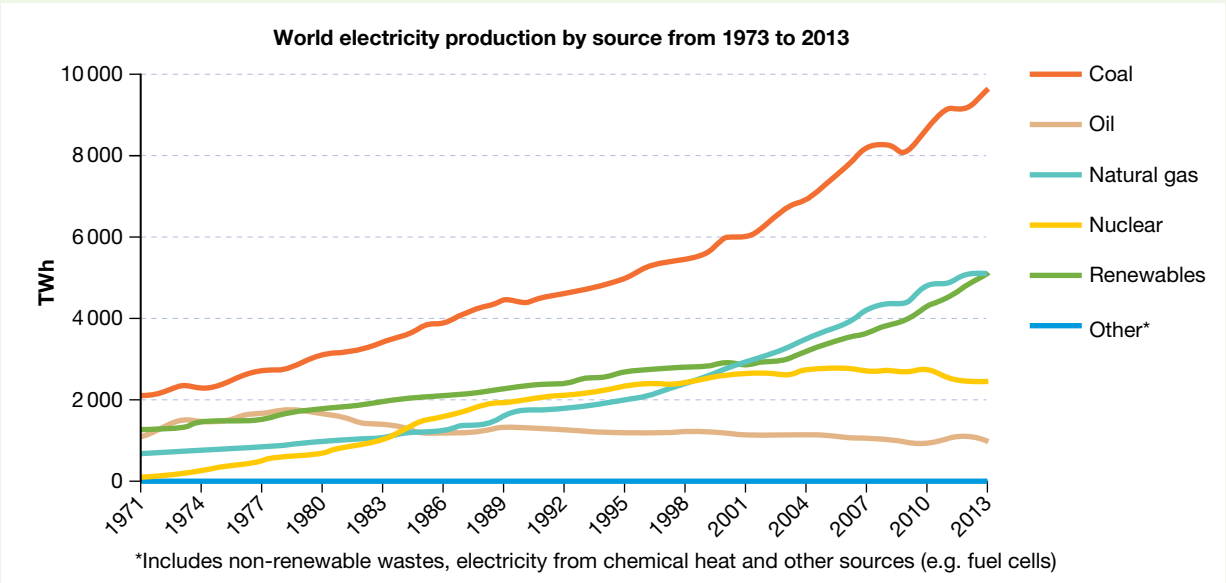


Source: World Energy Council

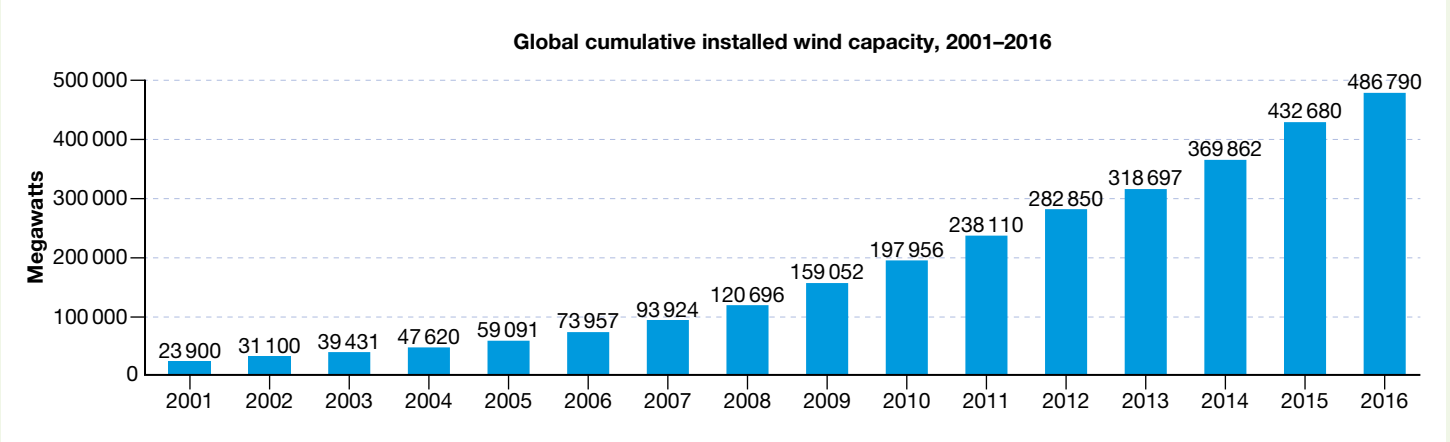
9.2.7 World energy consumption by source, 2015

Figure 9.2.9 shows the growth in the use of wind generation. Just over 1.4 per cent of the electricity used worldwide is produced by wind-powered generators. However, it accounts for approximately 42 per cent of electricity production in Denmark, 21 per cent in Spain, and 9 per cent in the UK and Germany. Canada plans to have 20 per cent of the country's electricity produced by wind turbines by 2025. Globally, wind power generation increased from 23 900 megawatts in 2001 to 486 790 megawatts in 2016 – an increase of 2000 per cent.

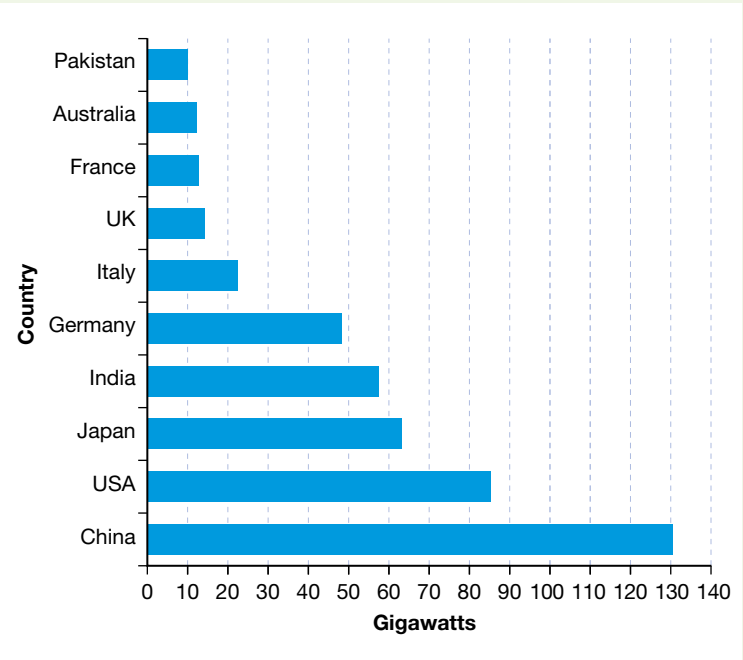
Figure 9.2.10 outlines the top 10 solar energy producing countries. With such a high level of sunshine, Australia has been criticised for not ranking higher than ninth on the list.



9.2.8 World electricity generation by source, 1973–2013



9.2.9 World wind energy: total installed capacity, 2001–2016



9.2.10 Top 10 solar energy producing countries, 2016

9.2.11 Sundrop Farms' South Australian solar facility and tomato greenhouses

South Australia's solar-powered tomato factory

Sundrop Farms is a global leader in sustainable agriculture, growing fresh fruits and vegetables using renewable energy. One of its most advanced facilities is located on Spencer Gulf near Port Augusta in South Australia. The facility produces approximately 15,000 tonnes of tomatoes a year to be sold by Coles supermarkets.

A team spent six years fine-tuning the system that pipes seawater in from the ocean and desalinates it using a state-of-the-art concentrated solar energy plant. The water is then used to irrigate 20 hectares of tomato plants grown in coconut husks instead of soil, in a network of greenhouses.

At the centre of the farm are the 23 000 mirrors that reflect sunlight towards a 115-metre high tower. All the concentrated sunlight produces an immense amount of power. That's more than enough power the meet the desalination needs of the farm and supply all the electricity needs of the greenhouses (see Figure 9.2.11).

Port Augusta solar thermal power plant

A new $650 million solar thermal power plant is under construction in South Australia. When complete, the 150 megawatt capacity plant will supply all of the state government's power needs.

The plant will have about 12 000 billboard-sized mirrors arranged in a circle over an area of about 600 hectares. The mirrors will focus light and heat at the top of a 227-metre tower—the tallest of its kind in the world. The process heats molten salt, pumped to the top of the tower, to 565°C. The molten salt provides a stored heat source which is used to create steam that drives the turbine that generates electricity. The plant will be able to generate power at full load for up to eight hours after sunset, and will be capable of storing between eight and 10 hours of energy when the sun is not shining.

Figure 9.2.12 shows a similar solar thermal plant in the Mojave Desert, California, USA.

9.2.12 Solar thermal power plants in the Mojave Desert, California, USA

9.2.13 The world's biggest battery, built by Tesla in South Australia. The battery will store the renewable energy generated by a nearby wind farm.

Storing renewable energy

One of the greatest challenges facing the renewable energy industry is the issue of storage. Because the wind does not always blow and solar panels are only effective during daylight, some form of storage is necessary. Battery technologies are one solution. Batteries range in scale from small domestic units such as the Tesla Powerwall to large-scale facilities such as the 100-megawatt/129 watt hours battery built in Jamestown, South Australia by Tesla, shown in Figure 9.2.13.

Pumped hydro is another form of storage. Surplus renewable energy is used to pump water, which has already passed through the turbines of hydroelectric power station, back up into the dam. At night the water is reused to generate electricity. The Snowy 2.0 proposal has the potential to increase the generation capacity of the iconic Snowy Scheme by up to 50 per cent, making up to 2000 megawatts available to the National Electricity Market.

Activities

Working geographically

1 State why there is a growing interest in renewable energy. What role is it expected to play in the future? What could governments do to promote the development of renewable energy?

2 Study Figure 9.2.7.
   - **a** State the percentage of the world's total energy consumption derived from fossil-based sources in 2015.
   - **b** State the percentage of the world's total energy consumption derived from renewable sources in 2015.

3 Study Figure 9.2.9.
   - **a** By how much did the world wind energy capacity increase between 2001–2016?
   - **b** Brainstorm the advantages and disadvantages of producing energy using wind farms.

4 Study Figure 9.2.10. Identify the major solar energy producing countries. Where does Australia rank in this energy sector?

5 Outline the role of renewable energy in the Sundrop Farm's tomato-growing venture in South Australia. As a class, discuss the future of such enterprises in securing the world's food in the future.

6 What is a solar thermal power plant? How do they overcome the principal limitation of solar energy technologies?

7 Outline the developments that address the challenges associated with the intermittent nature of renewable energy.

8 There is more to be sustained in forests than timber production. Write a set of guidelines indicating what logging operations must achieve if harvested forests are to be appropriately 'renewed'.

9 Discuss the future of fossil fuel use.
   - **a** Write a paragraph about the factors that could eventually cause fossil fuels to be displaced as a major energy source.
   - **b** Write a paragraph about the role of governments in this process.

10 Is hydro-electricity a truly environmentally acceptable form of energy generation? Write a short exposition to substantiate your point of view.

11 Using internet sources, write a series of paragraphs explaining how wind energy, water, the tides and geothermal energy sources can be used to produce electricity.

UNIT 9.3

Patterns of natural resources

There are huge disparities between, and within, countries in terms of access to and use of resources. It is too simplistic to simply consider the availability of a particular resource when drawing conclusions.

Studying resource distribution in isolation will not always provide meaningful conclusions about people's relative wellbeing either. Often a more meaningful picture will be achieved by studying the consequences of a lack of effective resources. This may be evident in low levels of income, gross national product (GNP), education and energy consumption; high dependency on aid; severe environmental degradation; negligible exports; and possibly poor health, high infant mortality and short life expectancy.

Whatever the indicators used, care must be taken when interpreting information. Average data for an individual country may suggest that few resource problems exist. However, within that country, there may be a vast gap between the rich and the poor, and there may be serious localised food shortages.

The uneven global distribution of natural resources

The physical processes of the earth have resulted in an uneven distribution of resources around the globe. Rich basalt soils are a result of volcanic activity. Rainfall is largely a function of topography and prevailing winds, position relative to the sea and the local nature of ocean currents. Coal deposits are related to the position of swamplands dating back to the Carboniferous era, about 345 million years ago. Other minerals have been concentrated in particular regions through deposition or other processes.

9.3.1 Deforestation to create agricultural land in Eastern Ghana, Africa

Land resources

Land resources often involve a trade-off. Clearing forested land for cropping or grazing may be at the expense of important timber resources and habitats, for people as well as other biota (see Figure 9.3.1). Large-scale clearing can destroy the society of forest-dwelling indigenous peoples.

The responsibility for clearing forests for agriculture is often not in the hands of the resource-poor farmers. In the Amazon Basin, much of the worst devastation has been caused by wealthier landowners from São Paulo or other cities, who receive taxation advantages for land clearing for development of agricultural land.

SPOTLIGHT

Mongabay, keeping watch on the plight of the world's tropical forests

Mongabay, a website dedicated to the environmental sciences and the state of the world's tropical forests, estimates that only 81 per cent of the pre-1970 Brazilian Amazon rainforest remains intact. This represents an accumulated loss of 768 935 square kilometres of forest since 1970. That leaves 3.3 million square kilometres of forest cover in the Brazilian Amazon. Annual losses peaked in 1995 at 29 059 square kilometres. In 2016, the area lost was 7989 square kilometres.

Once exploited, old growth forests are being replaced by less biologically diverse plantations and secondary forests. Secondary forests are natural forests that have regrown after some major disturbance, such as logging. Due to a marked increase in plantation forests, forest cover has generally been expanding in North America, Europe and China while diminishing in the tropics. Industrial logging; conversion of forested land for agriculture (commercial and subsistence); and forest fires (often purposely lit) are responsible for the bulk of global deforestation today.

9.3.2 The nature of the biophysical environment ultimately determines the land's ability to produce food. **A** Dry, harsh inland unsuitable for food production. **B** Extensive agriculture: cattle grazing. **C** Intensive agriculture: rice cultivation.

Land and productivity

Land is a fundamentally important resource, and is at a premium in economic entities such as Hong Kong and Singapore, which are both relatively small. The land's ability to produce food is of particular significance in most developing countries. Consequently, while the area of land per unit of population offers a crude estimate of the potential of a country to feed itself, the areas of arable and irrigated land will provide some indication of the level of intensive production. Other information that helps to determine land productivity includes the soil type and topography; the amount, seasonality and reliability of rainfall; moisture loss due to evaporation; and pesticides and fertilisers used in agricultural production, as illustrated in Figure 9.3.2. Selected basic indicators of agricultural resources are shown in Figure 9.3.3.

Population and land resources

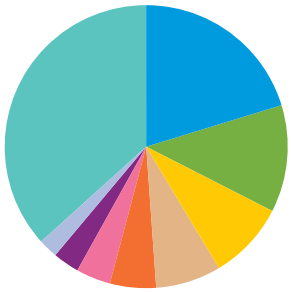
Region	Population mid-2017 (millions)	Land area (km^2 × 1000)	Arable land (% of total)	Irrigated land (% of total)
Developing countries	6273	78110	9.8	22
Least developed countries	1001	19330	6.1	12
Developed countries	1263	56620	12.9	9
World	7536	131730	10.7	18

9.3.3 Population and land resources

Forests

Forests are a particularly important resource for the rural populations of developing countries. They provide fuel and building materials, and are a source of food. Apart from their significance in maintaining biodiversity, they also have potential for wildlife tourism and ecotourism. Deforestation may have a major impact on the local climate. Some countries are well endowed with forests while others have only limited resources remaining. This resource is particularly limited in countries with harsher climates where there has also been a long history of livestock domestication.

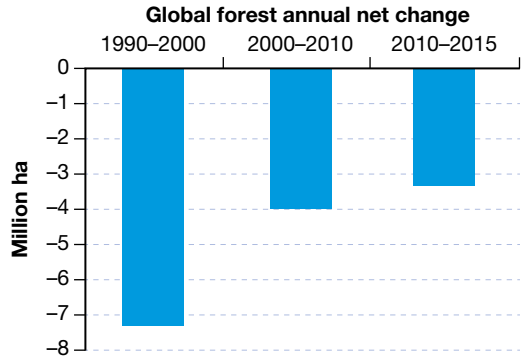
Given appropriate climate, management and financial resources, reafforestation is practical, either through planned activities or natural regeneration. Unfortunately, the rate of intentional clearing and over-cutting of forests heavily outweighs any reafforestation and regeneration. The highest rate of deforestation is occurring mainly in the developing countries that still have reasonable forest cover. Forests are cleared to create additional land for agriculture or to generate timber-based export income, shown in Figures 9.3.4 to 9.3.8.



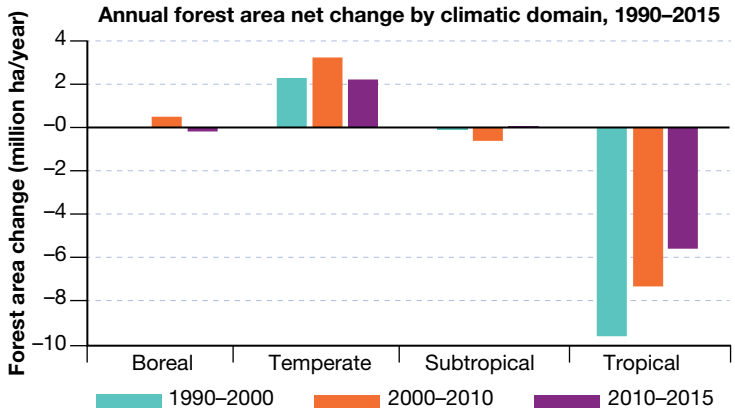
Country	Forest area (million hectares)
Russia	815
Brazil	494
Canada	347
USA	310
China	208
Dem. Rep. Congo	153
Australia	125
Indonesia	91
Other countries	1457

Source: FAO

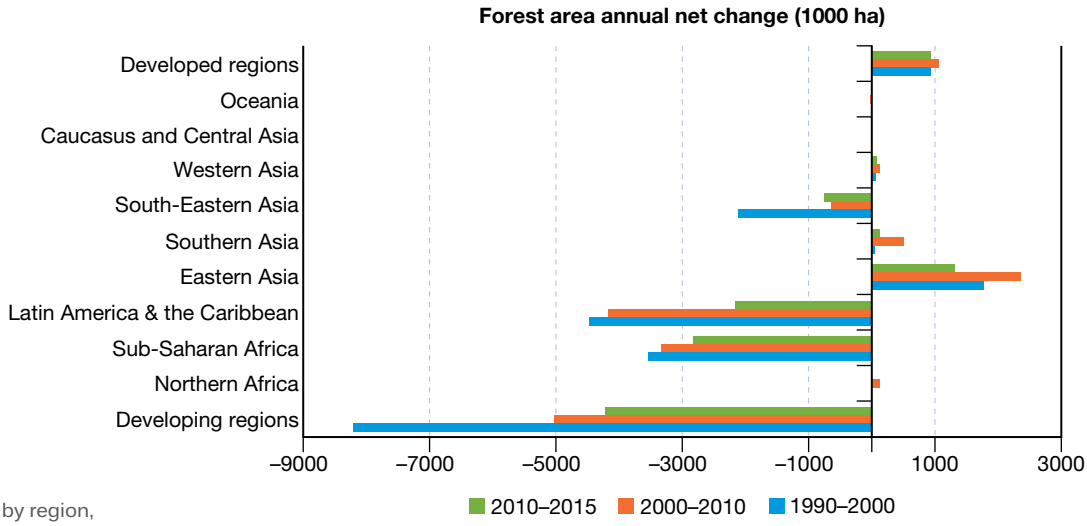
9.3.4 Global forest cover, 2015



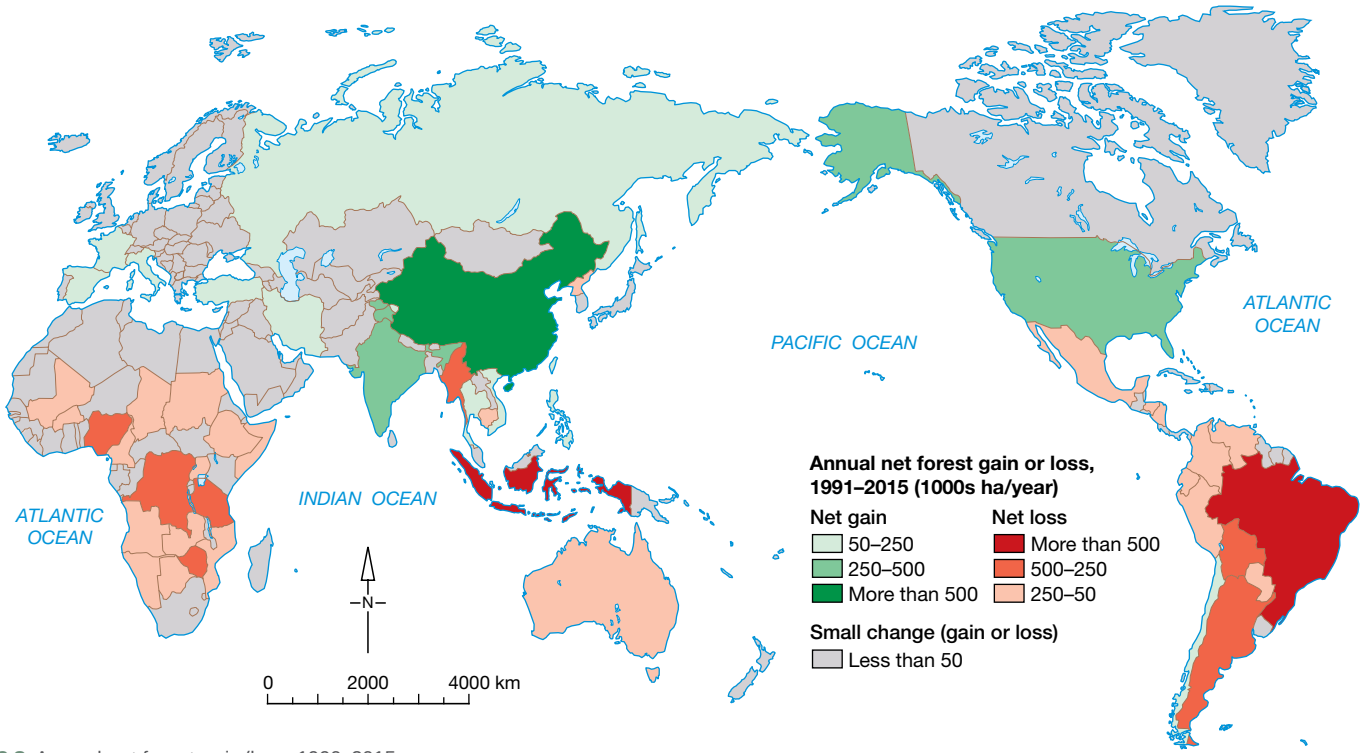
9.3.5 Global forest annual net change, 1990–2000, 2000–2010 and 2010–2015



9.3.6 Global forest cover change by forest type, 1990–2000, 2000–2010 and 2010–2015



9.3.7 Annual forest area net change by region, 1990–2000, 2000–2010 and 2010–2015



9.3.8 Annual net forest gain/loss, 1990–2015

SPOTLIGHT

Global forest facts

The importance of forests:

- Forests are vital sinks of carbon dioxide (296 gigatonnes of carbon dioxide, 2015). The world's forests absorb and store carbon in both above- and below-ground biomass.
- The world's forests are rich in biodiversity, and are vital habitats for biodiversity conservation.

Sustaining livelihood and economic opportunities:

- Forests are a provider of environmental services. Forests managed for clean water supply, resilience against disasters, recreation, cultural and spiritual activities have increased.

The area of forests included in protected areas has increased since 1990:

- 1990: 524 million hectares (total 4128 million ha)
- 2015: 651 million hectares (total 3999 million ha)
- Protection of soil and water: 1015 million ha (2015)
- Carbon storage and other cultural, spiritual and ecosystem services: 1163 million ha (2015)

The world's forests: annual net loss

1990–2000	7.3%
2000–2010	4.0%
2010–2015	3.3%

Carbon loss in in living forest biomass

1990–2000	480 million tonnes/year
2010–2015	280 million tonnes/year

The share of planted forest is increasing

	Natural forest	Planted forest
1990	96%	4%
2005	94%	6%
2015	93%	7%

Forest area per person

1990	0.8 ha per person
2015	0.6 ha per person

Activities

Understanding the text

1 State why we need to be careful when making generalisations about people's relative wellbeing and the pattern of resource endowments within countries.

2 State why land is described as a 'fundamentally important resource'. What is 'arable land'? Why is it important?

3 Outline the importance of forests. Why must they be managed sustainably?

Working geographically

4 Write an explanation outlining the reasons why a country's land area, on its own, is not a good indicator of that country's ability to feed its people.

5 Study Figure 9.3.3.
- a Which group of countries has the highest proportion of arable land?
- b Calculate the population per square kilometre for each category listed in Figure 9.3.3.

6 The least developed countries have more land per person than the average of all developing countries. Write a paragraph outlining what the other indicators in Figure 9.3.3 suggest in relation to the agricultural production of the least developed countries.

7 The division between the well-endowed and the less fortunate countries of the world is sometimes described as 'developed' versus 'developing'. As a class, discuss the appropriateness of such a division.

8 Study Figure 9.3.4.
- a Approximately what proportion of the world's forest cover is in Canada?
- b How much of the world's forest cover is found in North America?

9 Study Figure 9.3.5. Using data from the graph, describe the trend in annual net change in forest cover 1990–2000 to 2010–2015.

10 Study Figure 9.3.6. Using data from the graph, outline annual net change in forest cover by forest type, 1990–2015.

11 Study Figure 9.3.7. Using data from the graph, describe annual net change in forest cover by region.

12 Study Figure 9.3.8. With the aid of an atlas, identify the countries with the greatest change in total forest cover in the period 1990–2015.

13
- a Using the information in the Spotlight box about the Democratic Republic of the Congo, outline the nature and extent of the DRC's rainforests.
- b Identify the threats to the country's rainforest ecosystem.
- c Outline the role of the World Bank in the exploitation of the country's rainforests.
- d Explain the impact of population pressure.
- e Outline the role of fuelwood gathering and charcoal production in deforestation.

14 Write an extended response outlining the state of the world's forests.

SPOTLIGHT

Deforestation in Democratic Republic of the Congo

The rainforests of the Democratic Republic of the Congo (DRC) are the largest in Africa and second only to the Amazon Basin in size, with 300 million hectares compared to 800 million hectares in the Amazon. The forests are high in biodiversity, and are home to more than 10 000 types of plants and 600 species of timber, as well as 1000 bird species, 280 reptile species, and 400 mammal species. Many of these wildlife species are threatened, such as large lowland gorillas and chimpanzees. Many of the DRC's 82.2 million people depend on the rainforests for their basic needs, such as medicine, food and shelter.

The DRC is rich in natural resources. The country's untapped deposits of raw minerals are estimated to be worth in excess of US$24 trillion. The country has 70 per cent of the world's coltan, a third of its cobalt, more than 30 per cent of its diamond reserves, and a tenth of its copper. Despite this vast mineral wealth, the DRC is one of the world's poorest countries. Corruption is widespread.

Today, the DRC's forests are one of the world's most threatened ecosystems. Commercial logging (see Figure 9.3.9) and clearing for subsistence agriculture has devastated forests and displaced forest dwellers. Another contributing factor is the widespread civil strife in DRC, which during 1996–2003 resulted in the deaths of some 3.8 million people from violence and disease.

With the encouragement of the World Bank, which sees logging as a way to alleviate poverty and promote economic development, the DRC stepped up the commercial logging of its rainforests following the return of peace in 2003. The timber industry is a major employer in DRC, and thousands of workers rely on logging companies for basic health care and other services. Illegal logging is a significant problem as underpaid bureaucrats look to supplement their incomes by opening restricted areas to cutting. Since the end of the war in DRC, concessions have been granted and the pace of logging in Africa's largest remaining rainforest has accelerated. Timber production (as measured in cubic metres) continues to increase. Industrialised roundwood production has increased from 3.05 million cubic metres in 1990 to more than 4.45 million cubic metres annually.

Population pressure has also played a role. Most of the deforestation in DRC is caused by the subsistence activities of poor farmers and villagers who rely on the forests for agriculture and fuelwood collection. As seen in Figure 9.3.10, slash-and-burn is commonly used by poor farmers and villagers for clearing the forest. Typically, poor farmers and colonists gain access to forest lands by following newly built logging roads. During the civil war many people were driven deep into the rainforest to escape the widespread violence. This accelerated the rate of clearance in previously isolated regions.

Traditional fuelwood gathering is a serious source of tree removal around the DRC's rapidly growing urban centres. Around the capital of Kinshasa, for example, the forest has already receded by hundreds of kilometres. Fuelwood collection has increased from 44.2 million cubic metres in 1990 to more than 75.44 million cubic metres in 2016.

The rate of deforestation has also been affected by increases in charcoal production, seen in Figure 9.3.11. Charcoal plays an important role in most African countries. However, the inefficiencies inherent in the production and use of charcoal, rapid urbanisation and the preference of urban dwellers for charcoal (rather than fuelwood) place a heavy strain on local forest resources. This has severe environmental consequences.

Charcoal production harms the environment in two ways: deforestation and release of carbon dioxide gases. In order to make charcoal, the wood is burnt in kilns, slowly, for long periods of time. During this process, carbon dioxide is released into the air.

9.3.9 A mobile logging crew cut timber from a large hardwood tree.

9.3.10 Rainforest is cleared for small-scale farming using slash-and-burn, Democratic Republic of the Congo.

9.3.11 A woman carries charcoal bags to market in the Democratic Republic of the Congo.

Water

Rainfall varies widely around the globe, even at a continental scale. Many factors have an impact on the effectiveness of the rainfall received. Two such factors are water lost through evaporation and effective radiation, which is solar radiation that reaches the earth's surface at any particular point. Figure 9.3.12 indicates the pattern of rainfall, evaporation and radiation around the globe.

Fresh water: a vital resource

The world's supply of clean fresh water is threatened by growing levels of pollution. It is becoming so scarce that if current trends continue two-thirds of humanity will suffer 'moderate to severe water stress' within 20 years. This situation not only imperils human health and development on a vast scale, but also the aquatic and terrestrial ecosystems on which much of the earth's life depends.

There is clear and convincing evidence that the world faces a worsening series of local and regional water quantity and quality problems. These are largely the result of poor water allocation, wasteful use of the resource, lack of adequate management resources and climate change. One-third of the world's population already suffers from moderate to high stress as a result of over-demand and pollution of water supplies (see Figure 9.3.13). By 2025, if all humanity is to have access to safe drinking water and sanitation, the needs of an additional 1 billion people will have to be met.

Global annual rainfall, evaporation and effective radiation

Continent	Precipitation (mm)	Evaporation (mm)	Effective radiation index
South America	1630	700	1190
Africa	690	430	1156
North America	660	320	679
Asia	600	310	723
Australia	470	420	1190

9.3.12 Global annual rainfall, evaporation and effective radiation

9.3.13 Communal well in Nigeria. Access to clean water is a major issue for millions of the world's poor.

The growing scarcity of water is also hampering the expansion of agricultural production at a time when demand for food is rising with steady population growth. Efforts to deal with the water crisis need to be made in tandem with an international drive towards global food security. In some countries, there will be a need to move from food self-sufficiency to greater reliance on food purchases from world markets.

Water shortages

Current levels of water shortages and pollution are causing widespread public health problems, limiting economic and agricultural development and harming a wide range of ecosystems. They put global food supplies in jeopardy and lead to economic stagnation in many areas of the world. This is triggering a series of local and regional water crises with global implications.

Some countries, particularly in the developed world, have achieved significant improvements in water quality. They have also secured impressive reductions in agricultural, industrial and domestic water use. On balance, however, these gains have not reversed either the general trend towards water shortages or widespread decline in water quality.

Minerals

There is no consistent natural distribution of mineral wealth around the globe. Some countries are well endowed; others are not. While some minerals are produced in only a few countries, other minerals (including copper, lead and zinc) are more widely available, as seen in Figure 9.3.14.

Iron ore is a mineral of fundamental industrial importance. In excess of 75 per cent of the world's total production is provided by just four countries: Australia, Brazil, China and India. So great is China's requirement for iron ore that in 2016–17, its own significant production of 375 million tonnes accounted for a third of its needs. While it is one of the world's largest producers of iron ore, it is also a net importer.

Another key mineral, nickel, tends to be dominated by just five countries: Philippines, Russia, Canada, Australia and New Caledonia. Together, they mined 63 per cent of the world's total production in 2016–17.

Mineral production

There are two phases in the production of many minerals before they enter the manufacturing process. The first is mining of the ore body and the second is refining the ore into a usable form.

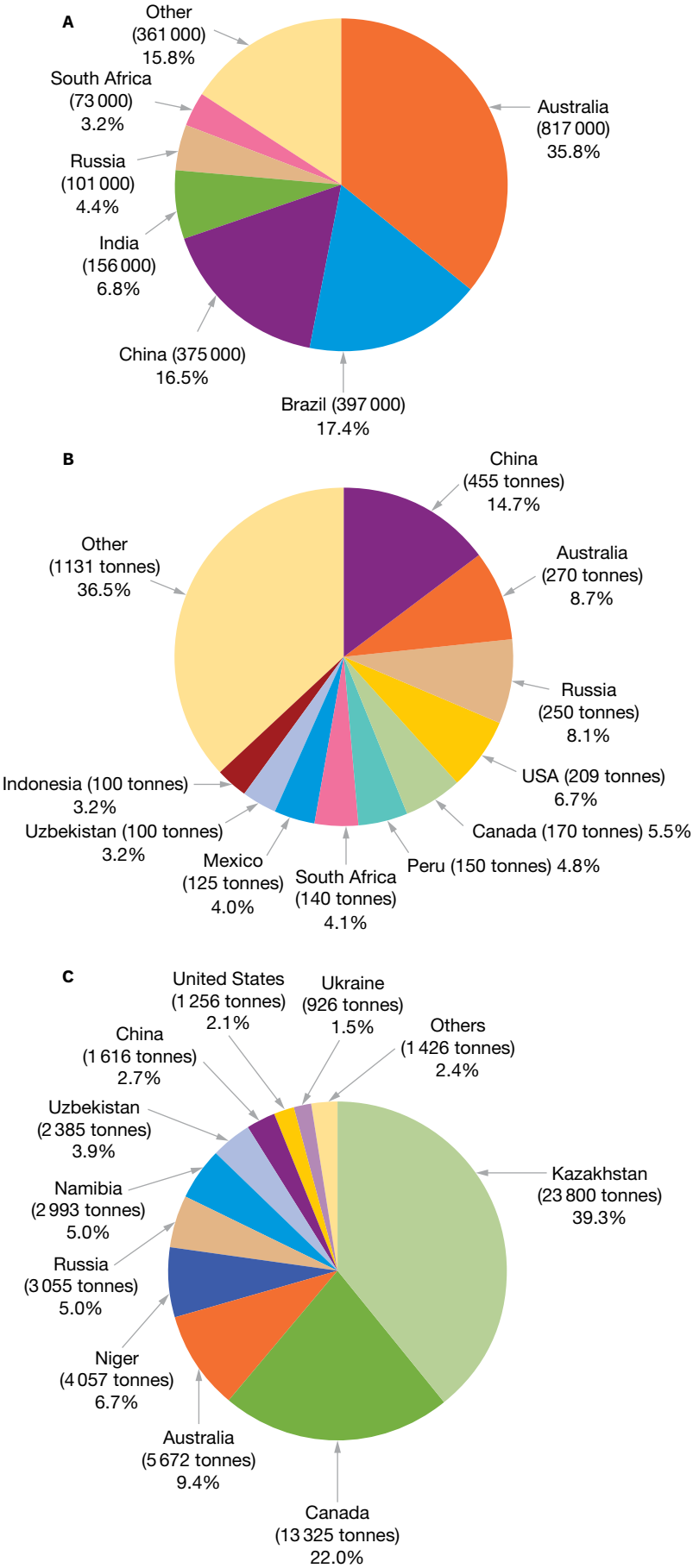
Aluminium metal does not occur naturally. Aluminium is mined in the form of bauxite, which contains hydrated oxides of aluminium, some silicon and other elements. Over three-quarters of global exports of bauxite come from just four countries: Australia, Guinea, Jamaica and Brazil. It is refined to alumina (aluminium oxide) and then into the metal aluminium. The last stage requires high inputs of electricity. Thus, while some countries with bauxite deposits will also refine the bauxite to alumina and then to aluminium, some countries with large amounts of cheap electricity will import either bauxite or alumina, and export the aluminium.

DID YOU KNOW?

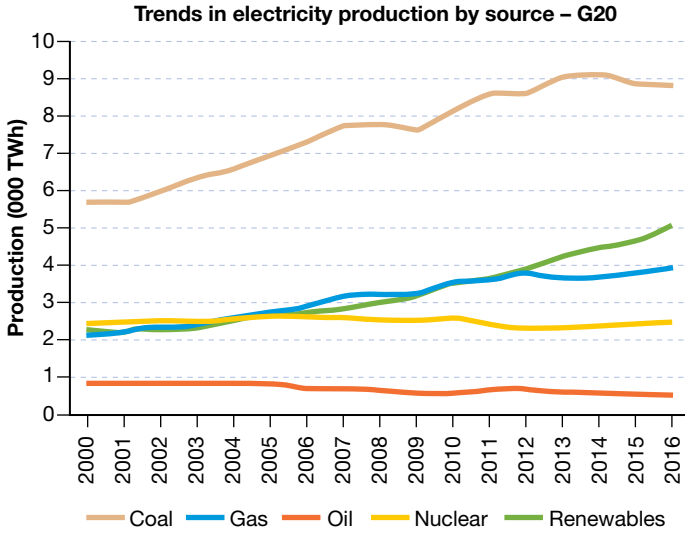
While it is often economically desirable to add value to the raw minerals through the smelting processes, this may come at a serious environmental cost. Ores that are high in sulfates produce high levels of sulfur dioxide during smelting, which can lead to acid rain.

Energy

Energy resources are unevenly distributed around the world. For electricity generation, the major fuels are coal and uranium. The burning of coal is a major environmental issue. It releases carbon dioxide into the atmosphere. This, in turn, is responsible for the enhanced greenhouse effect and climate change.



9.3.14 Major producers of selected minerals. **A** Iron ore ('000 tonnes), 2016. **B** Gold production (tonnes), 2016. **C** Top uranium producers, 2015.



9.3.15 Trends in electricity generation by source for the world's 20 largest economies (G20), 2000–2016

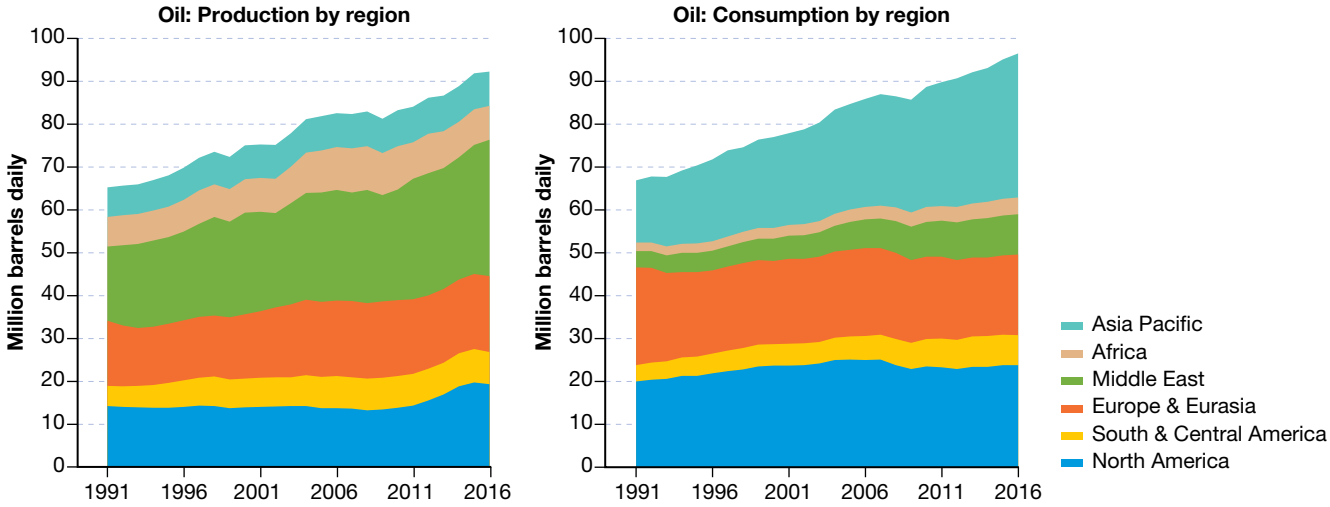
Energy is required for three basic purposes:

- electricity generation; from coal, oil, uranium, wind, solar and hydro-power (see Figure 9.3.15)
- industry; for example, coal for steel production
- fuel for transportation; mainly petroleum-based products but also electricity and nuclear fuel.

For transportation, the major energy sources are oil (petroleum) and, to a lesser extent, liquid petroleum gas. In some countries, ethanol produced from sugar or cereal crops is an important fuel. The Organization of the Petroleum Exporting Countries (OPEC) is the major bloc of fourteen of the main oil-producing countries. The former Soviet Union, Western Europe and North America are also major producers of oil. Due to their high levels of consumption, Western Europe and North America are still net importers of oil; that is, they consume more oil than they produce. Other, smaller oilfields exist outside these areas. In Australia there are a number of smaller fields but additional imports are increasingly necessary.

Petroleum

Petroleum-based products remain central to the functioning of the global economy (see Figure 9.3.16); however, they are also major contributors to a range of environmental concerns, especially global climate change and air pollution. As a result, there is a search for alternative (non–carbon dioxide producing) energy sources. The decision by a number of countries to phase out the use of cars and trucks powered by the internal combustion engine is an example of this trend.



9.3.16 Trends in the global production and consumption of oil, 1991–2016

Also driving the search for alternatives is the realisation that the world's petroleum resources are finite and that global production will soon peak and then start to decline. Just how much oil remains is unknown. In part, this is because rising oil prices (a result of increasing scarcity) will stimulate further exploration and make it feasible to recover deposits that are now marginal. As a result, there is a vigorous debate among petroleum geologists, energy economists, oil companies and other interested parties about the extent of the total resource and, more importantly, when production may peak.

To further complicate such assessments, the bulk of the world's petroleum resources are heavily concentrated in just a few countries, most of which are located in politically unstable regions (see Figure 9.3.17). Regional conflicts that could cause short-term interruptions to petroleum supplies cannot be ruled out.

Nor can a more gradual impact on the world's oil supplies. This could result from under-investment in production facilities in key oil-producing countries, particularly when petroleum production decisions reflect national policy and not just the demands of the market. New wells, pipelines and tanker platforms require massive amounts of capital, for which most major oil-exporting countries have other, competing demands.

Production and consumption of natural resources

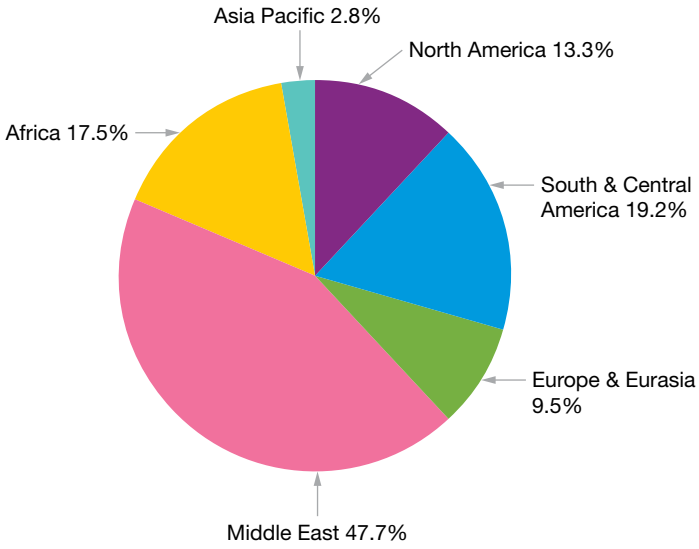
Truly subsistence agriculture represents the only authentic example of a closed loop between the production (point of origin) and the consumption (point of use) of the goods. As soon as a subsistence producer engages in exchange (for example, exchanging decorative feathers with a neighbouring group) the resulting trade breaks the closed loop.

Global trade has grown due to improvements in transport, some dismantling of trade barriers and greater competition for resources. Growth in global trade has led to fewer matches between areas of production and areas of consumption. Thus, although Australia produces vast quantities of different foods, many imported food items are available in our supermarkets, including hams from Canada and fruit juices from South America; see Figure 9.3.18. Imports meet shortages of locally available natural resources. The cost of imports is often offset by trade in other raw materials, other products or services (such as finance, expertise, tourism and education).

9.3.18 Port Botany container terminal, Sydney. World trade is a result of the broken loop between areas of production and areas of consumption of natural resources.

Dependence on resource extraction

In general, countries that have a rich endowment of natural resources have a trading advantage over other countries. This is provided the returns to the country are significant and are invested in other enterprises with long-term benefits for the community.



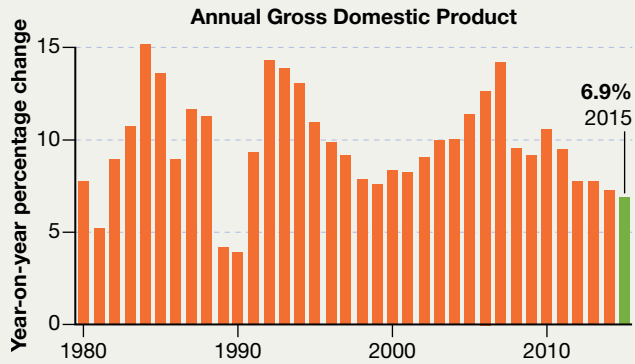
9.3.17 Distribution of global oil reserves, 2017

SPOTLIGHT

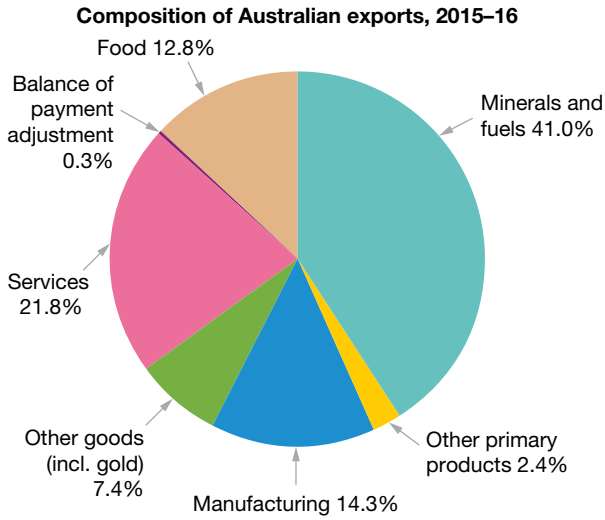
China's economic boom

China's economy was once a centrally planned system based on the principle of state (or collective) ownership. The economy was largely closed to international trade. During the last quarter century, it has changed to a more market-oriented economy that has a rapidly growing private sector. China's economy expanded at an average annual rate of 10 per cent over the 30 years to 2015. Since then, it has grown at an annual rate of around 7 per cent, shown in Figure 9.3.19.

China's emergence as a major economic power has resulted in a rapid increase in the country's consumption of natural resources. The rising demand for mineral ores has forced up commodity prices (the price of raw materials and primary products). Because of Australia's large reserves of mineral ores, the Australian economy has benefited greatly from the growth in the Chinese economy.



9.3.19 Annual growth of China's GDP, 1980–2016



9.3.20 Australia's exports by sector, 2015–16

Colonial Australia sent most of its resources to Britain, because it was in Britain's interests to receive the raw materials for its own manufacturing industry; this model continued until the 1950s. Due partly to this influence, and the success of its resource-based industries (such as gold, coal and wool), Australia had little encouragement to develop other competitive secondary (manufacturing) industries.

Australia still depends heavily on providing raw materials for the global industrial machine, and as a result is vulnerable to international economic fluctuations in the value of minerals. Figure 9.3.20 illustrates Australia's dependence on its rural and resource exports (still 53.8 per cent). Importantly, however, over the past decade or so there has been a growth in the contribution of manufacturing and services, including tourism and education.

This issue of dependence on resource extraction is not restricted to Australia. For example, countries that have valuable forest resources and offer timber concessions to overseas companies find that they become increasingly dependent on the logging activities. Not only do timber companies employ local people, but the government may become reliant on the royalties and taxes generated by the forestry industry. This situation is made worse if the government embarks on major construction developments, such as grandiose government buildings, that are not generating income to meet the debts incurred. Thus, developing countries have expanding forestry industries, which will probably not cease operations until there is little of commercial value remaining. Conservationists around the world are alarmed at the loss of ecologically important forests. However, there is little that can be done unless the debts of developing countries are removed through international intervention and other, sustainable, industries are developed to replace the exploitation of forest resources.

Activities

Understanding the text

1 Identify the factors that determine the effectiveness of rainfall received.

2 Explain why there is no consistent distribution of mineral wealth. What are the consequences of the unequal endowment of such resources?

3 Identify the two phases of mineral production.

4 Identify the three purposes for which energy is required.

5 State the inevitable outcome of breaking a closed loop between areas of production and consumption of natural resources.

6 Identify the factors that have facilitated the growth of world trade.

7 Outline, using Australia as an example, some of the challenges associated with a dependence on resource extraction.

8 Explain how a wealth of resources can present a problem, especially for people in developing countries.

Working geographically

9 Study Figure 9.3.12. Determine which continent has the highest aridity index (effective radiation divided by precipitation).

10 Outline the challenges associated with the provision of clean fresh water. What percentage of the world's population suffers from moderate to high stress? What are the consequences of this scarcity?

11 Study Figure 9.3.14. Outline what the graphs tell us about the global distribution of these mineral ores.

12 Study Figure 9.3.15. Using data from the graph describe the trends in electricity generation by source, 2000–2016.

13 **a** Outline the reasons why the use of petroleum-based products is being questioned.

b What factors complicate assessments about the future of the world's petroleum resources?

c Using data from Figure 9.3.16, describe the trends in the global production and consumption of oil, 1991–2016.

d Using data from Figure 9.3.17, describe the distribution of global oil reserves in 2017.

14 Study the Spotlight box, 'China's economic boom' and Figure 9.3.19. Outline the changing rate and nature of China's economic growth. Speculate on the consequences of this growth for the demand of mineral ores.

15 Study Figure 9.3.20. Identify Australia's principal exports by size. What proportion of Australia's exports are services?

CASE STUDY

Coal

Coal is a fossil fuel formed in wetland ecosystems where water and mud protected the plant remains from oxidation and biodegradation. Coal is principally used as a fuel to produce electricity and heat through combustion. World coal consumption now exceeds 7.5 billion tonnes a year, of which approximately 75 per cent is used for the production of electricity. China, which now consumes more than 3.2 billion tonnes of coal a year, plans to cap consumption below 3.8 billion tonnes. India, the world's second largest coal consumer, used an estimated 790 million tonnes of coal in 2016. The USA, the world's third largest consumer used 677.3 million tonnes in 2016.

Figure 9.3.21 outlines the top coal producing countries for 2016, and Figure 9.3.22 illustrates the changes in global coal production.

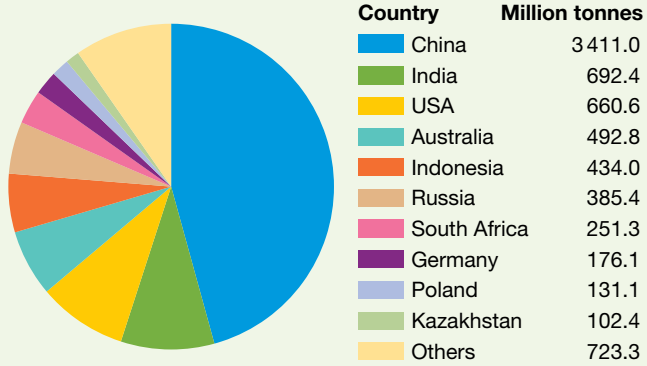
When coal is used to generate electricity it is usually crushed and then burned in a furnace attached to a boiler. The heat this generates converts water into steam, which is then used to turn turbines that generate electricity. Approximately 41 per cent of the world's electricity generation comes from coal-powered facilities. The total known deposits of coal recoverable by current technologies is sufficient for 300 years of use at current consumption levels. Figure 9.3.23 shows the distribution of proven coal reserves.

The combustion of coal is a major contributor to human-induced climate change and so the race is on to develop 'clean coal' technologies. These involve building more efficient power plants (ones that burn less coal) and capturing, separating and storing the carbon dioxide emitted. New ultra-supercritical coal power stations are capable of producing electricity using higher temperatures but with less coal. The other option is to develop renewable energy alternatives or substitutes. Over time, coal is likely to lose its resource value as the environmental cost of exploiting the resource becomes too great.

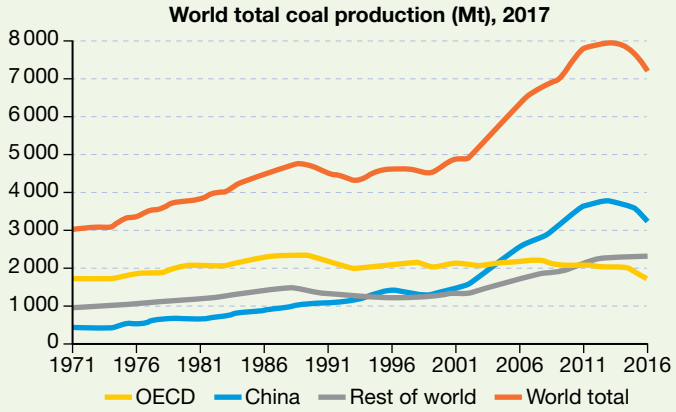
Declining consumption

Global coal consumption fell by 1.7 per cent in 2016, driven by a rise in natural gas, increasing deployment of wind and solar power, and a shift in China away from a reliance on heavy industry. In the USA, coal consumption dropped by nearly 10 per cent to levels not seen since the 1970s. In China, the world's biggest coal consumer, consumption fell by 1.6 per cent. In the UK, coal demand fell by 52.5 per cent as renewable energy generation increased significantly. All this after coal consumption had been increasing at an average annual rate of 1.7 per cent in the decade 2005–2015.

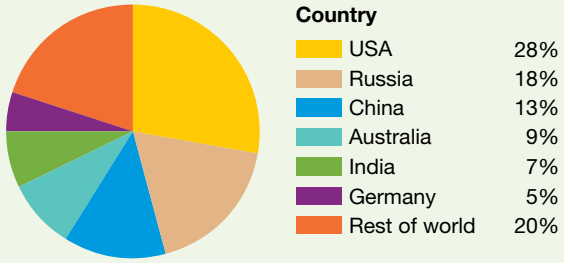
The UK is in the process of phasing out its coal-burning power plants, with the last scheduled to close in 2025, if not sooner. This is an impressive development for a nation that founded an industrial revolution powered by coal.



9.3.21 Top coal producers, 2016



9.3.22 Changes in global coal production, 1971–2016



9.3.23 Distribution of proven coal reserves, 2016

Activities

Working geographically

1. Which countries are the biggest consumers of coal?
2. What is the environmental impact of using coal as a source of energy?
3. Outline the trend in global coal consumption.
4. Study Figure 9.3.21. Identify the three biggest producers of coal. What proportion of total world coal production is by the three countries?
5. Study Figure 9.3.22. Using data from the graph, outline the trend in world coal production.
6. Study Figure 9.2.23. State the total coal reserves held by the USA, Russia and China.

CASE STUDY

The Amazon, South America

More than one-third of all species live in the Amazon rainforest. This represents the largest collection of living plants and animal species in the world. The region is home to about 2.5 million insect species, tens of thousands of plants, and some 2000 birds and mammals. To date, at least 40 000 plant species, 3000 fish, 1294 birds, 427 mammals, 427 amphibians and 378 reptiles have been scientifically classified in the region. Scientists have described between 96 660 and 128 843 invertebrate species in Brazil alone. One in five of all the birds in the world live in the rainforests of the Amazon.

The diversity of plant species is the highest on earth with some experts estimating that 1 square kilometre may contain over 75 000 types of trees and 150 000 species of higher plants. To date, an estimated 438 000 species of plants of economic and social interest have been registered in the region, with many more remaining to be discovered or catalogued. The Amazon's forests account for about 10 per cent of the world's terrestrial primary productivity.

Forests are among the world's chief carbon sinks. They store some 296 gigatonnes (Gt) of carbon in trees and vegetation. The carbon stored in forest biomass, deadwood, litter and soil together is more than all the carbon in the atmosphere. Globally, carbon stocks in forest biomass decreased by an estimated 0.5 gigatonnes a year in 2000–2010, mainly due to a reduction in total forest area. The Amazon is estimated to hold 10 per cent of the carbon stores in ecosystems.

Disappearing rainforest

The original area of the Amazon rainforest was 4 100 000 square kilometres. By 2016, deforestation had reduced its area by 19 per cent to 3 332 700 square kilometres.

This represents a total loss of 768 935 square kilometres—an area nearly as large as NSW (which has an area of 809 444 square kilometres).

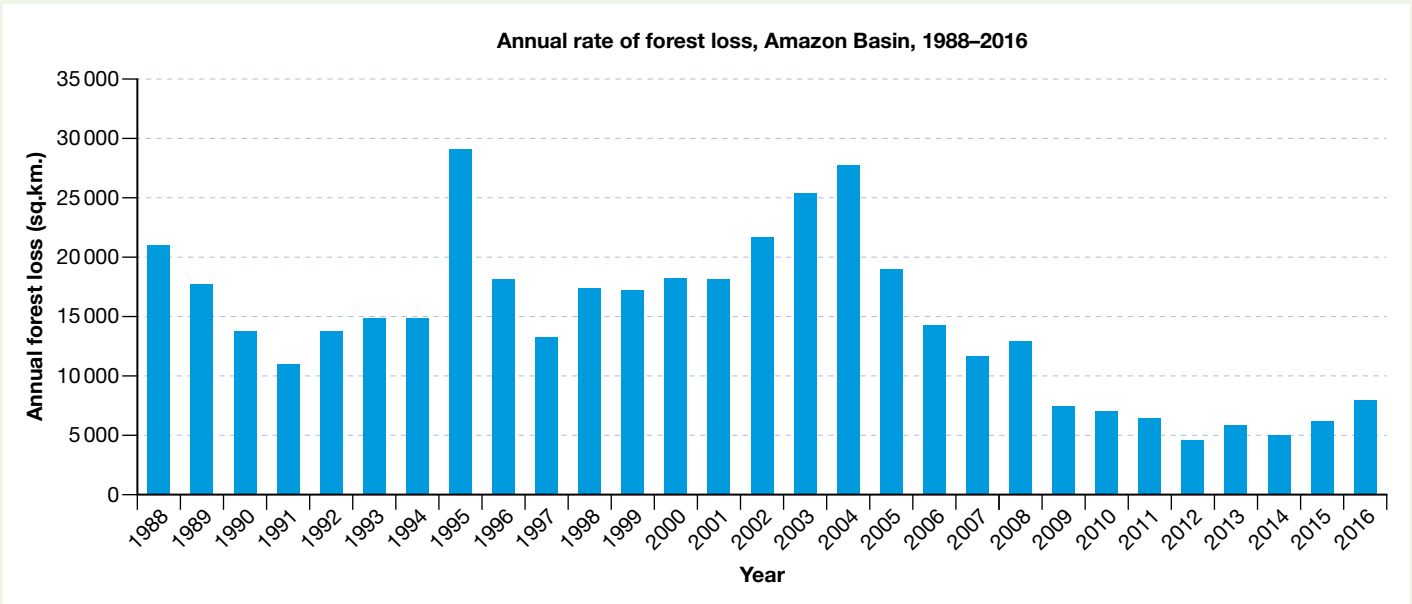
Brazil lost an average of 2.6 million hectares of forest annually in the last 10 years as compared with 2.9 million hectares per year in the 1990s. The annual rate of clearing the rainforest peaked in 1995 at 29 059 square kilometres. In the period 2010–2016, the average annual rate of loss has decreased to 6164 square kilometres. In 2016, 7989 square kilometres was lost, see Figure 9.3.24.

In addition to land clearing, drought is also having an impact on the Amazon's forest cover. This century, severe droughts have been experienced in 2005, 2006, 2010, 2015 and 2016. Scientists believe that the impact of drought, coupled with the effects of deforestation on the region's climate, are pushing the rainforest towards a 'tipping point' resulting in the death of large swathes of forest.

Yanomami

One of the most serious environmental catastrophes to have befallen indigenous people is the ongoing destruction of the world's tropical rainforests. This threatens not only their livelihoods and social fabric, but also their very existence. Home to 50 million indigenous people, rainforests are being logged to feed a lucrative export market and burned to clear new land for crops and grazing.

The results have been devastating: flooding; loss of biological diversity; desertification; destruction of sacred sites; disruption of traditional economic activities, such as fishing and hunting; and the forced relocation and displacement of people.



9.3.24 Annual rate of forest loss, Amazon Basin, 1988–2016

The costs of this dispossession include poverty, mental anguish, alcoholism, prostitution and high suicide rates, especially among the young.

The destruction is most evident in the Amazon region of South America. This majestic basin covers 7 per cent of the earth's surface and is home to more than half the world's biological heritage. Just 1 hectare of the Amazon's lush forests contains more tree species than all of North America. Yet, of the 6 million to 9 million indigenous people who once inhabited this paradise, only a few dispersed groups remain. In the twentieth century alone, as many as 90 entire tribes ceased to exist.

9.3.25 Yanomami Indians are the largest single Indian tribe on the planet still practising their traditional way of life.

The Amazon forests of Brazil are home to the Yanomami Indians (see Figure 9.3.25). Although they number fewer than 10 000, they are the largest single Indian tribe on the planet still practising their traditional way of life. Not only have the Yanomami seen their homelands disappear through deforestation, they have also had their health devastated by pollution and disease.

Prospectors invaded Yanomami lands in the mid-1980s in search of gold and diamonds. The mercury that the prospectors used poisoned nearly 1500 kilometres of the Amazonian river system, while the miners themselves brought in diseases unknown to forest dwellers. As a result, more than half the Yanomami population has been afflicted with measles, malaria, syphilis or other diseases.

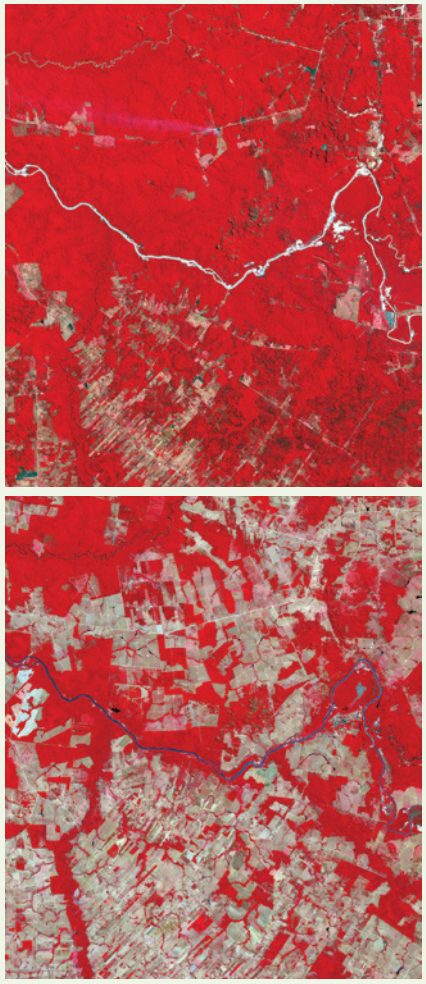
The Yanomami's plight sparked a global outcry. The resulting international campaign to save the Amazon rainforests and their inhabitants has had some success. On 15 November 1991, the then Brazilian president Fernando Collor de Mello declared 9.4 million hectares of the Amazon forests—an area comprising 11 per cent of Brazil's territory—as a permanent reserve for the Yanomami.

Such policies are the key to the continuing survival of the 400 ethnic groups who live in the Amazon. These groups have a population of about 1 million. The policies are also essential to sustainable management of this valuable region.

The area of conserved land in the Amazon rainforest has been increased significantly (with 25 million hectares added to the 12 million already under protection) and deforestation rates have dropped. About 44 per cent of the forest is now protected to at least some degree, with 10 per cent under strict supervision.

Mata Grosso

In Mata Grosso, clearing began with a road expansion in the 1980s that brought in loggers and mining operations. This was coupled with government programs to alleviate poverty by encouraging poor farmers to migrate and colonise the new frontier. In recent years, industrial-scale agriculture, particularly cattle ranching and soybean farming, has contributed to deforestation. The images in Figure 9.3.26 show the extent of clearing between 1992 and 2006.



9.3.26 This pair of false-colour satellite images shows the extent of clearing in the Amazon rainforest in the state of Mato Grosso, Brazil, between 1992 (top) and 2006 (bottom).

Activities

Working geographically

1 Identify an indigenous group, other than the Yanomami, that has been displaced by the destruction of their livelihood in the name of 'development'. Write an extended response on these people, the resources they used and how these have been lost, and what, if anything, can be done to address the problem.

2 Study Figure 9.3.24. Describe the trend in annual forest loss in the Amazon Basin, 1988–2016.

3 Outline the threat to the Yanomami people of Brazil. What has been done to ease their plight?

4 Study Figure 9.3.26. Describe what the images tell us about the impact of human activity on the forests of the Amazon between 1992 and 2006.

UNIT 9.4

Economic and political issues

Despite the concerns of conservationists, there is some economic rationale for increased rates of resource extraction while an item is in demand, provided environmental standards are not threatened as a consequence.

Rates of use

Demand for resources may vary over time. Depending on the type of resource, increasing and decreasing demands can have both a positive and negative impact.

Fish stocks

Overfishing may cause stocks to be reduced to such a level that it threatens the preservation of the fish species and leads to the loss of industry jobs (see Figure 9.4.1). In addition, this could impact on boat owners, who would incur increasing debts, and food supplies would be threatened by high prices and limited availability. Thus, strategies are required to control fishing so fish stocks do not decline. These controls include imposing taxes or fees, controlling the number of boats and/or people per boat or allocating a quota of fish per individual or boat. A combination of strategies that involves the payment of a tax or fee to the government is ideal, as it allows some wealth accruing from resource utilisation to be distributed to those not involved in the fishing industry.

9.4.1 Commercial salmon fishing in south-east Alaska

Resource use and developing countries

Due to the economic circumstances faced by many developing countries, maximising the long-term value of resources presents a major challenge. Often valuable assets, such as timber, represent only short-term opportunities. This provides limited benefit to the countries concerned, particularly when they are competing on unregulated markets. The following points demonstrate this.

- Due to low profit margins, emphasis is often placed on the volume of production (see Figure 9.4.2). In the case of forests, this provides little prospect for planned reafforestation.
- Because returns are depressed, there is the tendency for a high degree of mechanisation, with limited chances of local employment.
- High levels of mechanisation result in the need for more-specialised, qualified staff, further restricting the opportunities for unskilled local people.
- Limited funding is available for erosion control and the monitoring of degradation.
- If a transnational corporation (TNC) is involved, further concessions on royalties and environmental controls may be demanded. These demands are often accompanied by a threat to close down operations completely, thereby upsetting the local economy.

9.4.2 Due to low profit margins, developing countries often place emphasis on high volumes of production in order to maximise returns.

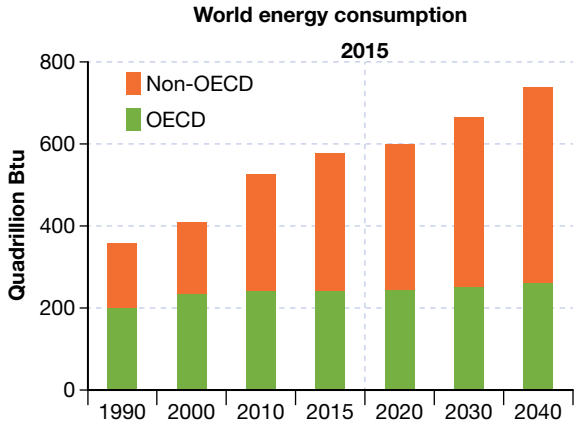
SPOTLIGHT

Coal's declining fortunes

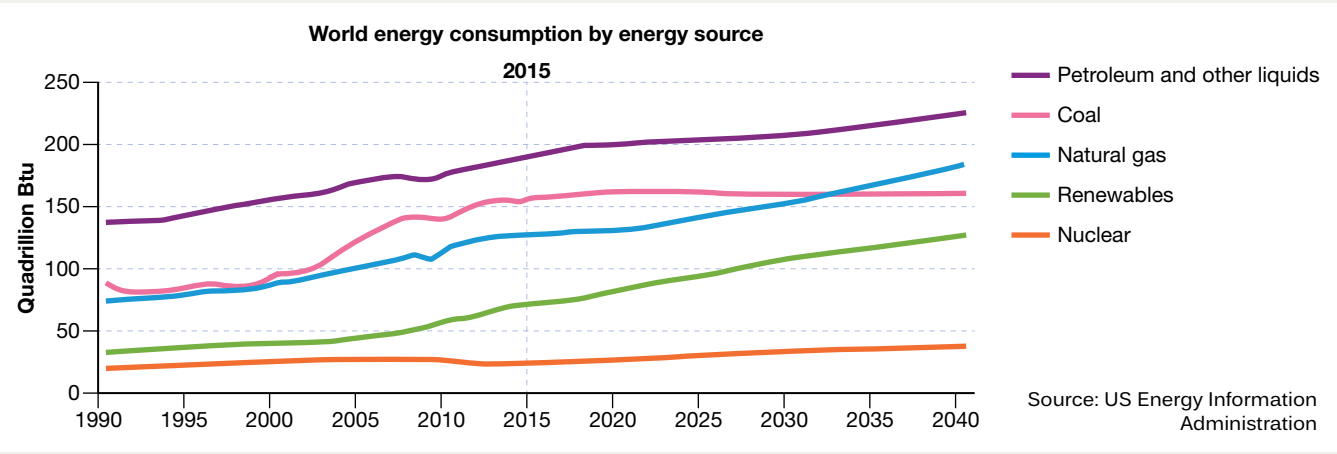
Coal is under siege. It is a resource with a reputational problem. It remains an important source of energy (supplying 41 per cent of the world's electricity) but is also a major source of greenhouse gas emissions that threaten the world's climate. To reduce the amount of coal burnt, governments are encouraging investment in renewable sources of energy (especially wind, solar and hydro). Financial institutions are also becoming increasingly reluctant to invest in coal related projects and ethical investors are eliminating coal-based resource companies from their investment portfolios. Figure 9.4.4 shows the world's energy consumption by energy source, actual and projected, in quadrillion British thermal units (Btu).

Coal's share is expected to plateau and then gradually decline. Renewables and natural gas (which releases much less carbon dioxide than coal when burnt) are projected to increase their share considerably. Figure 9.4.3 shows the actual and projected level of world energy consumption between 1990 and 2040. The majority of this growth will occur in non-OECD countries (the developing world). Asia will dominate this growth, as shown in Figure 9.4.5.

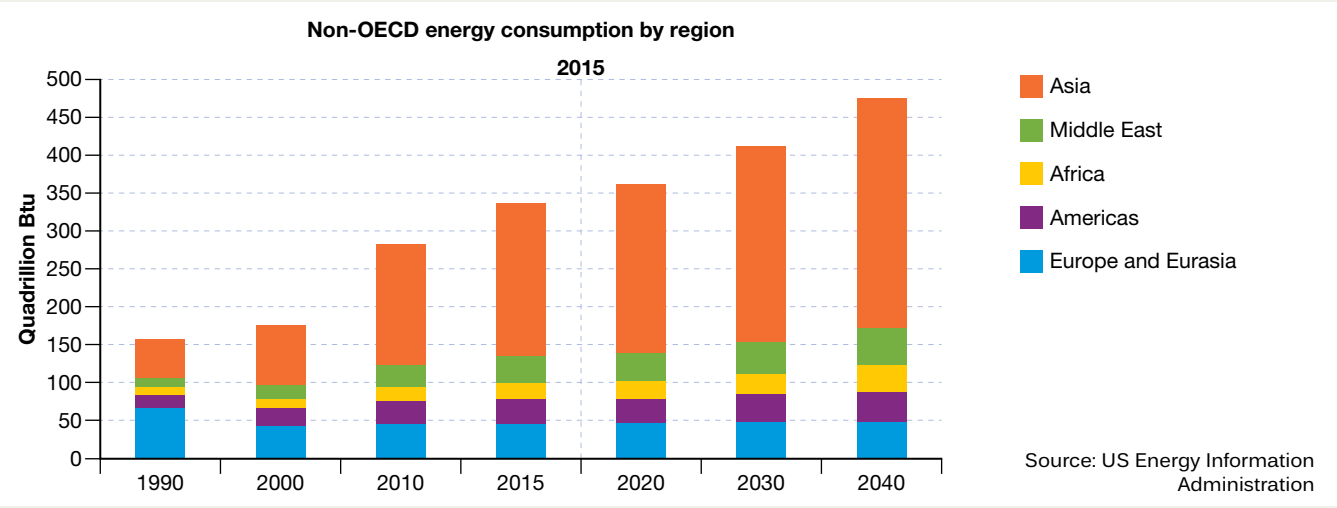
With Australia's vast coal resources it is quite feasible that they will never be fully realised nor will the potential wealth be generated by their exploitation.



9.4.3 World's energy consumption by OECD and Non-OECD countries



9.4.4 World's energy consumption by energy source



9.4.5 World's energy consumption by region

Sovereignty

The issue of sovereignty (effectively, ownership and control) over natural resources has long been a cause of confrontation. Sometimes claims of sovereignty on the basis of historical ownership are created to substantiate a political agenda. Two outcomes of such claims were Iraq's justification for invading Kuwait in 1990 and Argentina's attempted capture of the British-controlled Falkland Islands in the South Atlantic in 1982. Some claim that the US invasion of Iraq in 2003 was just as much about securing access to Middle East oil supplies as toppling Saddam Hussein or eliminating the threat of weapons of mass destruction. Water resources also represent a potential source of conflict.

Contests about claims for sovereignty over natural resources range from the peaceful to the militant. Possibly the most subtle form of control is achieved through the financial strategies of TNCs. Peasant farmers tempted to move from subsistence agriculture to cash cropping may find the opportunities attractive. A well-developed TNC operating an agribusiness can provide:

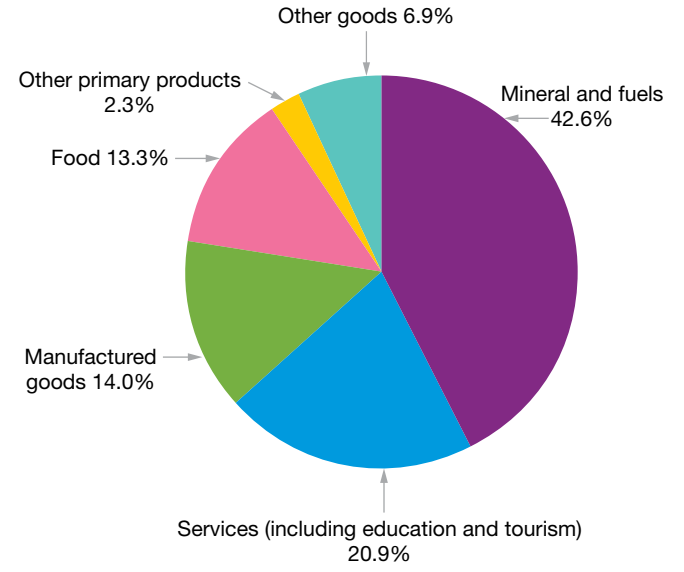
9.4.6 Commercial flower production in northern Africa has alienated large areas of land once used to grow subsistence crops.

- specialised advice and training
- tractors and other machinery
- seeds, fertilisers, fuels and pesticides
- contracts for produce
- financial loans to make it all possible.

In return, the TNC gains access to a reliable supply of agricultural products at a cost well below that available in developed countries.

Quite apart from the problems of social dislocation and food shortages that result from such a transformation, the TNC is in a position to manage the cost of inputs and the price of outputs. Whether the peasant farmers continue to maintain tenure of their land or forfeit it to the TNC through indebtedness, effective sovereignty over agricultural land is virtually surrendered (see Figure 9.4.6).

Sovereignty over offshore fishing grounds has consistently proved to be a contentious issue worldwide. In recent times, Australian authorities have endeavoured to manage their commercial fisheries in a manner that promotes sustainability but have often been thwarted by illegal operations of overseas fishing fleets.



Source: DFAT

9.4.7 Australia's exports, 2015: share of exports by sector

International trade

Trade barriers

Countries that have a heavy reliance on natural resource extraction often find it difficult to develop manufacturing industries. Australia is one such country. In the colonial era there was little encouragement for the development of manufacturing and the export of finished products (as Figure 9.4.7 shows, manufactured goods make up only 14 per cent of Australia's exports). Industrialising countries, such as Japan, relied on imports of resources. Over time, they built up industries and developed markets for their products.

Tariffs

When the original commodity producers, such as Australia, attempted to develop a manufacturing capacity using their natural resources, they encountered two problems. First, because of a limited scale of production (a result of small domestic markets), they were unable to compete with cheaper imported goods. Second, when they sought to improve the size of their markets and develop economies of scale, their exports had heavy tariffs (taxes imposed by governments on imports or exports) imposed on them by countries wishing to protect their own manufacturing industries.

This led to numerous international trade barriers (see Figure 9.4.8).

Developing countries with limited natural resources face a slightly different set of problems. While they may also be obliged to impose tariffs on competing imports, developing countries suffer more through the imposition of tariffs on their exports. They have an abundance of cheap labour and need free market access in order to utilise this competitive advantage, and stimulate employment and improve their standard of living.

Thus, export-oriented, value-adding industries are disadvantaged. Unless the domestic (local) market is large, diseconomies of small-scale production may mean the natural resource provider is still dependent on imports.

9.4.8 Tariffs (taxes imposed on imported goods) and subsidies (financial support for local businesses) are used by governments to influence the price of goods, and thus improve the competitiveness of their industries.

Non-tariff barriers

Non-tariff barriers include the following:

- import and export quotas
- various customs regulations that may target specific goods or countries of origin
- anti-dumping regulations, which prohibit the export of goods at a lower price than they are sold in the country of origin
- subsidies to domestic industries
- technical standards, such as motor vehicle safety requirements
- health standards, such as those relating to chemical residue levels.

All these barriers may be just as effective as the imposition of tariffs on imports.

Trade agreements

There are many developing countries whose economies are highly dependent on the export of one or more raw materials, often with little further processing or manufacturing undertaken to add value to the raw materials. This makes their economies highly vulnerable to currency exchange rate changes, market trends and speculation. During the 1990s, the price of most commodities fell as production increased. During the early 2000s, however, commodity prices grew strongly as producers struggled to meet the demand created by the growth of China and India.

Regional trade agreements provide some protection from these fluctuations and, if they foster internal trade, should be mutually beneficial. Another approach to the problem is the Common Fund for Commodities, established in 1989 under the umbrella of the UN Conference on Trade and Development (UNCTAD). UNCTAD is the permanent intergovernmental body and principal organ of the United Nations General Assembly that deals with trade, investment and development issues. The fund attempts to create a buffer in the global stocks of raw materials on the one hand, and to develop new methods of production and marketing on the other. However, there is yet to be established a global agreement on raw materials that effectively provides a reasonable return for mineral production and guarantees developing countries access to supplies.

Bilateral and miltilateral trade agreements (mutually beneficial agreements regarding the exchange of goods between two or more countries that facilitate trade and investment) have acted to reduce levels of protection among participating countries. Many, however, fail to see the benefits of such agreements if they don't personally benefit. President Donald Trump took political advantage of a widespread belief that trade agreements such as the North American Free Trade Agreement robbed America's working class of manufacturing jobs.

International treaties

Attempts to liberalise world trade have been met with some success but progress has been relatively slow. Factors affecting the rate of progress include the diverse range of objectives and cultures of the many countries, their varied natural resource bases, and their differing stages of economic and educational development. These difficulties are sometimes made more complex by occasional armed conflicts.

The General Agreement on Tariffs and Trade (GATT) represented a significant step in the direction of reducing, if not totally eliminating, trade barriers, including non-tariff barriers. It was more broadly based than UNCTAD. In 1947, the GATT was agreed upon. It provided a generally acceptable approach for the reduction of tariffs and other trade barriers. In 1995, the World Trade Organization (WTO) was established to carry out GATT's objectives, which also includes a consideration of environmental issues in relation to trade. However, with many countries facing strong internal political pressure for maintaining industry protection, it is yet to be determined just how effective the agreement will be when it is fully implemented.

SPOTLIGHT

Minority voices in parliament

Not all electoral systems provide for representation of minority groups, particularly in the lower houses of parliament. The Tasmanian system allows for five members (previously seven) to be elected from each of five large electorates. Despite receiving only a relatively small proportion of the total vote, this often enables the Greens to have one member elected in each electorate. Other voting systems, particularly those for the upper houses of parliament, provide opportunities for minority groups to be elected and, on occasions when their support is critical, they have the opportunity to influence public policy.

Union action

There have been occasions where unions have acted on matters concerning resources, especially if exploiting the resource has health-related implications. In Australia there have been instances, for example, when unionists have refused to handle yellowcake, which is unprocessed uranium ore. In addition, unionists have been involved in attempts to halt the shipping of nuclear fuel for reprocessing in either France or Japan.

Green politics

Worldwide, Green groups have reacted vigorously against a wide range of resource-based activities, particularly when these have had an impact on environmental quality. While protesting has achieved results, it has become increasingly apparent that a direct contribution to political decision-making can achieve sound resource and environmental management. In Germany, concern about the deterioration of forests due to acid rain was so great that several Green politicians campaigning on this issue were elected to parliament in the early 1980s. They are still making a significant impact and until 2008 formed part of the governing coalition government.

Green politics in Tasmania

Tasmania has a long history of environmental activism dating back to the flooding of Lake Pedder (see Figure 9.4.9) in the early 1970s. This led to the formation of the world's first 'green' political party, the United Tasmania Group, in 1972.

In 1989, concern about the environment and the major resource-based Wesley Vale pulp mill was so great that five Green politicians, led by Dr Bob Brown, were elected to state parliament. Because they held the balance of power, they were able to exert considerable influence over the development of public policy.

The Tasmanian Greens have since broadened their policy agenda to include many other social and economic reforms. A number of Greens have been elected to the Australian Senate and their preferences often play an important role in determining the outcome of elections in Australia.

9.4.9 The campaign to prevent the flooding of Lake Pedder galvanised the environmental movement in Australia. **A** Lake Pedder prior to flooding. **B** Lake Pedder after the flooding.

Activities

Understanding the text

1 Explain why is it difficult to establish the optimal rate of resource use.

2 Explain what is meant by sovereignty.

3 Explain how TNCs can gain actual or virtual sovereignty in a developing country.

4 Outline why developing countries experience difficulty in establishing their own resource-processing industries. Why are the economies of developing countries considered 'vulnerable'?

5 Cite examples of international trade barriers. Why are they imposed?

6 Cite examples of non-tariff trade barriers.

7 Identify the factors hindering progress on international trade treaties.

8 Outline how minority politicians, such as the Greens, can achieve representation and control in government.

Working geographically

9 Explain why coal's fortunes are described as 'declining'. Why has coal, as a source of energy, fallen out of favour? What are the alternatives?

10 Study Figure 9.4.4. Describe the trends and projected trends in world energy consumption by energy source, 1990–2040.

11 Study Figures 9.4.3 and 9.4.5. Describe the trends evident in the data provided on world energy consumption by OECD/non-OECD countries and geographic region.

12 Study Figure 9.4.7. Calculate the proportion of Australia's exports derived from the export of resources in 2015.

13 Analyse the Nicholson cartoon in Figure 9.4.8. As a class discuss the implications of protectionism on Australia's ability to export commodities.

CASE STUDY

Africa's diamonds and water

In Africa, the economic and political issues concerning natural resources are immense.

Blood diamonds

The issue of conflict diamonds, or 'blood' diamonds, first came to the public's attention in 1998 when a small, London-based non-governmental organisation (NGO) named Global Witness issued a report entitled *A Rough Trade*. This report detailed the way in which Angolan rebels were smuggling diamonds into the international markets. Implicated in the report was the South African diamond cartel De Beers, which at that point marketed approximately 80 per cent of the world's rough diamonds.

9.4.10 Diamond miners in Kono, Sierra Leone. Revenue from diamond mining and production was used to finance conflict in Africa.

These diamonds, mined in countries such as Sierra Leone, Angola, Liberia and Democratic Republic of the Congo were being used to fund both rebel and government combatants in civil wars, whose main targets are often civilians. In Sierra Leone and Angola, both government and rebel soldiers committed atrocities and used amputations as a way to coerce and terrorise the population. The civil wars during the 1990s in Sierra Leone left 50 000 dead, and 500 000 died in Angola.

The global diamond industry employs some 10 million people directly and indirectly all over the world, including Africa. The vast majority of the world's diamonds come from sources that use the revenues generated to aid their national development. Given good governance and appropriate laws, diamonds are a vital source of revenue for building infrastructure and essential social services such as hospitals and schools. Instead, the revenues generated from smuggling diamonds, in excess of US$250 million per year, played a key role in funding the food, clothing, transport and, most significantly, weapons, needed by civil war combatants.

The publication of the Global Witness report placed significant pressure on the diamond industry, which feared that their product would attract the sort of negative publicity associated with another luxury item, fur coats. The UN Security Council responded to the report by placing sanctions on the export of diamonds from Angola. These sanctions, however, did little to stop the illegal flow of diamonds. Sanctions were often ignored and the flow of illegal diamonds was widespread. The sanctions were finally lifted after the death of rebel leader Jonas Savimbi in 2002. His passing led to a lasting peace agreement between government forces and the rebel forces.

In 2000, another NGO, Partnership Africa Canada, issued a report titled *Heart of the Matter*, which exposed the corrupt diamond economy of Sierra Leone. The diamonds found in Sierra Leone are of very high quality (as opposed to industrial diamonds, which cannot be used for jewellery) and they are readily mined. They are alluvial (that is, they are found on the earth's surface, usually in riverbeds), making them accessible to anyone with a few basic hand tools and skills, as seen in Figure 9.4.10. With corrupt governments essentially acting as organised crime syndicates, these resources quickly became the property of whoever was able to exercise power in an area.

As a result of the *Heart of the Matter* report, the United Nations banned the import of diamonds from Sierra Leone. Again, the sanctions proved largely ineffective, but fighting in Sierra Leone ceased in 2001.

Governments, industry bodies and NGOs worked together to devise a system for excluding conflict diamonds from the international trade in gems. This system, known as the Kimberley process, was a response to the international outcry over the role of diamonds in sustaining armed conflict. Under the agreement, 70 countries agreed on a certification scheme that uses a certificate system to track diamonds from the mine to the retail counter.

Technical advances have also enabled the tracking of diamond movements across borders. Everledger is a company that has developed a global digital register for diamonds that can track and monitor diamonds from mines to jewellery stores. The company uses blockchain, a digital register, and each diamond is registered using colour and clarity to create a unique identification for each diamond.

Africa's potential water wars

The principal conflicts in Africa during the next 25–30 years could be over the most precious of all resources—water—as countries fight for access to scarce supplies. Potential 'water wars' are likely in areas where rivers and lakes are shared by more than one country. Possible flashpoints are the Nile, Niger, Volta and Zambezi basins.

Within 25 years, nearly one in two people in Africa will live in countries facing water scarcity or what is known as 'water stress'. Water scarcity means that less than 1000 cubic metres of water is available per person per year, while water stress means less than 1500 cubic metres of water is available per person per year. By 2025, 12 more African countries will join the 13 that already suffer from water stress or water scarcity.

The Nile runs through three countries: Ethiopia, Sudan and Egypt. If the combined population of these three countries rises as predicted, from 200 million today to 340 million in 2050, then there could be intense competition for increasingly limited water resources. Already there is little water left when the Nile reaches the sea. Egypt is unlikely to take kindly to losing out to Ethiopia: a country with one-tenth of the income of Egypt.

Water is already a cause of regional conflict; see Figure 9.4.11. In the late 1990s, tensions between the Ethiopian and Egyptian governments increased rapidly when the rulers in the Ethiopian capital of Addis Ababa considered a plan to construct dams on the Nile.

Activities

Working geographically

1 a Explain what is meant by the term blood diamonds.

b Outline the reasons why blood diamonds became central to conflicts affecting parts of Central Africa.

c Outline the actions that have been taken to address the issue.

2 a Explain why conflicts over access to water are likely to increase in the next 25 to 30 years.

b Give examples of geographical contexts where water is already a source of political conflict.

9.4.11 An armed drover guards stock at a water trough in northern Kenya.

There is another potential water war in Southern Africa involving Botswana, Namibia and Angola. The River Cuito begins in Angola before heading through the Caprivi strip in Namibia and ending in the marshlands of the Okavango Delta in Botswana. This river runs through an area that is no stranger to tensions and conflict between neighbours.

Fresh water is also becoming increasingly unusable because of pollution. This impacts on the health of people (and other life forms) who rely on the water of the delta for their wellbeing.

Agriculture is by far the biggest user of water in Africa, accounting for 88 per cent of water use. It takes about 1000 tonnes of water to produce every tonne of grain. One way of reducing the demand on water resources is by importing grain, but for poorer countries in Africa this may not be an option.

DID YOU KNOW?

The Caprivi strip is a narrow protrusion of land in Namibia that extends eastwards about 450 km. It is located between Botswana on the south, Angola and Zambia to the north.

UNIT 9.5

Natural resource ownership

The four main categories of ownership associated with natural resources are public, private, cooperative, and transnational corporation (TNC).

Within the public sphere, scales of ownership vary considerably, ranging from the local community to a global level. Resources that have the potential to be owned and managed at a global scale include the global commons: the atmosphere, the open oceans and the polar lands. The management of such resources should be:

- intentionally long term in its thinking and cautious in its approach
- concerned about equity for all countries/people
- not interested in short-term profits
- likely to take some time to reach a consensus
- probably less responsive to change than the private sector.

Many of these characteristics will also apply to the actions of government in an individual country. One difference is that governments tend to develop biases. Also, in democracies facing frequent elections, governments will often respond to public opinion or the lobbying of interest groups rather than apply sound long-term planning principles.

As information and business expertise flow around the globe, many developing countries are becoming stronger negotiators. There is a wider realisation of the importance and value of resources. Many developing countries, particularly those that have witnessed the failings of previous agreements, are not prepared to sacrifice their assets. Regional groupings of countries have more bargaining power than individual countries, and receive more favourable treatment.

Cooperatives involve decision-making by grassroots members who are effectively part owners. They provide some balance between the advantages of the private and public sectors.

Figure 9.5.1 provides a simple matrix of the characteristics of various ownership types. Care must be taken when using this information because many variables will influence individual situations. Also, this table does not provide an exhaustive list of the types of ownership. For example, another type is a joint venture between a government and a TNC. The degree of economic control in such cases can vary considerably. It will depend on the effectiveness of the government and its determination to follow its own agenda. Elected governments need to respond to changing priorities of the voting public, so there is still no guarantee of a long-term benefit for the country.

Attributes of resource projects by category of ownership

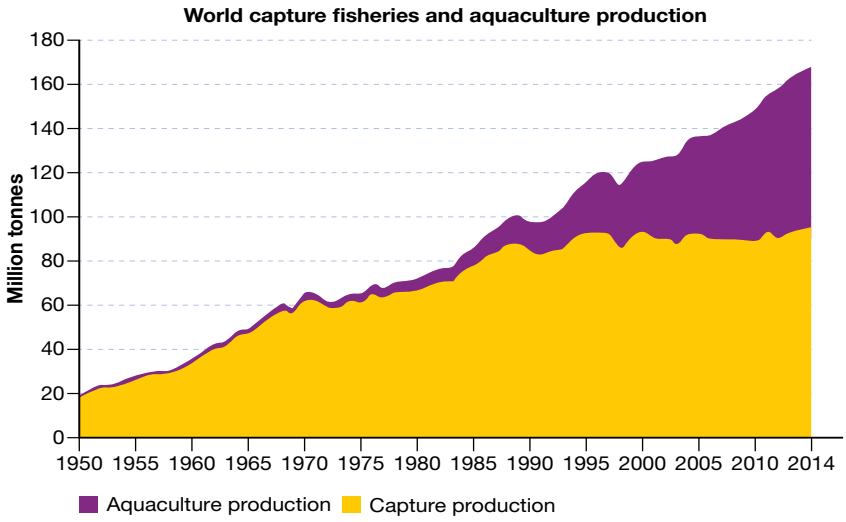
Attribute	Public	Cooperative	Private	TNC
Long-term planning	High	Medium	Low/Medium	Low/Medium
Efficiency	Low	Medium	Medium/High	Medium/High
Profit	Low	High	High	High
Equity concern	High	High	Low/Medium	Negligible
Income distribution	Medium	High	Low/Medium	Negligible
Skills training	Long term	Short/Medium term	Short/Medium term	Immediate needs only
Environmental concern	High	Medium	Low/Medium	Negligible

9.5.1 Attributes of resource projects by category of ownership

Global fishing industry

Commercial fishing operations, shown in Figure 9.5.2, are exceeding the ocean's ecological limits; with serious impacts on the intricate web of marine life that makes the sea a vital part of the earth's support system. Almost 70 per cent of all fish stocks have been heavily exploited or brought close to extinction. In one-third of the earth's major fishing regions, the annual catch is down 20 per cent or more from peak years. Without sweeping changes in current fishing practices and remedial action to allow endangered fish stocks to regenerate (see Figure 9.5.3), the world's fisheries face possible collapse.

To help offset the decline in fish stock and to meet the growing demand for seafood there has been a rapid expansion of aquaculture, shown in Figure 9.5.4. An increasing proportion of the seafood consumed on earth now comes from aquaculture enterprises. Figure 9.5.5 shows the trends in capture and aquaculture production. As a result of the increase in aquaculture production, captured production has plateaued since the later 1980s.



9.5.5 World capture and aquaculture production, 1950–2014

9.5.2 Modern commercial fishing practices can result in overexploitation of fish stocks.

9.5.3 Traditional fishing techniques are more likely to be sustainable than modern techniques.

9.5.4 Salmon farm in Norway. Aquaculture is the intensive farming of seafood in specially designed breeding pens.

SPOTLIGHT

The Law of the Sea

The 1982 UN Convention on the Law of the Sea established a set of rules for the use of the world's oceans, which cover 70 per cent of the earth's surface. In the decade following its adoption, fishing on the high seas became a source of international conflict. The convention gave all countries the freedom to fish without regulation on the high seas. It also gave all countries exclusive economic rights, including the right to fish within 320 kilometres of their shoreline. Local operators began to complain that large fishing fleets operating on the high seas were reducing catches in their domestic waters. Violent clashes between the operators of coastal fleets and those from more distant places became increasingly frequent.

In December 1995 a further agreement was drafted. To manage fish stocks sustainably and settle disputes peacefully, the agreement established the basis for the sustainable management and conservation of the world's fisheries. It also:

- addressed the problem of inadequate data on fish stocks
- provided for the establishment of quotas
- called for the setting up of further regional fishing organisations
- tackled the problem of unauthorised fishing
- outlined options for peaceful settlement of disputes.

Since 2017, 167 countries and the European Union had joined the convention. Significantly, the USA has declined to ratify the treaty.

Resource management by indigenous people

Indigenous peoples are often skilful managers of natural resources, proven by the fact that many have existed in balance with their environment, for tens of thousands of years. Some of these groups, including Australia's Indigenous peoples, work actively to develop specific resources and focus on the conservation of species.

Many forms of resource conservation are part of Aboriginal or Torres Strait Islander culture. The following list represents, as an example, some of the techniques used to preserve fish stocks:

- direction by elders (those knowledgeable about the local ecology)
- designated fishing areas for individuals and/or groups
- restrictions on species caught
- closed seasons
- specified methods of fishing
- various taboos concerning fishing
- total avoidance of fishing
- sacred pools.

The last approach has been adopted by Aboriginal people in parts of inland Australia. The sacred pools, where fishing is prohibited, ensure that stocks remain to build up supplies in a river system once a drought has ended.

Resource use and management in developing countries

The scale and complexity of some resource management projects is often too vast for the expertise of a developing country. In a mineral development project, for example, exploration using remote sensing, drilling, assaying (assessing) the mineral, and costing the project for feasibility are all technical, but essential, preliminary activities. Often, developing countries lack the equipment and finance to undertake these tasks, as well as skilled workers with the necessary expertise.

TNC alliance

In developing countries an alliance with a TNC or even a consortium (group) of TNCs may be necessary in order to undertake a large and/or complex resource development project. There are few guarantees that such alliances will proceed smoothly and this may be the fault of either party. Sometimes the most appropriate strategy is for a government to contract a TNC in order to take advantage of its technical know-how and business expertise. The TNC would be contracted to initiate the project and train local people to assume key operational and management positions. This can ensure that the host country receives an equitable (fair) share of profits from the exploitation of its own resources.

Alternate alliances

Another option is the establishment of an alliance with an industrial country that is in need of an assured supply of raw materials. The industrial country provides expertise and finance in return for access to resources. It may also restrict the expansion of some of its own manufacturing industries to enable the developing countries to diversify their economic base in those areas.

The remaining alternative for developing countries is to join either a resource production group or a regional trading bloc. While these have their shortcomings, as discussed later, they still offer some prospect of success if properly organised.

SPOTLIGHT

Integrated resource management

Resource management in many developing countries depends on a high degree of integration with, and mutual benefits from, related activities. This is particularly true of traditional Chinese agriculture. Where such integration occurs it is referred to as integrated resource management. For example, Chinese villagers spread human and animal effluent on their fields instead of having to depend on costly commercial fertilisers. However, the drive for economic development in many developed countries tends to ignore the importance of an integrated planning approach. To ensure economic viability and to maximise the benefit achieved from available resources, advantages to related industries need to be realised. Thus, the broad integrated approach evident in planning and total catchment management (TCM) is increasingly being considered when resource-based projects are being planned.

Resource use and management in developed countries

Effective resource management by governments in developed countries has evolved, although somewhat erratically, with their industrial growth. In colonial Australia, the first environmental controls were placed on land use in the areas adjacent to Sydney's Tank Stream when it was threatened by pollution.

Since the 1980s, there has been focused attention on resource management. This was due to several major factors, including the oil crisis of the 1970s, the impact of acid rain on the forests and ecosystems of Europe and North America, and a growing appreciation that misuse of resources was increasingly placing the whole biosphere at risk.

A country may develop its natural resource base for a variety of reasons: to reduce dependence on imports, meet strategic goals or foster local economic development. When establishing a natural resource base, various options are available. This includes the following policies:

- provision of a bounty (payment of reward) on new discoveries of minerals
- granting of a 'tax holiday' (temporary reduction or elimination of a tax) on new resource-based commercial undertakings
- stimulus of resource-related developments/technologies through support of research conducted and/or funded by the government
- provision of infrastructure, for example, railways and port facilities
- supply of cheap power
- training of staff.

Controlling resource use

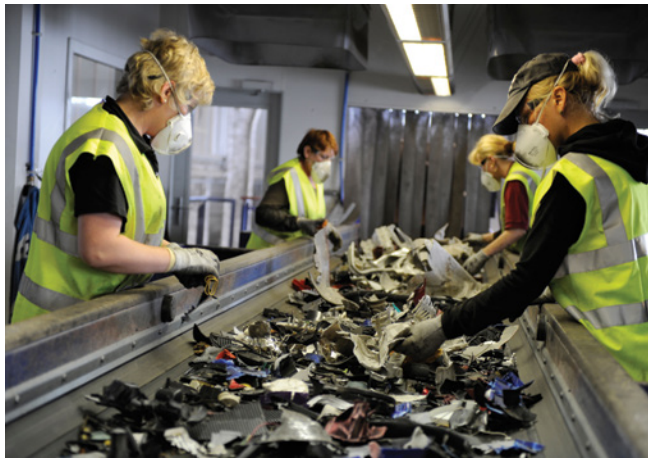
Developed countries have several options to control resource use. The option chosen will depend on the country's objective. If the aim is to increase efficiency of use, then a project to provide a national power grid to distribute electricity from low-cost energy sources will be attractive economically and optimise resource use.

Another approach is the 'user pays' principle. This economic rationalist approach, if implemented rigorously, will ensure that all costs are passed on to the consumer. The costs include those needed to manage pollution as well as provision for infrastructure. In the case of irrigation, the cost of dams, the value of submerged land and the environmental costs of river degradation would be factored into the actual fee charged for the water used.

Governments also have the option to tax resources to restrict their consumption. As Australia's oil reserves dwindle, we will need to import more petroleum products. A further increase in fuel taxes may be inflationary, but it can meet several worthwhile objectives. Both the amount of fuel consumed and the resulting pollution would be reduced. It would also reduce the number of vehicles using roads in the cities, especially if a parallel policy of improving public transport was introduced. This could then reduce the resources directed towards freeway construction.

At a national level, recycling has been increasing steadily. A central, related issue is finding space for waste and garbage disposal. This is especially true of solid waste disposal. Recycling is a positive way to foster appreciation of the environment (see Figure 9.5.6). Unfortunately, however, often the economics of collecting and reprocessing recyclable waste does not make it commercially attractive. Through subsidies, tax concessions or other forms of assistance, governments can stimulate recycling industries (see Figure 9.5.7), provided society sees merit in the idea. However, in Australia, for example, the producers of non-recycled goods often claim that unfair competition results from such government assistance.

9.5.6 A wall painting at Sydney's Bondi Beach encouraging recycling



9.5.7 Recycling of electronic waste in Hamburg, Germany

Activities

Understanding the text

1 List the four main categories of ownership associated with natural resources.

2 Explain what is meant by the term global commons. What are the implications for the management of such resources?

3 Outline the proof that shows that most indigenous peoples have been effective resource managers.

4 Outline the strategies used by indigenous peoples to conserve food sources.

Working geographically

5 Study Figure 9.5.1. Write a series of paragraphs outlining the nature of the resource projects based on the type of ownership.

6 a State why better management of the earth's fish resources is considered essential.

b Outline the extent to which the Law of the Sea has addressed these concerns.

7 Study Figure 9.5.5. Describe the trends in captive production and aquaculture since 1950. What does this suggest about the world's stock of marine life?

8 Study Figures 9.5.2 to 9.5.4. Describe the differences in fishing technologies evident in the three photographs.

9 Write a paragraph explaining, in your own words, the concept of integrated resource management.

Resource concerns in Australia

Australia has at times played a leading role in focusing international attention on global resource issues, including whaling and resource management in the Antarctic. It has also enacted legislation enabling it to bring about the implementation of international treaties that address global concerns.

The Federal Government passed the Great Barrier Reef Marine Park Act in 1975 to safeguard the reef from oil drilling. The act was passed in response to the reef's growing national and international significance and the importance of related tourism and fishing industries. Careful management codes have been developed to ensure the protection of this unique natural wonder. The reef was inscribed on the World Heritage list within a decade of the act being passed.

In 1983 the Federal Government passed the World Heritage Properties Conservation Act. In some instances, the act may place restrictions on resource use, particularly where a World Heritage area's natural attributes are endangered by human activity. For example, the proposed Gordon-below-Franklin power scheme in Tasmania was rejected because it threatened Aboriginal sites, relics and artefacts. The area has since been granted World Heritage status. Several other natural sites, including much of the south-west of Tasmania, have also been included on the World Heritage listing.

Global resource management

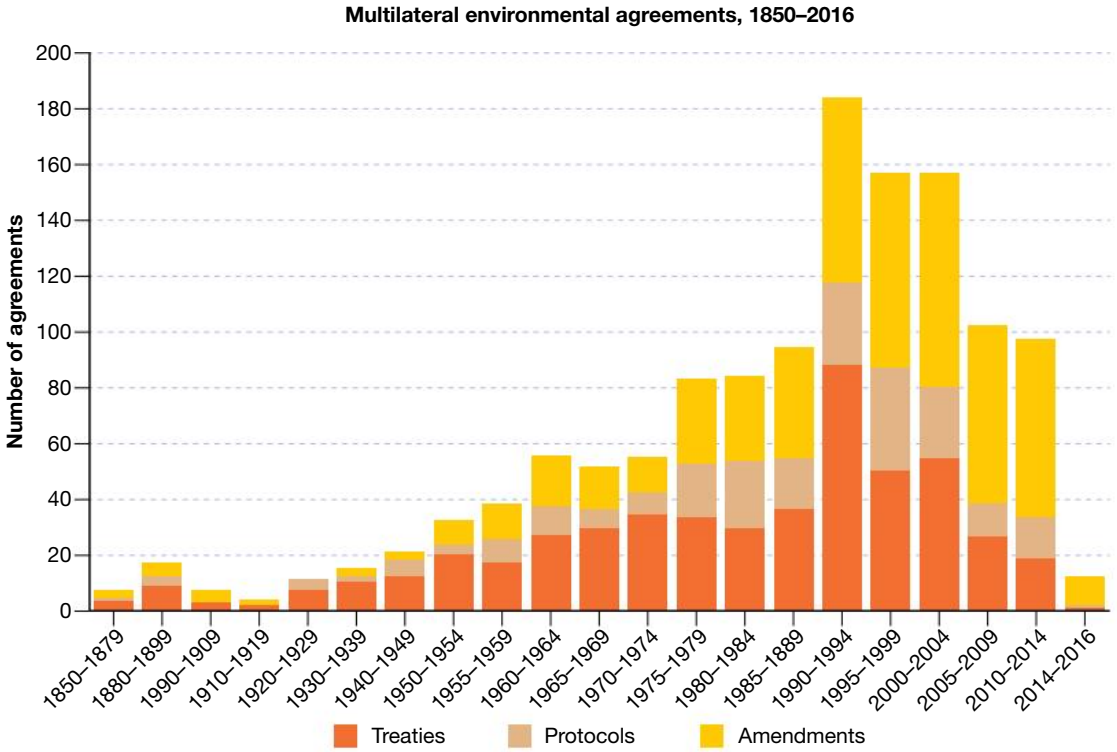
With improvements in transport and communication, it is becoming increasingly possible to develop a global resource-management structure. This could lead to efficient resource use and equitable distribution, while also incorporating effective environmental safeguards.

While such a structure has not yet been achieved, some success has been achieved globally in terms of resource-management strategies. Several global treaties on aspects of the biosphere have been negotiated. Figure 9.5.9 outlines the number of multilateral agreements from 1850 to 2016. In terms of effectiveness, some have been more successful than others. Agreements include the following initiatives:

- International Convention for the Regulation of Whaling, 1937
- Convention on International Trade in Endangered Species, 1973
- Convention on Long-Range Transboundary Air Pollution, 1979
- Montreal Protocol on Substances that Deplete the Ozone Layer, designed to phase out chlorofluorocarbons (CFCs), 1987, see Figure 9.5.8
- Basel Convention on Control of Transboundary Movements of Hazardous Wastes, 1989
- Convention on Biological Diversity, Rio de Janeiro, 1992
- Convention to Combat Desertification, 1994
- Kyoto Protocol, designed to reduce carbon dioxide emissions, 1997
- Paris Climate Agreement, designed to reduce carbon dioxide emissions, 2015.

Progress towards many of these objectives has been achieved, but in some instances progress has been minimal. In the context of renewable resources, for example, there are at least a dozen major international fisheries commissions. Despite the existence of these commissions, fish stocks continue to decline.

9.5.8 The Montreal Protocol on Substances that Deplete the Ozone Layer, designed to phase out chlorofluorocarbons, is an example of an effective treaty.



9.5.9 Multilateral environmental agreements, 1850–2016. The number of treaties, protocols and agreements surged in the 1990s and early 2000s as global environmental awareness increased.

SPOTLIGHT

Strategies to preserve the global environment

To improve and maintain access to essential natural resources for all people and preserve the global environment, a range of strategies needs to be collectively advocated. There is a need to:

- continue to develop dialogue between and within countries—in particular the potential for hostilities needs to be reduced
- ensure adequate access to food and water, shelter, fuel and health care for all people—unless basic needs are met, there is little chance to focus on further achievements
- provide widespread education and training to enable people to accept responsibility for their actions and to embrace opportunities
- curb population growth
- accept that life forms that have no obvious significance to humans still have the right to exist on the planet with us
- curb reliance on non-renewable resources and research and use more environmentally sustainable technologies
- ensure that renewable resources remain so—forests, for example, are only renewable if managed carefully
- facilitate fair trading—particularly providing developing countries with access to markets in developed countries
- develop a mechanism to reduce debt among developing countries
- assist governments in developing countries—enabling them, for example, to negotiate equitable arrangements with TNCs
- accept the right of individuals, communities or countries that may not wish to depart from their traditional lives to remain as they are—while development may mean more material wealth, it may also mean surrendering cultural and social networks.

Activities

Understanding the text

1 Outline the nature of resource use and management in developing countries.

2 Outline the ways in which resource use and management are conducted in developed countries, such as Australia.

3 Explain how Australia has responded to specific global resource management issues.

Working geographically

4 Study Figure 9.5.9. Using data from the graph, outline the trend in multilateral environmental agreements. What does this suggest about the general level of environmental awareness over time?

5 Australia must be one of the better-resourced countries on earth, yet we sometimes import more food (by value) than we export. As a class, discuss why this is so, whether it really matters and what, if anything, can be done about it.

6 Debate which categories of resources are probably more in need of controls over utilisation rates. Compile your own inventory and rank them in order of priority. Are your decisions based on the issue of limited stocks, possible alternatives, long-term sustainability or environmental criteria?

7 Identify the resources that are globally owned. Compile an inventory and indicate who, if anybody, is responsible for looking after them.

8 Discuss how realistic the concept of global ownership is. If its characteristics are considered too idealistic, does the concept still have value? Debate how the ownership should be managed and just how realistic the expectation is that it might work.

9 Why can't democratically elected governments always act as responsible resource managers? Working in groups, devise a list of reasons. Share your group's list with the rest of the class. Discuss possible ways to promote responsible resource management.

10 From alternative sources, identify some foreign-owned resource companies that are operating in Australia. Discuss what you consider to be equitable operating conditions in relation to how Australia is and/or should be benefiting.

11 Do Australian companies operate in resource-based activities in other countries? Devise a 'code of conduct' that lists the principles they should adopt in these circumstances. Do you feel that their approach of operating in developing countries should differ from their approach in developed countries?

12 Australia provides millions of dollars of aid each year to support economic development in developing countries. Would it be better to give preferential treatment to imports from those countries? Write down the reasons for your answers and then share your thoughts with the rest of the class.

13 a In a global context, what concerns result from resource-exporting countries being forced to accept lower commodity prices? As a class, make a list of the consequences.

b Suggest some arrangements that could minimise this chain reaction.

14 Carry out a short research project into a resource-management technique as practised by an indigenous population. Present your findings as an oral report.

15 Undertake a short library or internet-based study of a transnational resource-based project in either a developing country or in Australia.

a Identify the objectives of the TNC and why it appears that the host country was willing to permit its operations.

b As far as available material permits, document the progress of the activity, identifying any major problems encountered in the environment or by community. Write a report outlining the findings of your research.

UNIT 9.6

Environmental, economic and social issues

One of the outcomes of World War II was a rapid advance in technology, ranging from communications to nuclear physics. The economic development that followed was matched by the increasing conviction that technology could solve all global problems, from diseases to world food shortages. In Australia, as in other countries, schemes such as the Snowy Mountains Scheme were considered proof of people's ability to modify nature in order to meet society's needs.

Linking economics to environmental issues

The global spread of industrial-based economies and lifestyles is exhausting the basic ecological wealth of our planet faster than it can be replenished. Year after year, areas of productive agricultural land almost as large as Tasmania are devastated and three times as much land is so eroded that it is no longer commercially useful. The earth's deserts increase annually by 6 million hectares.

Almost every country in the world is confronted with water contamination or shortages and at least 844 million people do not have clean drinking water. Surface and groundwater is being poisoned by nitrates and pesticides from agribusiness and public and industrial wastewater.

Add to this the difficulties with 'treatment and disposal' of highly poisonous wastes produced by industry. Some countries take advantage of foreign currency shortages and insufficient legal requirements in developing countries to rid themselves of these problems cheaply.

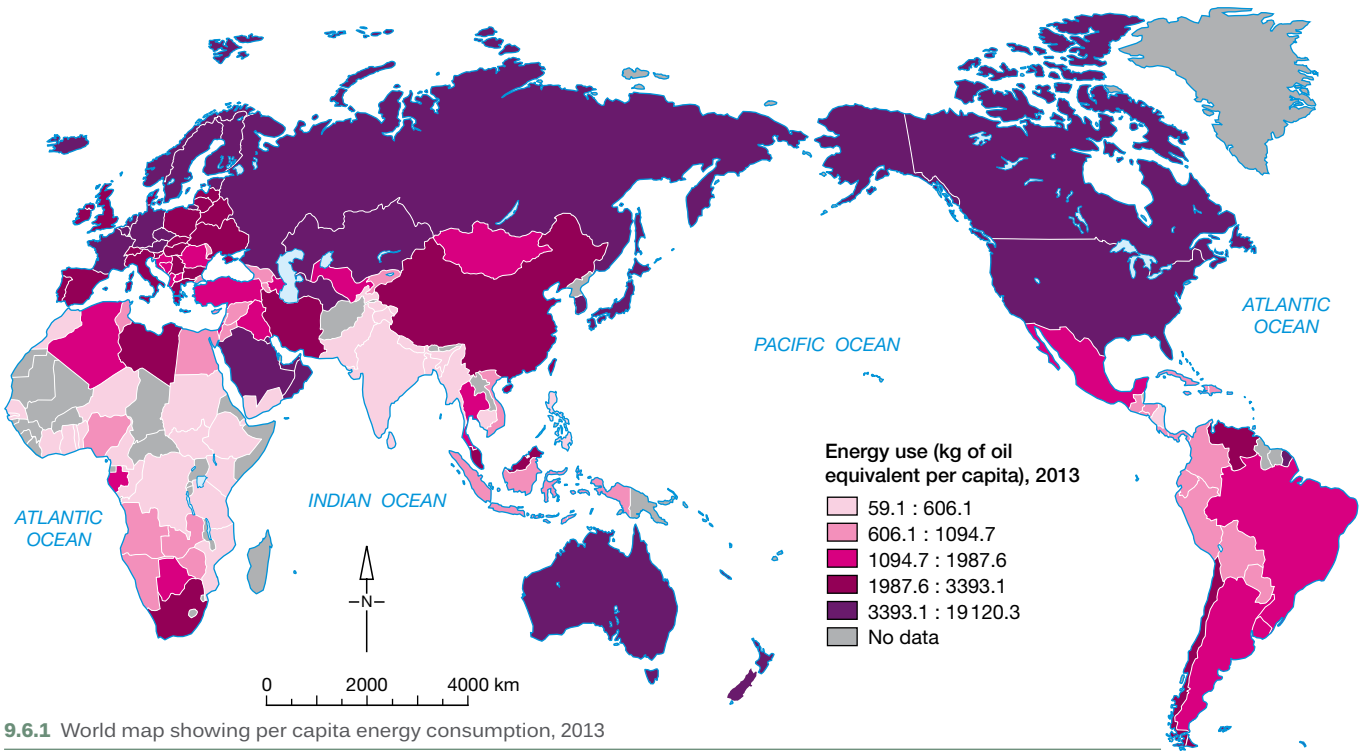
Meanwhile, the forests disappear. In Europe, forests have become victims of environmental poisoning (acid rain); in the tropics, they are cut for commercial purposes. Clear-felling is causing the largest loss of species in history.

Nearly 7.5 billion people now inhabit the planet. It is estimated that by the year 2050 this population will have increased to 9.8 billion. Eighty-seven per cent of the population will live in developing countries, some of which experience widespread hunger and suffering because of misdirected development aid, environmental degradation and debts.

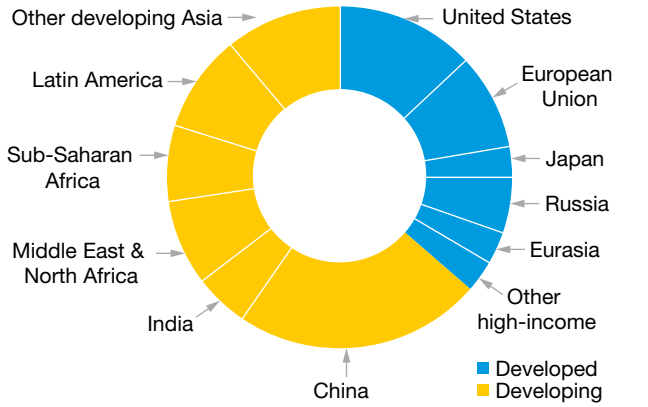
SPOTLIGHT

Energy use

With only 17 per cent of the world's population, the industrial countries consume far more energy, food and resources than developing countries. Industrial states consume 70 per cent of all energy produced and almost 75 per cent of all commercial fuels (see Figure 9.6.1). Americans make up less than 5 per cent of the world's population and yet consume as much as 25 per cent of its energy.



9.6.1 World map showing per capita energy consumption, 2013



Source: Centre for Global Development

9.6.2 Carbon emissions by region, 2016

Paralleling this unequal consumption, a disproportionate share of climate-threatening gaseous emissions comes from developed countries and the rapidly industrialising countries of the developing world. In 2017, 37 per cent of such emissions were produced by just 17 per cent of the world's population living in developed countries. China is the largest single emitter, producing 23 per cent of total emissions. People living in Sub-Saharan Africa contribute just 7 per cent and all of South America contributes 9 per cent, as shown in Figure 9.6.2.

The pollution balance for carbon dioxide produced by burning fossil fuels is similar. The entire African continent is responsible for only 2.8 per cent of energy-related carbon dioxide emissions. The North American continent, by way of comparison, produces 17.6 per cent.

Environmental issues

The 1960s saw an increasing level of concern about the rate of development and associated environmental degradation, as well as an apparent unawareness, indifference or inability to effectively control the mounting problems.

Economic growth has enormously increased humanity's capacity to do irreparable harm to the environment. Such harm, the unintentional by-product of modern technology, is increasingly international or global in its impact. This contrasts sharply with the more local pollution problems of earlier times.

Not until the mid-1980s did the cumulative impact of technology and the associated increased consumption of fossil fuels and build-up of atmospheric contaminants become a matter of growing global concern. The Montreal Protocol was an agreement made in 1987 to phase out the production of CFCs, which is the main class of chemicals that destroy the ultraviolet-screening ozone in the atmosphere. It represented one of the first global environmental agreements. The Montreal Protocol stands as an example of what can be achieved through international cooperation.

DID YOU KNOW?

Australian households on average produce 17.0 tonnes of carbon dioxide emissions, compared with a worldwide average of 4.5 tonnes. Only Qatar (36.9 tonnes) and the USA (17.3 tonnes) use more. The average for all of Africa is 0.9 tonnes.

Greenhouse gases rising

There is a growing concern regarding the impact of carbon dioxide on the atmosphere. Other gases, such as methane, may also lead to global warming. However, the rise in carbon dioxide levels is directly linked to increases in the consumption of coal, particularly for power generation and industry, and oil for transport. While many uncertainties surround the precise extent of global warming, there is a growing consensus that the earth's ecosystem is becoming precariously balanced. Any additional major disruption, either through additional atmospheric load or in the form of a major natural hazard (such as large-scale volcanic activity), may upset the balance.

9.6.3 Large-scale protests about climate change are an example of people's growing awareness of environmental issues related to resource exploitation.

Tackling environmental degradation

As awareness of environmental issues has grown, public attention has turned towards the need to tackle environmental degradation, including the earth's changing climate. The refusal of the Howard Government (1996–2007) to sign the Kyoto Protocol became a major political issue and is credited with being a major vote-changing issue at the 2007 Federal Election. In that election not only did the Howard Government lose power, John Howard also lost his own seat in parliament, only the second prime minister ever to do so. Since then climate change, and how to tackle it, has become one of the most divisive issues in Australian politics; see Figure 9.6.3.

Support for developing countries

The problems of pollution and degradation are magnified for most developing countries. Often these countries have been exploited by colonial powers and they inherit a legacy of degradation. Most are poor, have limited profitable resources and, with growing populations, they need to produce more food and create new employment. Despite these massive responsibilities, they are still expected to meet the extra costs imposed by reductions in CFC use and carbon dioxide emission. Industrial countries have grown without being constrained by these matters. They have done so partly through ignorance and partly through not wishing to acknowledge the problem. Meanwhile, the developing countries are further handicapped. This situation is inequitable and morally unacceptable.

SPOTLIGHT

Chernobyl and Fukushima

The Chernobyl disaster of 1986 was the worst nuclear power plant accident in history. The reactor meltdown and resulting fire sent a plume of highly radioactive fallout into the atmosphere and across a wide geographical area.

The next biggest disaster was the meltdown of the Fukushima Daiichi reactor in Japan in 2011. The devastating Tohoku Tsunami set off a series of equipment failures resulting in the release of radioactive materials.

SPOTLIGHT

The 2015 Paris climate agreement

The Paris climate agreement represents one of the first truly global responses to the threat of climate change. The pact links almost every country in a joint effort to cut greenhouse gas emissions and stave off human-influenced climate change.

Beginning in 2020 each country will determine, plan and regularly report its contribution to the mitigation of global warming. There is no mechanism to force countries to set a specific target by a specific date, but each target should go beyond previously set targets (typically those agreed to under the Kyoto Protocol of 1992).

Under the agreement countries commit to:

- holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change
- increasing their ability to adapt to the adverse impacts of climate change, while also fostering climate resilience and development in line with low greenhouse gas emissions, in a manner that does not threaten food production
- making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

A global solution

While acknowledging that the problem of global pollution needs global solutions, it is important that the developed countries assist the less wealthy countries in reducing pollution. It is possible to achieve this. First, developed countries need to set their own targets and go about achieving them. Second, they need to assist developing countries with training, technology and finance to enable them to meet the global standards without being further disadvantaged. In addition, there needs to be a persistent awareness and action campaign to:

- foster the notion that human action can and does cause pollution or degradation
- ensure everybody accepts that the cumulative effect of small contributions will have a significant global impact
- have every individual understand that they may be part of the cause
- ensure that all individuals take responsibility to solve the problem
- ensure that all know what to do to combat pollution and its effects
- locate financial resources and commit them to control pollution and rehabilitate affected areas.

The scale of human actions and the cumulative impact of many small activities are increasing the potential for severe disruptions to the global environment. The only environmentally safe path is to ensure that human activity takes place with no further net environmental damage, and, ideally, reduces the present level of damage. For example, if forest is to be cleared for one activity, it should be replaced in another area.

Concessions will need to be made by industrially developed countries to ensure that developing countries have the opportunity to reach a secure standard of living. This may also involve changes in traditional culture and a reduction in population growth in the developing world. It also requires changes in the consumer culture of the developed world and its disproportionate use and abuse of resources.

Transnational corporations and the environment

Many of the processes that refine ore into usable minerals involve considerable amounts of pollution. Similarly, some industrial processes, although not normally a major threat to the environment and the health of people in the vicinity, can be catastrophic if an accident occurs.

9.6.4 Women and children collect water from a truck after their groundwater supplies were contaminated by highly toxic pollution from the local Union Carbide plant. The contamination killed 2500 people.

Union Carbide accident, Bhopal, India

The accident that caused the release of toxic methyl isocyanate (MIC) from the Union Carbide pesticide plant at Bhopal, India, in December 1984 killed 2500 people, seriously injured a further 10 000 and partially disabled 20 000.

Union Carbide also had many plants in its home country of the United States. The equipment there was much more modern, well maintained and computer controlled. In Bhopal, to keep production costs down, a cheaper manufacturing process was used, despite its greater potential risks. In addition, there had been frequent warnings about the dangers of the systems at the plant.

The Bhopal plant was not directly involved with resource processing, but it is indicative of a double standard that has existed between developed countries and developing countries. Despite continuing outrage on such issues, there remain instances where there appears to be less concern about environmental damage and potential hazards in developing countries, see Figure 9.6.4.

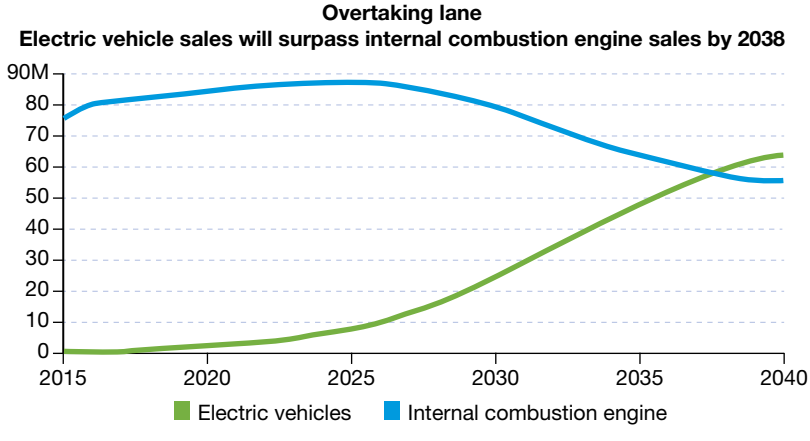
9.6.5 The Bento Rodrigues iron ore sludge dam collapsed and buried villages in thick, red, toxic mud.

Pacific Gas and Electric Company (PG&E), California, USA

In 1993, the Pacific Gas and Electric Company (PG&E) of California was sued for the contamination of drinking water with hexavalent, also known as chromium (VI), in the southern California town of Hinkley. Chromium (VI) is known to be toxic and carcinogenic. The case was settled in 1996 for US$333 million, the largest settlement ever paid in a direct action lawsuit in US history.

Bento Rodrigues dam collapse, Brazil

In November 2015, an iron ore tailings dam at Bento Rodrigues suffered a catastrophic failure causing flooding. Two villages and 200 homes were destroyed and at least 17 people died (see Figure 9.6.5). The dam and adjacent mine is owned by Samarco, a joint venture between Vale (South Africa) and Australia's mining giant, BHP. Initially, it was thought that the cause of the collapse was a weakness in the dam's structure. The investigation into the cause of the failure continues. Tailings from the dam polluted the Rio Doce and by November, the toxic sludge had reached the Atlantic Ocean, forcing authorities to close beaches. The joint partners face fines and clean-up costs estimated in the billions.



9.6.6 By 2038, sales of electric vehicles are expected to surpass sales of vehicles with internal combustion engines.

Increased environmental responsibility

Today, many companies are taking their environmental responsibilities more seriously, especially in respect to their carbon footprint. Many are investing heavily in energy efficiency initiatives. Large financial institutions are increasingly reluctant to finance fossil fuel-based projects (especially coal mines). Others, including Volvo, are phasing out the production of vehicles powered by internal combustion engines. These decisions have been prompted by an increasing number of governments deciding to phase out the use of internal combustion engines, including Germany (phased out by 2030), France (2040), Norway (2025), and the UK (2040) which will ban diesel and gas powered vehicles, see Figure 9.6.6.

Social issues

How the impact of natural resource use is viewed depends upon the circumstances of each society and the worldview of individuals.

In a developed country such as Australia concern is focused on environmental aspects of resource use and the political consequences of misuse. There is some concern about resource allocation, but the division is predominantly between the economy (and jobs) and the environment. The traditional argument put forward by economic rationalists is that protecting the environment will destroy jobs. This is demonstrated by the battle over the logging of old-growth forests in Tasmania. The alternative to this argument is that protecting old-growth forests will provide new economic opportunities in new industries such as tourism.

In Australia, as well as other developed countries, decisions to legislate and protect the environment are undertaken during a short-term political cycle. The focus is often on the next election and not the long-term benefits to the environment.

Environmental interest groups

Much of the public awareness of global environmental issues is raised by groups such as the World Wide Fund for Nature and Greenpeace. These and similar organisations keep environmental issues prominent in the media and can be effective in some instances. In 1985, in response to Greenpeace's vigorous protests against nuclear testing by France at their Pacific island of Mururoa, French secret agents sabotaged Greenpeace's vessel, the Rainbow Warrior. This international terrorist action in Auckland Harbour, which killed a Greenpeace crew member, further mounted pressure against the French nuclear-testing program.

Greenpeace, together with the Sea Shepherd Conservation Society, has also proved successful in raising international awareness of Japanese whale hunting. As seen in Figure 9.6.7, Greenpeace is active in promoting global awareness of climate change, forest destruction and the protection of the world's oceans.

9.6.7 Greenpeace activists attempt to disrupt a Japanese whaling fleet.

SPOTLIGHT

Debt-for-nature swaps

As the world's debtor countries struggle to meet their financial obligations and are forced to cut back government spending, environment protection programs are often the first to go. Debt-for-nature swaps are designed to free up resources in debtor countries for much needed conservation activities. A debt swap involves purchasing foreign debt at a discount, converting the debt into local currency, and using the proceeds to finance local conservation initiatives.

9.6.8 This Atlantic coast rainforest in the mountains near Rio de Janeiro, Brazil, will be conserved as a result of a debt-for-nature swap.

The World Wide Fund for Nature (WWF) was one of the pioneers of debt-for-nature swaps and successfully facilitated its first swap in Ecuador in 1987. Since then, WWF has played an important role in the implementation of debt-for-nature swaps around the world. Since 1987, debt-for-nature agreements have generated over US$1 billion for conservation in developing countries

In 2006, The Nature Conservancy facilitated one of the largest debt-for-nature swaps. Under the agreement, the US Government waived a US$24 million in debt owed to it by Guatemala. This $24 million instead is being used to finance forest conservation in Guatemala over a 15-year period. In 2010 the United States and Brazil signed an agreement converting US$21 million of Brazilian debt into a fund to protect tropical ecosystems. Instead of paying back the debt, Brazil will use the money to conserve its Atlantic coastal rainforest (see Figure 9.6.8), as well as the Cerrado and Caatinga ecosystems. All three are under threat from severe deforestation, but receive much less attention than the Amazon. The US has signed similar debt swap agreements with 15 other countries.

9.6.9 Adani protesters campaign outside Queensland's Parliament House in Brisbane in 2017.

General activist groups such as GetUp! also play an important role in raising the public's awareness of environmental issues. The group campaigns on the issues of economic fairness, environmental sustainability, and social justice. They have been active in campaigning against the giant Adani coal project in Queensland's Galilee Basin, as has the Australian Conservation Foundation (ACF), seen in Figure 9.6.9. If the mine goes ahead, it will be the biggest in Australia, and the coal mined there will add massively to carbon dioxide emissions for decades. It will also mean massive and continual dredging and dumping in the Great Barrier Reef World Heritage Area and will result in thousands of coal ships passing through the reef every year.

SPOTLIGHT

Women bear the costs of environmental degradation

In developing countries, women are doubly affected by environmental deterioration; first because of poverty and second because of their gender. Environmental degradation places a disproportionate burden on women largely because of their social and economic roles, which expose them to greater numbers of environmental hazards.

Apart from suffering from smoke inhalation from their indoor cooking, they take primary responsibility for obtaining water and washing the family's clothes. These activities can be hazardous where sanitation is poor, washing facilities inadequate and water supplies contaminated.

The kind of employment that women do often puts them at risk as well. In rural areas, many women work in agricultural fields, where they are exposed to toxic chemicals from fertilisers and pesticides.

In poor households, women are responsible for food preparation and collecting fuelwood and cow dung to meet the family's energy requirements. In an environment depleted of forests this may mean many hours of walking every day. Girls often help their mothers fetch water and fuelwood (see Figure 9.6.10), depriving them of an education.

9.6.10 Ethiopian girls collect firewood for cooking.

Social issues in developing countries

In developing countries, the environmental issues of greatest concern are those that have a direct impact on an individual. Shortages of food, of fuel to cook it with and of clean water remain the most important issues. In many societies, political or ethnic oppression, lack of education and training, and absence of both physical and financial resources mean there is little opportunity for altering existing circumstances. The need for life's essentials persists, as does a certain amount of resigned acceptance that environmental degradation is inevitable. In many cases, major social changes are an integral factor in the solutions to the problems.

Figure 9.6.11 outlines the issue of natural resource loss through desertification (seen in Figure 9.6.12) and possible approaches to solving the problem.

Symptoms →	Causes →	Solutions →	Outcomes
■ Loss of soil ■ Loss of farmland ■ Catchment degradation ■ Poor nutrition ■ Morbidity ■ Poverty	■ Grazing pressure ■ Over cultivation ■ Climate modification ■ Fuelwood collection	■ Education and training ■ Environmental education ■ Alternative fuel sources ■ Reafforestation	■ Other occupations ■ Reduced, but sustainable agriculture ■ Preserved vegetation ■ Environmental rehabilitation

9.6.11 Desertification: the symptoms, causes, solutions and outcomes

9.6.12 Desertification often results from unsustainable land use practices.

Responsibility and solutions

The example of desertification shows that resource-based problems have many causes. The solutions for these may well require changes in society rather than modification of the physical environment. What is often lacking is the institutional resolve and support necessary to lead and sustain the social change. Resources for education and post-school training, or funds for tree planting, are typical needs.

On occasions where local entrepreneurs or, probably more typically, TNCs have exploited natural resources, indigenous societies have suffered. Responsibility for this normally lies in the hands of the country's government. The many reasons for inaction may include:

- a lack of effective control at a government level
- no laws to protect the environment
- indigenous people having no effective voice in their government
- inadequate official communication channels
- laws being bypassed due to a corrupt system
- inadequate monitoring of regulations, making it difficult to pinpoint responsibility
- inadequate penalties, especially if the potential rewards are high by comparison.

To local indigenous peoples, particularly those living at a subsistence level, a project that degrades the environment may be devastating. They may be helpless to alter the circumstances due to the following reasons:

- Small groups or tribes are politically insignificant on their own.
- Tribal disputes, cultural differences, geography and poor communications may impede the establishment of a united pressure group.
- Their sentiments may consequently be ignored or they may be swayed by articulate politicians—with empty promises.
- Sometimes key local leaders are 'bought' (that is, are given inducements to act in support of a particular vested interest).

Should the project proceed, it is likely that several of the local people will pick up relatively well-paid employment. Acquiring the material trappings of a cash economy, they may attract others to a dependency on a very different way of life. Thus, the local economy moves away from a subsistence base and relies increasingly on food purchased from outside the area. This may well lead to a weakening of interest in the management of local food-growing areas and lessen concern about degradation. Sometimes the passage towards degradation in developing countries is very subtle but the consequences may be serious, far-reaching and irreversible.

Activities

Understanding the text

1 Outline the developments in environmental awareness since World War II.

2 Identify the factors that have enormously increased humanity's capacity to do irreparable harm to the environment.

3 Explain what the Montreal Protocol is. Why is it considered significant?

4 Outline the steps people can take to address issues of environmental degradation.

5 Outline why global pollution controls are seen as representing a threat to developing countries, especially if they have few industries. What is the fairest way to deal with this issue?

6 Outline the reasons why governments of developing countries often find it difficult to manage the impacts of resource exploitation. How can developed countries assist developing countries to tackle environmental degradation?

7 Identify the 'choice' central to arguments over natural resource use.

8 Outline why indigenous people find it difficult to resist TNCs and environmentally damaging projects they promote. What are the main reasons for inaction by governments? When resource related projects go ahead, what impact might they have on indigenous communities?

9 Define the term desertification. What are its causes and the solutions to this problem?

Working geographically

10 Outline the impacts of the global spread of industrial-based economies and lifestyles. What problems have they created? Why do those living in developed countries have an ethical responsibility to assist those living in developing countries?

11 Study Figure 9.6.1. With the aid of an atlas describe the global pattern of energy consumption.

12 Study Figure 9.6.2. Identify the principal carbon emitting regions.

13 Outline the principal commitments parties to the 2015 Paris Climate Agreement have committed to do from 2020.

14 Study the section about 'Transnational corporations and the environment', then answer the following questions.

- **a** Outline the ways corporations are beginning to take their environmental responsibilities more seriously.
- **b** Select a recent resource-related environmental issue. What were its causes and impacts? What is being done to repair the damage?

15 Explain what 'Debt-for-nature swaps' involve. What are their benefits?

16 Outline the role played by environmental interest groups.

17 Study Figure 9.6.11. Write an extended response outlining the symptoms, causes, solutions and outcomes of desertification.

18 Outline the ways in which women in resource-poor countries bear an above-average burden.

19 Contact a non-governmental organisation, such as World Vision, and learn of its activities in relation to providing food, shelter, water and possibly education to communities in developing countries. How does the organisation promote effective management of natural resources? Share your thoughts with the rest of the class.

20 Study past and current resource-related events reported in newspapers and online sources and identify items relating to:

- **a** resource planning or decision-making
- **b** other items on resource issues
- **c** resource policies of Green politicians.

Keep a media file on these issues.

21 Undertake internet-based research into a major resource-related controversy. Explain how the groups opposed to the development used the internet to conduct their campaign.

22 Investigate the objectives of the Snowy Mountains Scheme. What have been the environmental consequences of the scheme? Debate whether you think this scheme would be approved if it was proposed today.

23 Write a report outlining why developing countries are vulnerable to disasters such as the Union Carbide accident at Bhopal. Consider what must be done to ensure that the frequency of such events is minimised.

24 List the major contributors of carbon dioxide to the atmosphere in your area. List any other significant greenhouse gas contributions.

25 As a class, discuss whether you feel that it is reasonable to allow developing countries to produce high levels of pollutants over the next decade or more so they can become more developed. What steps could be put in place to achieve this without the global environment being threatened further?

26 While the aims of ecologically sustainable development are desirable, discuss whether you think it is realistic to gauge what the needs of future generations might be. Consider a range of future scenarios.

27 Study Figure 9.6.11.

- **a** Write a report outlining how physical problems can require social solutions.
- **b** List the resources that you consider would be required in order to provide an effective solution to the problem of desertification.

28 As a class, compile a list of what can be achieved locally to reduce the net emissions of carbon dioxide. Critically evaluate these possible initiatives in terms of their practicality and effectiveness.

29 List other major local pollutants in your area and indicate what could be done to reduce them.

UNIT 9.7

Evaluating resource management strategies

Evaluating a resource management strategy involves more than simply appraising a scheme at its conclusion. Evaluation should begin at the project-planning stage to ensure that all the specified goals are being met. Quantitative measures of success are ideal because they are specific; however, most projects will also include a number of qualitative benchmarks. These benchmarks must be clearly defined, able to be replicated and reliably assessed by other persons.

The project's proponents will often pay most attention to production and economic indicators. The government, or the relevant project-approval authority, may also impose a range of environmental targets that need to be considered. Increasingly, there is greater emphasis placed on social consequences of large-scale projects, such as the availability of jobs and schooling for family members and adequate hospital facilities. Other social impacts that need to be considered might include its impact on unemployment, crime and supply of goods and services.

Even for projects that have a relatively short operational lifespan, it is desirable to have a set of intermediate benchmarks. They provide a ready indication of the shortcomings of projects as they develop and may indicate potential improvements in terms of their management. In large-scale operations, the evaluation process should involve project staff and independent assessors from the initial stages, particularly where rigorous environmental monitoring is necessary. A lack of adequate long-term monitoring has been a weakness of many past projects.

Over the last decade or so, increased attention has been given to environmental auditing. Using a mine site as an example, this process involves measuring key aspects of the site to ensure that the mine's operation does not cause levels of pollution above acceptable levels. Measurements also need to ensure that, after mining has ceased, rehabilitation returns the mine site to predetermined environmental standards. Specifications may range from water and sediment yield to the leakage of toxic material. Establishing these standards at the start of the project is crucial in evaluating the net environmental impact.

Evaluations of resource management strategies are rarely as open as they should be. The corporations involved may be concerned about investor confidence, share market performance, the imposition of more stringent conditions from the authorities, debates over working conditions, and union negotiations. Governments may distort or conceal unsatisfactory outcomes arising from its mismanagement if they are concerned about its political impact.

Coal mining threatens Sydney's water supply

In mid-2017, environmental groups (including 4nature) scored a victory against coal mining in Sydney's water catchment when the NSW Court of Appeal ruled that consent should not have been granted to a mine near Lithgow.

Centennial Coal's Springvale mine (seen in Figure 9.7.1) was granted a 13-year extension in 2015 by the NSW Government, even though the mine was discharging millions of litres of untreated wastewater directly into the Coxs River. The river is the second largest source of water for the Warragamba Dam, which supplies most of Sydney's drinking water.

The NSW Environmental Protection Authority was among the agencies that raised objections to the extension granted to the mine. Of particular concern was the high level of salinity and other contaminants in its wastewater. Without its own treatment plant, the mine discharges as much as 19 million litres of waste a day into the Coxs River.

9.7.1 The Springvale mine and the adjacent Mt Piper power station

4nature, an environment group, challenged the extension of the mine's operational approval, arguing it was in clear conflict with the 2011 State Environmental Planning Policy requiring any development in the catchment to have a neutral or beneficial effect on water quality.

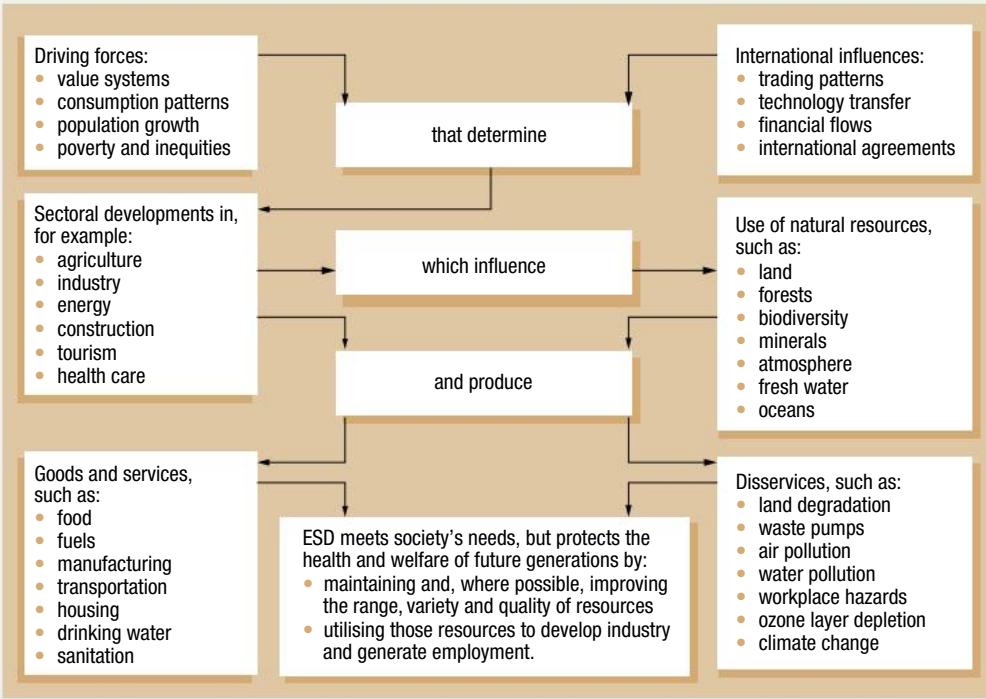
Pressure to keep Springvale operational came from Energy Australia, the operator of Mt Piper power station, which generates about 15 per cent of the NSW's electricity.

In response to the NSW Court of Appeal ruling, the NSW Government adjusted legislation in order to keep the mine operational, and announced the construction of a new water treatment plant due for completion in 2019. However, environmental groups including 4Nature criticised the state government's decision, stating that the mine is still operational and produces millions of litres of wastewater every day.

SPOTLIGHT

Ecologically sustainable development in Australia

The National Strategy for Ecologically Sustainable Development provides guidelines for the future of Australian economic expansion. The strategy aims to enhance individual and community wellbeing and welfare by requiring economic development to safeguard the interests of future generations. It also endeavours to ensure equitable distribution within and between generations and to protect biological diversity and maintain ecosystems. The elements of sustainable development are shown in Figure 9.7.2.



9.7.2 Elements of ecologically sustainable development

Activities

Understanding the text

1. Outline what must occur if the evaluation of a resource management strategy is to be effective.
2. Identify the social outcomes typically assessed as part of a projects evaluation.
3. State what is meant by the term environmental audit.
4. Identify who needs to be involved in the evolution of large-scale projects.
5. Identify the factors limiting the openness of evaluations of resource management strategies.

Working geographically

6. Study the section of text, 'Coal mining threatens Sydney's water supply', and answer the following questions.
   a. Outline the environmental concerns associated with the extension of the Springvale mine's operating lease.
   b. What strategies did environmental groups adopt to protect the water quality in Sydney's catchment?
7. From your nearest Department of Planning and Environment office, or from its website, obtain details of the environmental impact assessment procedure. Identify directions that relate to resources and the environment. Note that an Environmental Impact Study (EIS) is required for certain proposed projects. These are made available for public criticism and are often modified as a consequence.
8. Obtain a copy of an Environmental Impact Study (EIS), preferably from a nearby area, that is related to the use of resources.
   a. Study the EIS and identify the resources involved.
   b. Why it is appropriate that the resources should be used?
   c. What are the economic, environmental and social consequences of their use?

Exam-style questions

Extended responses

- What are natural resources? How are they classified? Give examples of each.
- Examine the renewable, recyclable and exhaustible nature of natural resources.
- With the aid of examples, explain the spatial variation in the distribution and consumption of natural resources on a global scale.
- Outline the economic, political and social issues related to the use of natural resources.
- Examine the economic and political issues related to the ownership and management of natural resources.
- Examine the environmental issues related to the use of natural resources.
- Outline the impact on, and responses of, indigenous peoples to the use of natural resources.
- Explain what needs to be done to achieve the ecologically sustainable use of natural resources.

Glossary

agribusiness large-scale, organised production of food, farm machinery and supplies as well as the storage, sale and distribution of farm commodities, for profit

anthropocentric centred on human beings

arable land an agricultural term, meaning land that can be used for growing crops

benchmark a reference point against which performance can be measured

biocentric centred on the worldwide system of all life functions

bloc a group of states or countries united by some common factor

cartel a group of producers of a single commodity that mutually agree to fix prices

cash crop a crop grown for cash

clear-felling logging operation involving the cutting of all standing timber in an area

diseconomies forces or factors that cause larger firms to produce goods and services at increased per-unit costs

environmental audit an account of environmental attributes

equity the quality of fairness and impartiality

gross national product (GNP) the total value of goods and services produced in a country together with income earned from investments and other earnings overseas

host country the country that provides the location and resources for a foreign company's project

integrated resource management the management of resources to achieve mutually beneficial goals in two or more projects

natural resource a natural item that, after processing or manufacture, meets the needs of society

natural resource base the earth-based materials from which potential resources are to be drawn

non-renewable resources resources that have finite stocks and, once used, are not replaced or recycled; also known as exhaustible resources

Organisation of Petroleum Exporting Countries (OPEC) founded in 1960, its current members are Algeria, Angola, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela

qualitative relating to characteristics, properties and attributes

quantitative relating to measurements

reafforestation the process of restoring and recreating areas of woodlands or forests that once existed but were deforested or otherwise removed or destroyed at some point in the past

recyclable resources those materials that can be processed for reuse

renewable resources those resources that, if carefully managed, will be replenished after use

sovereignty the principle that the state exercises absolute power over its territory, system of government, and population

speculation trading with the purpose of making profits

subsistence agriculture the growing of crops and/or the raising of livestock to support the members of a household rather than producing food for sale

tariff duty imposed by governments, particularly on imports

timber concession the authority to log a specific area of forest

total catchment management (TCM) the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a catchment basis

'user-pays' principle an economic rationalist approach whereby those who need a service pay for it directly without subsidy; economic rationalists tend to favour deregulation, a free market economy, privatisation of state-owned industries, lower direct taxation and higher indirect taxation, and a reduction of the size of the 'welfare state'

CHAPTER

10 Cultural integration

It was thought that the process of globalisation and the revolution in information and communication technologies would bring the people of the world closer together in a process known as cultural integration. But the opposite appears to be happening. While global economies are converging, cultures appear to be diverging, and the widening cultural differences are leading us into a period of heightened social conflict, growing inequality and increased segregation. This is most apparent in the divisions emerging between the democracies of the Western world and the wave of religious fundamentalism sweeping the Islamic world.

At a global scale, old national identities are proving surprisingly durable, and, in some instances, have been radicalised by the process of globalisation. Even the most superficial analysis of contemporary geopolitical events draws attention to the role played by groups that both fear and reject the intrusion of outside cultural influences.

This chapter examines the process of cultural integration, the aspects of global culture where the impact has been greatest and the extent to which the spread of Western culture has provoked a backlash from those who fear that it threatens to overwhelm their own cultural traditions and beliefs.

> **It seems we get so obsessed with the death of Australian English that we miss those many great terms that are being created beneath our very eyes in Australia and by Australians.**
> **... hornbag, snot block, checkout chick, firie, tradie, trackie daks ...**
>
> **Kate Burridge, Professor of Linguistics, Monash University**

10.0.1 Australia vs Brazil, Tournament of Nations, 2017. Soccer, or football, originated in the UK and is now played around the world.

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10
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UNIT 10.1

Defining cultural integration

Cultural integration is made up of many concepts. The idea of a multicultural society reflects cultural integration at work; so does the idea of the 'global village', where, through technology and trade, a seemingly borderless world is created. Cultural integration is also linked with the adoption of a mass consumer culture where everything from fashion to sport, and from music to TV, becomes integrated into a country's culture. This may be viewed by some as a positive step towards a new unified world. To others, however, cultural integration is seen as a threat to national sovereignty and cultural diversity. Geographically, where a person lives in the world often determines what part, if any, they can play in this globalisation process.

SPOTLIGHT

Global village

Marshall McLuhan, a Canadian philosopher and academic, first used the term 'global village' in 1964. His insights were considered revolutionary at the time, and fundamentally changed how people thought about media, technology, and communications. McLuhan chose the term to highlight his contention that the media was rapidly integrating the planet. He argued that events in one part of the world could be experienced in other places in real time, which is what human experience was like when we lived in small villages.

A definition of culture

In a very general sense, culture can be defined as the 'way of life' of a group of people. More specifically, culture can be described as those elements of human existence like the traditions, customs, languages, belief systems, art, architecture, music, food and institutions that are passed down from one generation to the next. It includes the material goods the group creates and uses, and the skills it has developed. It also includes territorial affiliation and shared history; and shared political and education systems.

No culture is static. Ideas, technologies, products and people move from place to place. When cultures come into contact through migration, trade, or the latest telecommunications technologies, they impact on each other. Some people fear that the earth's cultural diversity is under threat. They are concerned that cultures are being swamped by Western (mainly US) cultural influences. Others see this development as part of the ongoing process by which particular cultures evolve and are enriched by the cultures with which they interact. Advanced communication technologies make it inevitable that cultures, of all types, will become more interrelated and interdependent.

Cultures have evolved in response to contact with other people and cultures for thousands of years. What is new is the pace of change. In the past, distant cultural influences spread slowly, delayed by the distances involved and limitations of the available transport technologies. Today, because of the internet, the rapidly evolving telecommunications technologies, the media, world trade, and the ease (and increasing affordability) of long-distance travel, cultural influences can spread across the planet at the click of a mouse.

Criticisms of cultural integration

Critics of cultural integration and globalisation fear that a sort of cultural cloning is the inevitable outcome of the cultural influence caused by global brands like, McDonald's, Coca-Cola®, Disney, and the English language itself. Critics argue that Western—often equated with American—influences will eventually erase every cultural difference, to produce what some have called one big 'McWorld' (see Figure 10.1.1). They argue that everywhere will look like everywhere else, with the same McDonald's, KFC® and Starbucks®, the same television programs with Hollywood movies and television series, access to the same streaming media content available on platforms like Netflix®, Amazon Video and the shopping centres selling the same global brands. Events happening on the other side of the world will be seen, heard and felt with the same sense of immediacy as events happening across town.

The logical outcome of such a proposition is that national differences and regional cultures will disappear as a global marketplace brings uniform dispersion of people, tastes and ideas. However, such an outcome is, in fact, highly unlikely. Even in the Information Age, geography still matters.

10.1.1 The influence of a mass consumer culture is clearly evident in the streetscape of Sydney.

Places and regions will inevitably change as a result of the new global context but geography still matters because of several important factors: transport costs, variations in resource endowments, people's territorial impulses, the resilience of local cultures, and the legacy of the past.

Cultural diffusion, adoption and adaption

Cultural diffusion is the term used to describe the dispersion, or spread, of different cultural elements between countries. When confronted with new cultural influences, people can reject them outright, adopt the change, or find a way to adapt to the changed circumstances. Cultural adoption involves the acceptance and integration of different cultural elements into your own. Cultural adaptation involves the modification of a culture to incorporate aspects of another culture.

There are many measures of cultural diversity, but one of the best indicators is the state of the world's languages. Some languages are growing, while others are fading. Many blame globalisation: a growing uniformity fuelled by technological advances in telecommunications and the emergence of the global economy.

DID YOU KNOW?

- English is now spoken by more than one fifth of the world's population.
- About half the world's languages have fewer than 1000 speakers.

SPOTLIGHT

Culture and perceptions of beauty

Throughout history and across the world, cultural ideals of beauty have varied. In Mauritania, for example, large women are considered beautiful, as they are in Fiji.

In many countries throughout Asia and Africa, light skin is seen as desirable for some people. There are numerous marketing campaigns for skin whitening products, as shown in Figure 10.1.2.

10.1.2 An advertisement for skin-whitening cream in Abidjan, Ivory Coast. Many African countries have banned the use of skin-lightening products because of health concerns.

Padaung women of Thailand begin to wear neck coils from as young as two years of age. The length of the coil is gradually increased to as much as twenty turns. The weight of the coils will eventually place sufficient pressure on the clavicles to cause them to deform and create an impression of a longer neck, a sign of beauty (see Figure 10.1.3).

10.1.3 Padaung women with neck rings. Long necks are seen as a symbol of great beauty.

In Ethiopia, the Mursi and Suri tribes consider lip plates a sign of beauty. When the women are ready to marry, they begin the process of the lip plate by making a hole in the lower lip with a wood stick. The hole is expanded a little every day. Eventually, when the hole is big enough, women insert a plate and gradually, a bigger plate replaces the plate, until it has reached its full size, seen in Figure 10.1.4.

10.1.4 Woman of the Suri tribe, Omo Valley, Ethiopia

In some societies, plastic surgery is seen as a way of achieving a level of beauty that is impossible to achieve otherwise. South Korea has the highest per capita incidence of plastic surgery in Asia. One in five women between 19 and 49 have had a surgical procedure. The most popular procedures are rhinoplasty (a nose reconstruction), blepharoplasty (eyelid lifts) and jaw reconstructions—all designed to produce a more Caucasian appearance. The dominance of Western celebrities and models in popular culture has reinforced this trend and is also seen as promoting thin, model-like figures as the norm. This has increased the incidence of eating disorders among girls. Boys have also been tempted to emulate the body profiles of male models. This has led to the abuse of steroids and psychological disorders associated with poor body image.

Globalisation

Globalisation is a driver of cultural integration. It involves the increasing interconnectedness of different parts of the world through the processes of technological, economic, political and cultural change. Globalisation is not a new process. It has been occurring since at least the sixteenth century, albeit at a much slower pace than is apparent today.

In the nineteenth century, the competitive system of nation states (typified by the processes of colonialism and imperialism) resulted in the emergence and refinement of international agencies and institutions, global networks of communication, a standardised system of global time, the beginning of international law, and internationally shared notions of citizenship and human rights. This provided the basic framework for modern globalisation. However, today's process of globalisation differs from that which came before in a number of important ways:

- Globalisation is occurring at a much faster speed than ever before, facilitated by great advances in transport and communications technologies.
- It operates on a much larger scale, leaving few people unaffected, even in the most remote corners of the earth.
- The scope of global connections is much broader and has multiple dimensions: economic, technological, political, legal and cultural.
- The nature and complexity of the interactions between global actors has increased, as has the relationship between places and regions.

Over the last few decades, advances in transport and telecommunications technologies, corporate strategies and institutional arrangements have combined to create a new geographical context. Such advances have also resulted in the development of a complex international financial system, while transnational corporations (TNCs) are now able to shift their production activities from one part of the world to another. Today, products, markets and organisations are spread and linked across the globe.

Economics

The economic basis of globalisation can be seen in the complex commodity chains that span the globe. Commodity chains are the networks of labour and production processes that begin with the extraction of raw materials and whose outcome is the distribution and consumption of finished products. These vast networks often span countries and continents, linking the production, processing and supply of raw materials, the production of component parts, and the assembly and distribution of finished products. These supply chains play an increasingly important role in shaping places and regions.

Culture

Globalisation also has important cultural dimensions. The first of these is the diffusion of all sorts of cultural forms, practices and artefacts that were once confined to specific places or regions. Examples include ethnic and regional cuisines, sports and music.
A second dimension is the emergence of a global consumer culture. Everything is now sold on international markets. Brands once confined to specific economic contexts have gone global. The automobile, hotel and travel, clothing and footwear, and electronic goods sectors are now all dominated by global brands. This has resulted in some observers arguing that globalisation has resulted in a new universally shared set of images, practices and values—a de facto global culture.

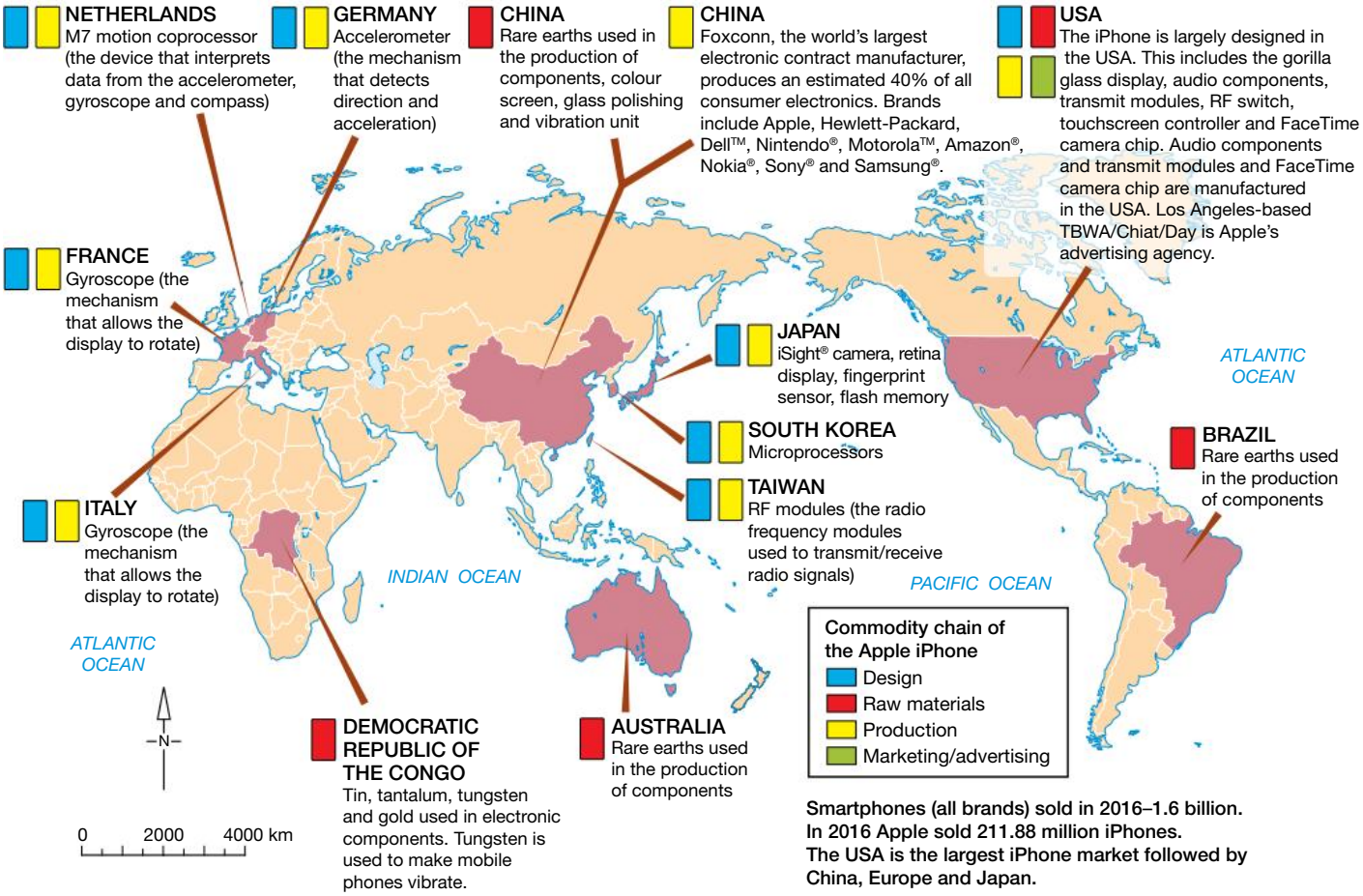
Globalisation is a major step forward in terms of global interconnectedness and the emergence of the world as an interdependent system. It represents a major reorganisation of the world economy and a significant realignment of our relationships with other people and places.

For some places and regions, globalisation has been transformative, in others it has been of marginal importance. Some regions have become more closely integrated and interdependent, while others have been marginalised or excluded entirely. There has, in reality, been no common experience of globalisation. It has been variously embraced, resisted and exploited in different cultures.

SPOTLIGHT

The iPhone® 'commodity chain'

The majority of technologies we use are manufactured in China; however, the supply and manufacturing process of these technologies is global. The raw materials and components from which these technologies are made are sourced from many different countries, as illustrated in Figure 10.1.5. More than most large corporations, Apple® is a master of using the commodity supply chain to its advantage. It contracts suppliers that can provide the raw materials and components it needs in the most cost-effective way while still maintaining the company's stringent quality requirements. Foxconn, the world's largest electronic contract manufacturer, assembles the iPhone for Apple in its Chinese factories at US$4 cheaper than it would cost to assemble the iPhone in a US factory which, crucially for Apple, also means the company is able to avoid a lot more tax on its profits—35 per cent (as of 2017) as opposed to just 2 per cent in China.



10.1.5 The commodity chain of the Apple iPhone

SPOTLIGHT

Dubai: cultural crossroads

Over the last two to three decades, oil-rich Dubai (see Figure 10.1.6) has emerged as one of the world's most fascinating examples of cultural integration. Money has transformed this small desert emirate into the world's largest construction site, major international airline hub and popular tourist destination.

10.1.6 Dating back to 3000 BCE, Dubai has been transformed from a small fishing village into a dazzling city and one of the world's most prominent business and trade centres.

Dubai offers tourists an amazing range of attractions. In a single day, they can experience everything from four-wheel-drive sand dune adventures, to sandy beaches and artificial islands, amazing waterparks, lush green parks, luxurious residential districts and ultra-modern shopping malls selling the world's most fashionable brands. Visitors can even go skiing on one of the world's largest indoor ski slopes, seen in Figure 10.1.7, measuring 400 metres and using 6000 tonnes of snow. It provides a great attraction, featuring a revolving ski slope, an artificial mountain range, an ice bridge, a cable lift, a snow maze, an ice slide, polar bears, cold-water aquaria and special sound and light effects.

10.1.7 Ski Dubai, the world's largest indoor ski area

10.1.8 Dubai International Airport, the world's third busiest

The cultural diversity of Dubai is further highlighted by the composition of its population. Only 15 per cent of the population of the emirate are UAE nationals. The rest of the population is made up of expatriates. About 85 per cent of the expatriate population (and 71 per cent of the emirate's total population) is Asian, mainly Indian (51 per cent), Pakistani (16 per cent), Bangladeshi (9 per cent) and Filipino (3 per cent). There are also over 100 000 British expatriates living in Dubai.

Dubai is also one of the world's most connected cities. The state-owned airline, Emirates (founded in 1985), is now the world's fourth largest international airline. Each week Emirates operates more than 3600 flights from its hub at Dubai International Airport to more than 140 cities in 81 countries across six continents. The airline has more than 239 aircraft, including a fleet of 96 Airbus A380s (with another 46 on order) and 130 Boeing 777 aircraft. Dubai International Airport is the world's third busiest airport as measured by passenger traffic. In 2016, the airport handled 83.6 million passenger movements and 418 220 aircraft movements (see Figure 10.1.8).

Activities

Understanding the text

1 Explain what is meant by the term cultural integration. Why do some people regard it as a threat? What positive benefits may it have?
2 Define the term culture. What are its main elements? How is it expressed?
3 Explain why some people fear the process of cultural integration.
4 Define the term cultural diffusion.
5 Distinguish between cultural adoption and cultural adaptation.
6 Outline the ways today's process of globalisation differs from that which came before.
7 Outline the impacts of advances in transport and communications technologies.
8 Outline the impacts of globalisation.

Working geographically

9 Working in groups, brainstorm the elements of Australian culture that have their origins in other parts of the world. Compare your group's list with other groups. Compile a class list. What conclusions can you draw from this activity?
10 Collect photographs that help to illustrate the process of cultural integration. Mount a wall display. Add to the display over the course of the year.
11 Explain, in your own words, the concept of 'global village'.
12 What does the state of the world's languages tell us about the process of cultural integration?
13 Brainstorm culturally based examples of ways perceptions of beauty vary across the globe. What aspects of beauty are privileged in Australian society? Give examples of the ways people in Australian society seek to modify their appearance. Do you find these more socially acceptable than those highlighted?
14 Explain what is meant by the term commodity chain. What does the iPhone commodity chain tell us about the nature of economic activity in the integrated global economy?
15 Undertake further internet research on Dubai. Write an extended response on the topic: 'In what ways does Dubai illustrate the process of globalisation and the emergence of an interdependent world?'

UNIT 10.2

The diffusion, adoption and adaptation of mass consumer culture

Cultural integration is about accepting globalisation. It is a process where the issues of class, gender, race and ethnicity are denoted simply by what brand of clothing we wear, where we live, what music we listen to and what cultural events we attend. The following examples of food, fashion, advertising, sport, music and religion demonstrate the nature and extent of cultural integration.

10.2.1 East Nanjing Road, Shanghai, China. The global fast-food industry and brands of soft drink are ubiquitous features of streetscapes around the world.

Fast food going global

One of the most obvious examples of globalisation has been the proliferation of fast-food retailers, such as McDonald's, Burger King®, KFC, Domino's Pizza® and Starbucks. Today, these giants of the fast-food industry are a ubiquitous feature of streetscapes around the world (see Figure 10.2.1). Their proliferation has helped transform the diets of people in many countries and helped shape (through advertising) the lifestyle aspirations of people, especially the young. Vendors of traditional foods have responded by adapting the fast-food industry's approach to the promotion, production and sale of food. In some cases, the fast-food giants have adapted their products to the cultural context in which they operate.

Global fashion

The fashion industry is both dynamic and competitive. It is an industry that thrives on constant change and the promotion of youthful and status-based images. It dictates what is 'in' and what is not. Each season, designers look to the traditional fashion capitals of London, New York, Paris and Milan for inspiration. Globalisation of the fashion industry is everywhere and it is the United States that leads the way. Calvin Klein®, Levi Strauss®, Tommy Hilfiger®, Gap®, Nike® (see Figure 10.2.2) are all brand names owned by large transnational corporations that target the youth market and subtly influence which brand of T-shirt or designer jeans you buy. Most are made in developing countries where labour is relatively cheap and health and safety conditions are not considered an important issue.

10.2.2 Nike advertisement featuring Polish soccer stars Blaszczykowski and Szczesny covering the 27-floor ORCO Tower in Warsaw, Poland: a symbol of mass consumer culture on a global scale

More recently, European retailers have taken up the global fashion challenge. Retailers such as Zara® and H&M® now have a growing presence in the Australia–Pacific region. Both are described as Fast Fashion retailers. Their corporate strategy centres move quickly to capture current fashion trends and have clothing in stores within weeks.

Promoting global consumerism: advertising and the media

The process of globalisation is responsible for both cultural and economic integration. As trade barriers around the world are lifted or altered, large corporations have played an increasingly prominent role in reshaping society. Encouraged by the possibility of making huge profits, new industries in advertising, media, creative production, consumer research and marketing education have emerged to promote consumer consumption. When global corporations reach out and touch the four corners of the globe, they bring with them not only established products and brand names, but also their favoured media and sophisticated marketing methods.

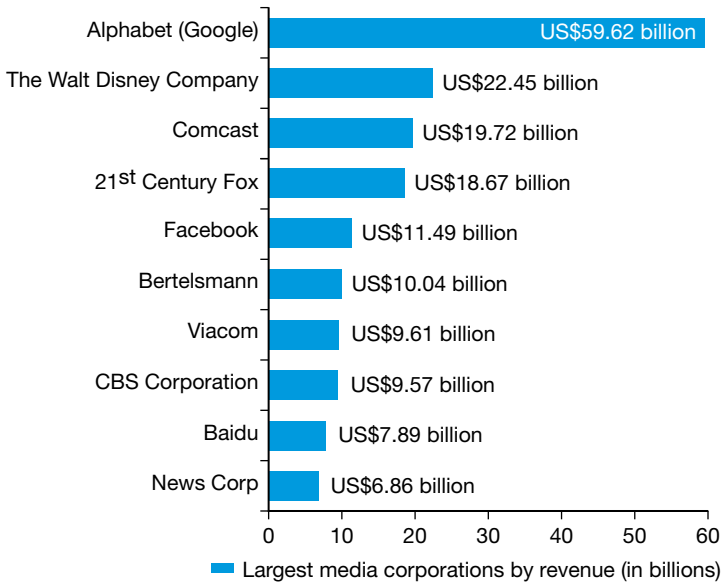
The media, in all its forms, has become a central influence in shaping individual, community and national identities. It is also the preferred medium by which large corporations create a market for the products they sell. Global marketing campaigns, based on advertising and the sponsorship of major events (see Figure 10.2.3), are used to promote products to vast audiences. By the end of 2017, just 10 media giants dominated the global advertising market: these were Alphabet (the holding company that owns Google), the Walt Disney Company, Comcast (NBC Universal cable networks and television), 21st Century Fox, Facebook®, Bertelsmann, Viacom, CBS Corporation, Baidu (the Chinese language search engine) and News Corp, shown in Figure 10.2.4. Other big players include Time Warner®, Yahoo® and Microsoft®. These corporations not only control the vast majority of media content available to audiences in most countries, they also have the power to determine what information is available and thereby influence public opinion, cultural identity and lifestyle expectations.

10.2.3 Corporate sponsorship of large-scale sporting event: South African Jordy Smith celebrates winning the Rip Curl Pro World Surfing League competition at Bells Beach, Victoria in April 2017.

Advertising and marketing

Advertising is one of the largest industries in the world. Tens of billions of dollars are spent annually creating demand for goods and services, all intended to improve one's 'self-worth' or 'lifestyle'.

Advertisers employ persuasive language. They bombard audiences with jingles, trendy rhymes, rock songs and a variety of fashionable images, which subtly take effect. Repetition and action are the key weapons used to reinforce the names and images of products in the audience's head. It is not uncommon during a sustained advertising campaign to see or hear the same advertisement broadcast numerous times throughout a TV program, particularly if a program is sponsored by a particular corporation; sponsorship is big business.



10.2.4 Ten largest media corporations by revenue, 2016

Two of the largest sponsors of community-related events and activities are Coca-Cola and McDonald's. Their aim is to create a forum in which their brand names can appear in front of vast numbers of people and thereby increase their sales. Coca-Cola, for example, is a major sponsor of the Olympic Games. The exposure gained through such an event is enormous, as are the profits gained from this marketing opportunity.

Traditionally, advertisers tended to target two groups: children and what was referred to as the 'youth market' (11- to 19-year-olds). There has, however, been a reclassification of 'youth' to include all those under 30. The reasons for this shift are many, but perhaps the most significant is the growing trend of this under-30s group to live at home longer and marry when they are older. This, supposedly, leaves them with greater disposable income available for the purchase of goods and services, such as cars, travel, computers, sporting equipment, gym memberships and home furnishings.

DID YOU KNOW?

- There are 1.2 billion teenagers in the world, the most there has ever been. Their purchasing power exceeds US$819 billion a year. Australian children and teenagers now have an annual spending power of over $1.8 billion.
- In the USA, there are 25.6 million teenagers. Their total annual spending exceeds US$208.7 billion. Eighteen per cent is spent on fast food.

Activities

Understanding the text

1. Outline the spatial and cultural impact of the fast-food industry. Explain how vendors of traditional foods have responded to the competition.
2. Explain the driving force of the fashion industry.
3. Identify where an increasing amount of clothing is made. Explain why.
4. Explain what allowed large corporations to play an increasingly prominent role in reshaping society.
5. Identify the new industries that have emerged to promote the consumption of the goods and services produced by TNCs.
6. Outline the role played by the media in the integrated global economy.
7. Explain why some people are concerned about the concentration of media ownership and control.

Working geographically

8. Outline the tactics employed by companies to sell their products. Choose a popular brand you identify with and investigate its selling tactics.
9. At home, make a list of the brand names you can find on the clothes in your wardrobe. Identify which are foreign made. In class, compare these lists and research where these companies are based.
10. Identify another popular brand you identify with and investigate its origins and global spread.
11. Most large retailers are TNCs. Use the internet to find out about the operations of one TNC. Write a report outlining its business operations and its record on environmental and human rights issues.
12. Take a class survey of the most memorable commercials. Consider what characteristics made them memorable. Also consider the image the commercial is trying to sell. As a consumer, would you be tempted to buy the product? Why or why not?

Sport

World sport is increasingly dominated by the three Ms: multinationals, marketers and managers. Tradition, loyalty and community heritage count for little. Sport is now a product to be sold like any other.

Players are bought and sold on the transfer market and have been transformed into human billboards. They carry advertising on their clothing and sporting equipment. Sporting personalities often have a number of corporate sponsorships, and product-endorsement agreements are negotiated by their management team.

One outcome of this process has been an increase in what critics have labelled 'visual pollution'. Naming rights to stadiums are for sale together with their playing surface, decorated with corporate logos that appear in perfect perspective on TV screens. Virtual advertising is also common with the advertiser's message being temporarily 'projected' onto any surface, including spectators. America's Cup yachts are floating billboards, with no name other than that of the corporate sponsor—a strategy that ensures maximum exposure of the sponsor's name and product.

Sport in Australia

Sport is widely recognised as an important part of Australian culture. For many Australians, sport is tied up with the image we have of ourselves and the image we want the rest of the world to have of us. Sports stars often become celebrities, sometimes placed on higher pedestals than film or rock stars. We watch and judge their performance keenly and share their triumphs and their failures, sometimes as if they were our own. For many, Australia's participation in international sporting events becomes an opportunity to express patriotism. Where sport is concerned, however, this appears to be an urge that is shared the world over; one only needs to look at international cricket or rugby matches to see evidence of this.

In Australia, sport was once considered to be the great 'leveller'. It symbolised equality between people by evening out differences and establishing what was once seen as a working class alternative to 'high culture'. Today, this is not so evident, particularly with the infiltration of sports from other countries and events such as the Olympic Games, which attracts people from all classes in society.

10.2.5 The Sydney–Hobart Yacht Race

10.2.6 Matt Prior of the Cronulla Sharks is tackled by Michael Morgan of the North Sydney Cowboys in the Elimination Final of the NRL, 2017. In the ARL, every camera angle captures the logos of a team's major corporate sponsors.

Most of the big sporting events in Australia now include the name of their main sponsor. The Melbourne Cup is now the Emirates Melbourne Cup. Cricket's historic Sheffield Shield has been replaced by JLT Sheffield Shield. The 'JLT' element of the name refers to the competition's sponsor, the Jardine Lloyd Thompson Group, an international insurance broker. There is the KFC Big Bash League Cricket, The Louis Vuitton Cup (sailing), the Kia Australian Open tennis, Toyota AFL, Telstra NRL, Rolex Sydney–Hobart Yacht Race (see Figure 10.2.5), and so on.

It is not only the sporting personalities that can be hired, bought and sold; clubs too are now a product. They can be created to fit a corporate vision and can be destroyed when they no longer fit into a marketing strategy (rugby league's Perth Reds, Adelaide Rams and Hunter Mariners, for example). In rugby league, many older community-based clubs were compelled to merge and when they failed to comply with the new corporate vision they were forced from the competition.

Two important factors are at play in this process:

- **Demographic change:** Larger disposable incomes, shorter working weeks, earlier retirement, longer life expectancy and healthier lifestyles have boosted the global demand for sport.
- **The communications revolution:** Ever more sophisticated TV coverage has made top sport (and the advertising, sponsorship and marketing that accompany it) available to a wider audience; see Figure 10.2.6.

The future of sport is closely linked to that of the global media networks. Rupert Murdoch's News Ltd (part of a New York and Australian listed public company News Corp.) owns 50 per cent of the National Rugby League in both Australia and New Zealand. In addition to this, News Ltd is the owner of the Brisbane Broncos and the Melbourne Storm teams, and part owner of the Gold Coast Titans.

The amount of money involved is huge. Australia's top sportspeople now command million-dollar contracts.

There has been a subtle change in the variety of sports played in Australia. It is only within the past 20 years that certain sports, including baseball and basketball, have taken off. Today, players from the US National Basketball Association (NBA) are recognised worldwide due to a slick marketing campaign that has sold the game and their faces are on everything from caps to bubble-gum packets. As a result, Australia has created its own Basketball Australia (BA) and has had some success in promoting players, such as Matthew Dellavedova and Thon Maker (Milwaukee Bucks), Joe Ingles and Dante Exum (Utah Jazz), Andrew Bogut (Dallas Mavericks), Patty Mills (San Antonio Spurs), Aron Baynes (Detroit Pistons) and Ben Simmons (Philadelphia 76ers) to the US 'major league'. Like sponsorship deals, the 'buying' and 'selling' of players has become big business. Once again, cultural integration through economic activity is at work.

The merchandising associated with sport is also another readily identifiable indicator of cultural integration. In common with their peers around the world, Australian teenagers wear clothing and caps with the names, logos and colours of US basketball and football teams.

Music

One industry that is particularly at the mercy of marketing and globalisation is the music industry. If artists are to succeed in this highly competitive industry, they generally need to be contracted to one of the large music corporations: Sony Music Entertainment, EMI, Universal Music Group or the Warner Music Group. These four companies have taken over vertical and horizontal control over almost every aspect of the industry. Universal maintains its position as the world's biggest recording company, with a 29.85 per cent share of the world market. Sony Music Entertainment is next with a 29.29 per cent share followed by Warner at 19.3 per cent and EMI at 9.62 per cent. The independent sector holds a 12.11 per cent global share. In Australia, small bands are finding it difficult to compete and many of the local venues where they once played can no longer afford to sponsor them.

The only alternatives that exist for the truly competitive artist are to fund production of their own music or compete for a position as an opening act when internationally recognised groups or individuals perform, seen in Figure 10.2.7.

Globalisation of the music industry also means that the music Australians are exposed to on streaming platforms and radio stations is mainly that of bands from the United States, Britain or Ireland. Australian artists account for less than 40 per cent of the top 100 Australian album sales by volume. This is considered an achievement given that recorded music is the most concentrated global media market and that Australia's share of global music sales is less than 2 per cent. Part of this success can be attributed to radio stations such as Triple J and The Edge 96.ONE, which offer alternative music for the Australian 'youth' market.

10.2.7 Beyoncé, US singer, songwriter, dancer and actress, performs live at London's Wembley Arena. Globalisation is well advanced in the music industry. Many artists attract a worldwide following.

SPOTLIGHT

Hip hop (rap)

Hip hop (now more commonly known as rap) is a style of music that emerged in the Bronx, a borough of New York City, in the mid-1970s and became part of popular culture during the 1980s. Together with its associated breakdancing and urban-inspired graffiti art, hip hop is a cultural movement initiated by inner-city youth, mostly African-Americans and Latino-Americans. From New York it spread around the world. It is now widely regarded as an international, rather than American, genre of music.

In France, hip hop music and culture is closely associated with African and Arab teenagers living in the housing projects on the outskirts of Paris. Many of these teenagers have been alienated by racism and economic disadvantage.

10.2.8 Hip hop–inspired graffiti, an important part of the urban environment

Hip hop in the United Kingdom has been strongly influenced by the country's colonial links with the Caribbean and India. The influx of immigrants from these regions during the 1960s and 1970s has led to a hip hop focused generation born of immigrant parents and influenced by their cultural heritage, but who are firmly rooted in the Anglo-British culture.

In Japan, the interest in hip hop mirrors the interest of many Japanese teenagers in all things African-American. A fashion style known as ganguro has emerged whereby young Japanese women darken their skin, apply flashy make-up and perm their hair or wear blond extensions in order to imitate hip hop beauty ideals.

Modern hip hop graffiti (see Figure 10.2.8) originated in Philadelphia and spread to New York City. It then spread to the rest of the world, with teenagers imitating and adapting the hip hop graffiti style. Today, there are also strong graffiti scenes in Europe, South America, Australia and Japan. Graffiti has been attacked by authorities and made subject to criminal sanctions.

Throughout the early 2000s, hip hop's popularity decreased. By the 2010s, a number of artists from the 'golden age of rap' started mounting comebacks. These included Eric B. & Rakim, and Pete Rock & CL Smooth. A Tribe Called Quest released their latest album, We Got It from Here... Thank You 4 Your Service, in late 2016.

Religion

Globalisation affects religion in many subtle ways. The internet has enabled worldwide religious debates, discussion of ethical issues and the publishing of religious tracts.

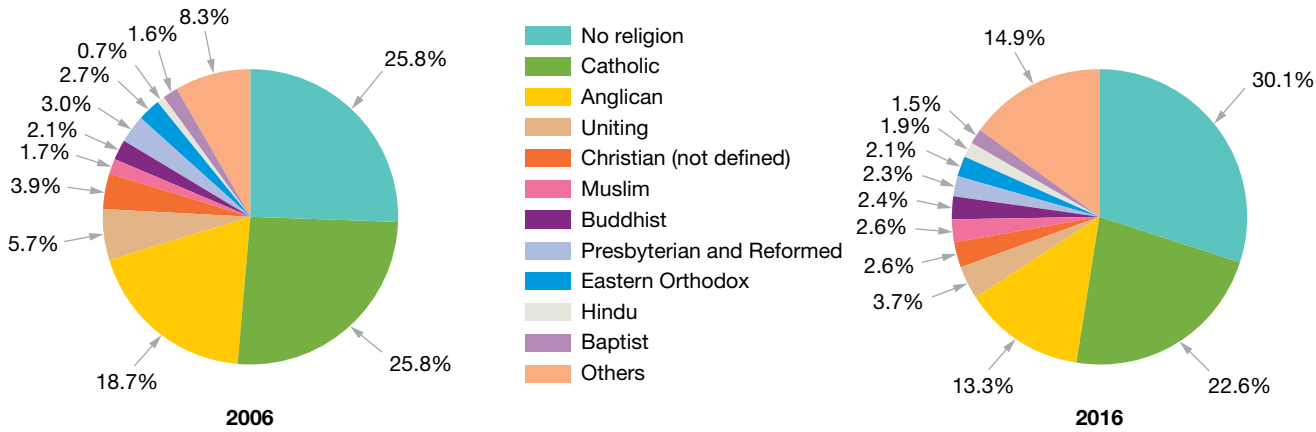
With increased tourism opportunities, people are able to visit cathedrals and other religious monuments far more easily than previous generations could. Muslims around the globe, who once thought they may never be able to make a pilgrimage to Mecca, now can with the increasing frequency and affordability of international flights. All these developments promote cultural integration and are a consequence of globalisation.

Religion in Australia

Cultural integration in Australia has seen religious affiliation change over time. Anglicanism was once the largest religious denomination in Australia's colonial years. The 2016 census showed that of the 52 per cent of people who say they are Christian, the largest group is now Roman Catholics.

In time, this may change again as Australians embrace different religions or no religion at all. Figure 10.2.10 outlines the change in Australia's religious affiliation between 2006 and 2016. See also Figure 10.2.9.

10.2.9 A Russian Orthodox church in suburban Sydney. As our society has become increasingly multicultural, Australia's religious diversity has grown.



10.2.10 Religious affiliation, Australia, 2006 and 2016 Census

Activities

Understanding the text

1. Identify some of the techniques that advertisers use to promote a product or service.
2. Explain why corporations such as Coca-Cola and McDonald's sponsor community-related activities.
3. Outline the role of sport in defining the Australian image.
4. Explain how the role of sport has changed in Australian society.
5. Explain how Australian sport has been influenced by the sports of other countries.
6. Explain why the music industry is described as being 'at the mercy of marketing and globalisation'.
7. Explain how globalisation has affected religion.

Working geographically

8. Working in groups, brainstorm the ways in which international sports have influenced Australia's culture. Share your findings with others in the class.
9. Working in groups, brainstorm the impact of US sports marketing on Australian teenagers. Share the key points of your group's discussion.
10. As a class, discuss the reasons why US sports have made little headway in securing commercial TV coverage in Australia.
11. Use the Australian Sports Directory website to access the sites of the major Australian sporting organisations. Compile a list of the principal corporate sponsors of each sport.
12. Research which companies are sponsoring major events in your city or town. Consider areas such as sporting events, the arts, cultural events and educational activities. Try to find out how much money each of these companies spends on sponsorship and advertising and how many of them are foreign owned.
13. Access the websites of the National Rugby League, Australian Football League and the Rugby Union. Compare these with the internet site of the NBA in the United States. Assess the extent to which the Australian sites reflect a US approach to sports marketing.
14. Investigate a song or artist that has been marketed without backing from music labels, or has used the internet to market their music in an innovative way.
15. Investigate the origins and spread of another music genre. Write a report outlining your findings.
16. Study Figure 10.2.10. Write a paragraph outlining the changes in religious affiliation in Australia from 2006 to 2016. Speculate on the reasons for these changes.

CASE STUDY

Fast food, global companies

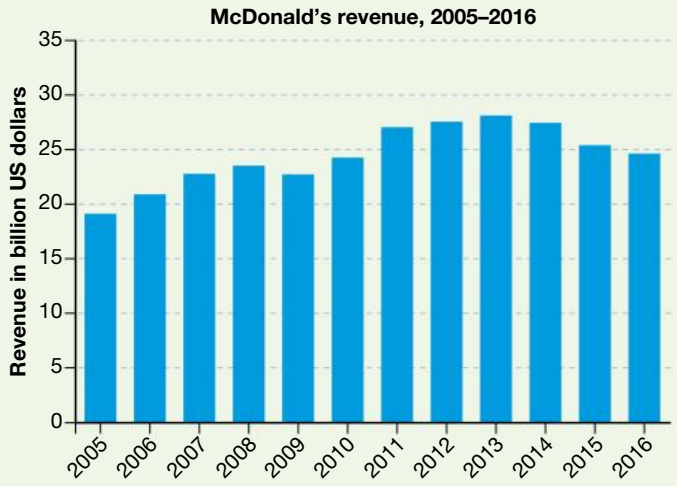
Fast food companies are at the forefront of mass consumer culture—diffusion, adoption and adaptation

The golden arches: spanning the globe

The McDonald's Corporation had its beginnings in 1955. Ray Kroc, a Multi-Mixer milkshake-maker salesman, received an order for eight Multi-Mixer machines from the McDonald brothers, the owners of a takeaway food outlet.

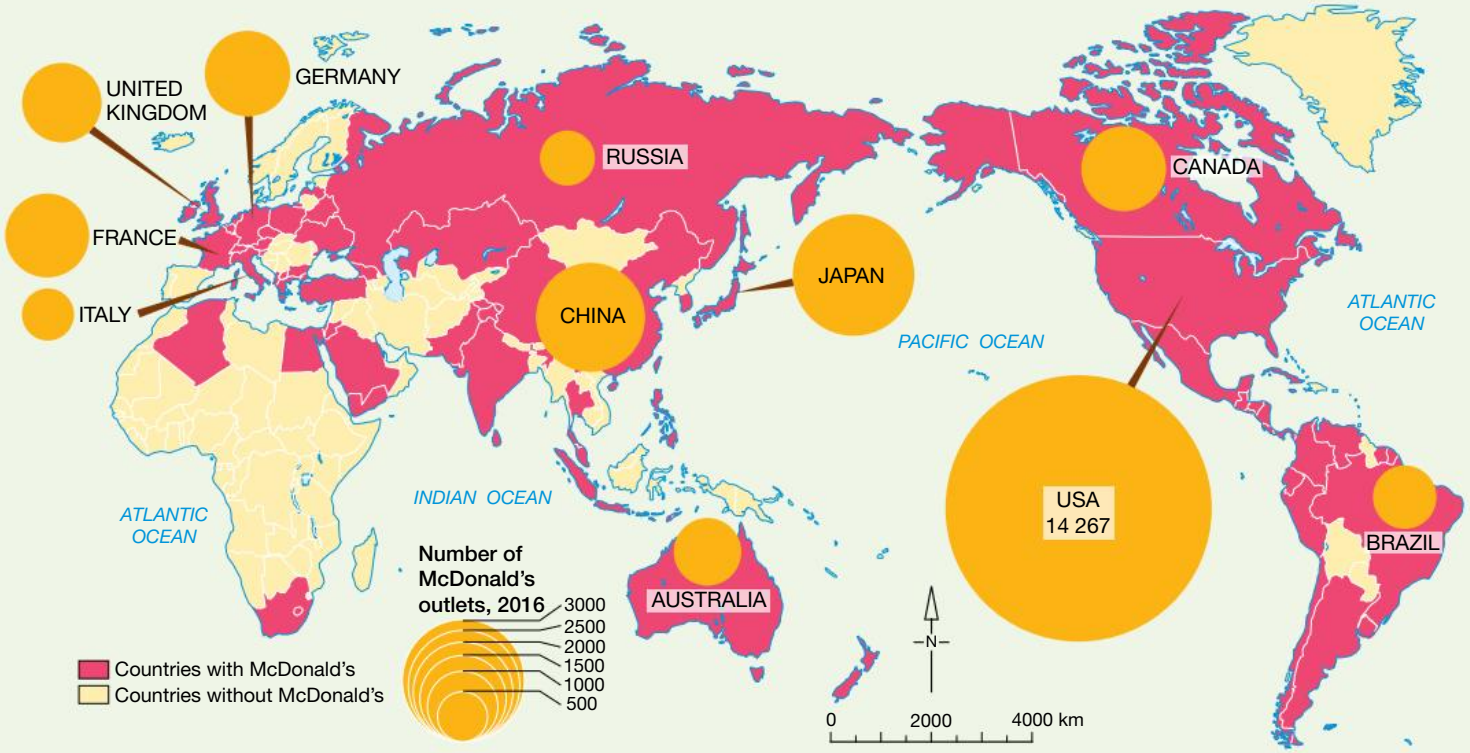
Ray was fascinated by the way the McDonald brothers operated their business. He convinced the brothers to allow him to open new McDonald's stores. In return, Ray agreed to pay the brothers 0.5 per cent of the gross sales of the new stores. Ray opened the first of the new stores in Illinois. He expanded his business by granting franchises to local entrepreneurs. By 1960 Ray had opened 200 outlets across the United States. In 1961 he bought out the McDonald brothers for US$3 million.

By late 2016, McDonald's had more than 36 900 outlets in over 119 countries (see Figures 10.2.11, 10.2.12 and 10.2.13). Every day, McDonald's serves 69 million people worldwide. A new store is opened somewhere in the world every 15 hours. McDonald's is one of the USA's largest corporations, employing 375 000 people directly and a further 1.5 million in its franchise operations. McDonald's revenues reached US$24 622 billion in 2016.



10.2.11 McDonald's revenue, 2005–2016

10.2.12 McDonald's in Zermatt, Switzerland



10.2.13 McDonald's global reach and 10 largest international markets (by number of stores, as of end 2016)

McDonald's promotes its products via extensive worldwide marketing campaigns. In developing countries, these campaigns target the young and the elite. The campaigns promote Western fast food as a fashionable alternative to traditional foods and also that they are more hygienic than local restaurants.

ADAPTATIONS

In some developing countries, governments have resisted the spread of Western-based fast-food retailers, such as McDonald's. India, for example, imposes tough rules on foreign entrants to its markets. Nevertheless, McDonald's established its first two outlets in India in 1996: one in Delhi, the other in Mumbai. To accommodate local religious beliefs, vegetarian burgers are on the menu, and a special egg-free based sauce is used. McDonald's also uses separate kitchen space and utensils to prepare vegetarian and non-vegetarian meals, a highly sensitive issue with traditional Hindus.

In Japan, customers can pair a Teriyaki McBurger, made from pork, with a bag of Seaweed Shaker fries. They can get a Croquette Burger or a Bacon Potato Pie. The most distinctively Japanese dish is the Ebi Filet-O, a fried shrimp patty on a bun.

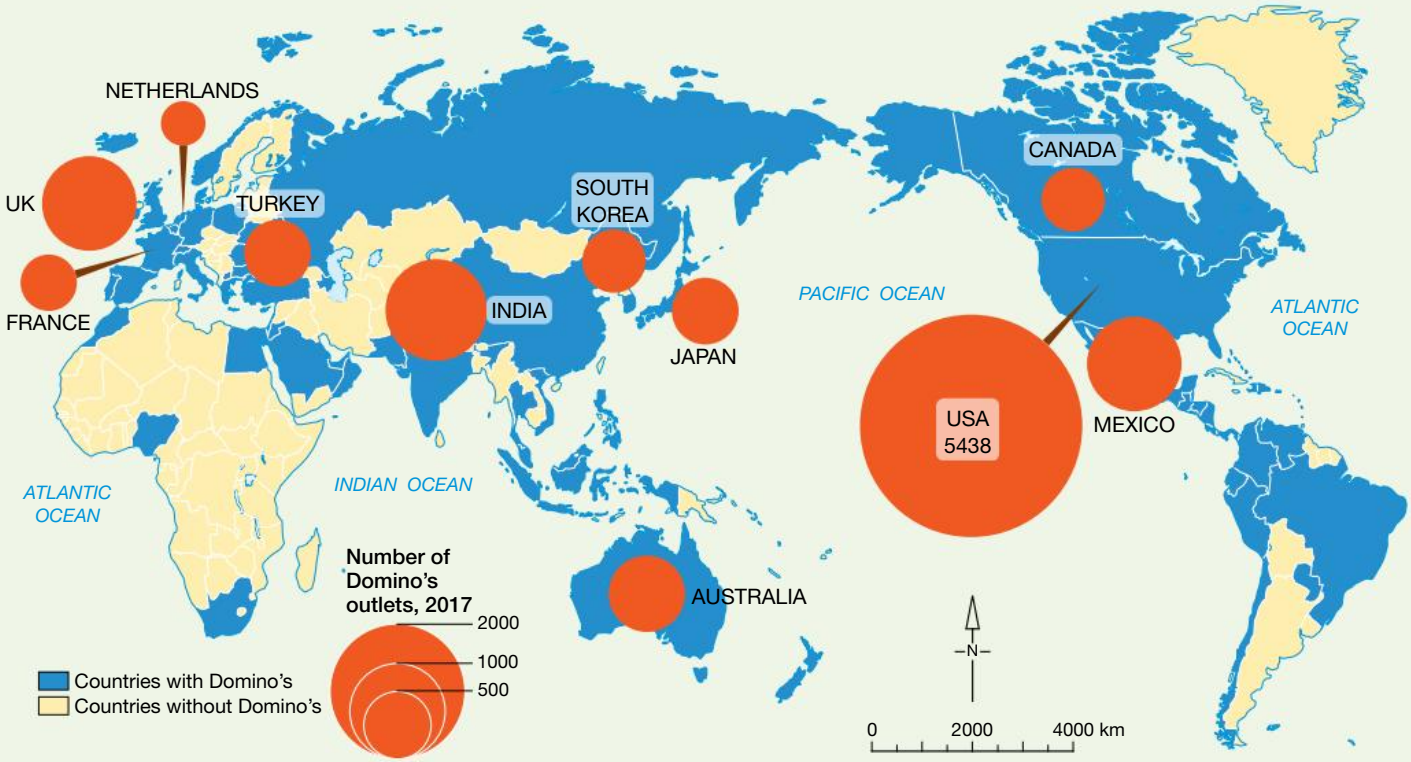
Domino's Pizza—Anywhere, any time!

Domino's Pizza is a large American-based pizza chain founded in 1960. It started out small—with just one store in 1960. By 1983, there were 1000 Domino's stores and by 1989, 5000. Today, there are over 14 200 stores in more than 85 countries, including more than 5000 outside the USA. (See Figure 10.2.14.)

In 2016 Domino's employed 260 000 people worldwide and had global retail sales of $10.9 billion. More than half of Domino's sales now come from outside the US ($5.3 billion domestic, $5.5 billion international).

Domino's is the largest foreign fast-food chain in India, seen in Figure 10.2.15. A key to its success has been its ability to craft a menu that appeals to local palates. It offers a corn and black olive pizza for vegetarians and *keema do pyaaza* (ground lamb and onions) for meat eaters.

10.2.15 Domino's store in Mumbai, India



10.2.14 Domino's global reach and its 10 largest international markets (by number of stores as of 2017)

Starbucks

Starbucks is a multinational coffeehouse chain with its corporate base in Seattle, the capital of Washington State in the United States. Named after the first mate in the novel Moby Dick, Starbucks is now the largest coffeehouse company in the world. By mid-2017, there were 24 000 Starbucks stores across 70 countries. (See Figure 10.2.16.)

Starbucks has expanded rapidly. In the 1990s, the company was opening a new store in the United States and Canada every workday, a pace that continued into the 2000s. Domestic growth has since slowed, but the company continues to expand internationally and continues to open, on average, seven new outlets a day worldwide. The first outlet outside North America opened in 1996. Almost one-third of all outlets are now outside the United States and Canada (see Figure 10.2.17).

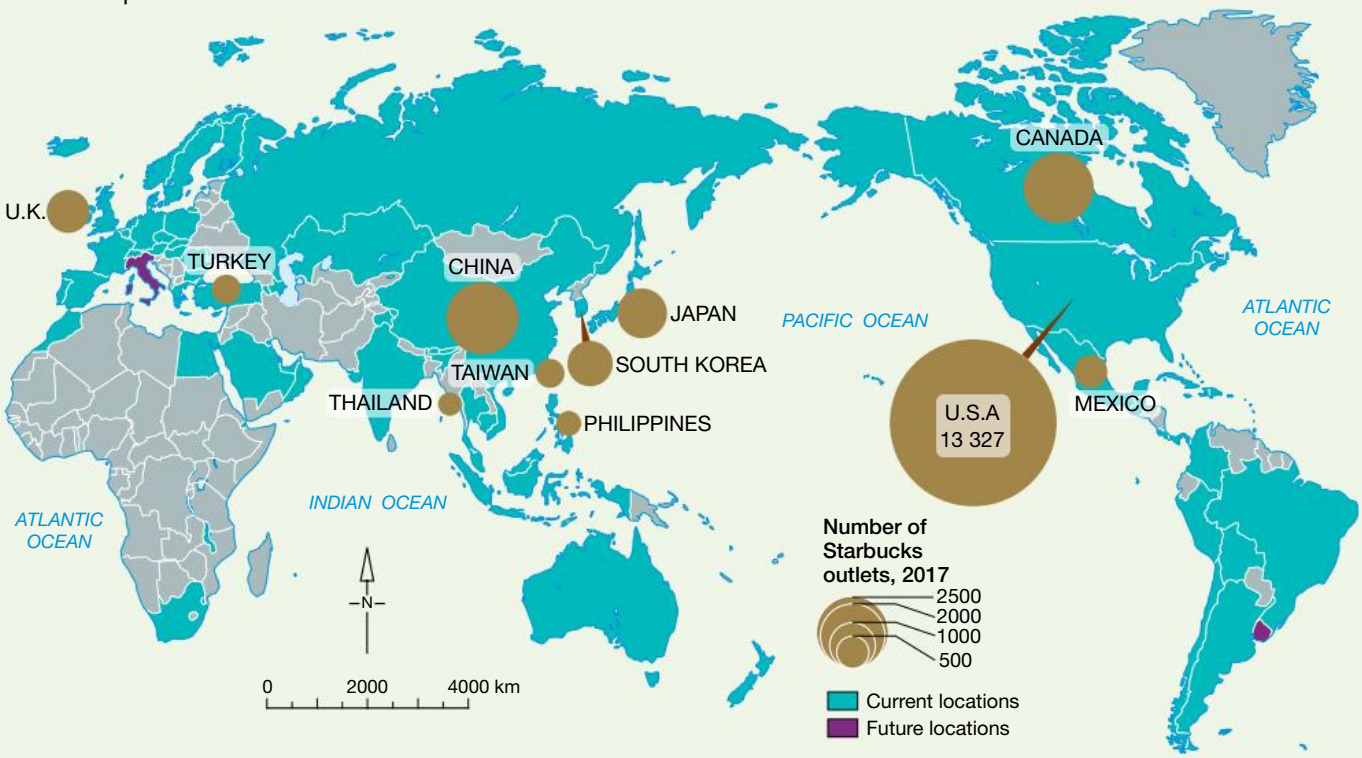
Starbucks' entry into the Australian market proved difficult. In 2008, Starbucks announced that it would close 61 of its 84 stores. Critics claimed that Starbucks had failed to understand Australia's sophisticated coffee culture—a product of post–World War II Italian immigration. Only 25 stores remain; thirteen of these are in Sydney.

10.2.17 Starbucks Coffee outlet in Geneva, Switzerland

Coca-Cola: the real global thing

Coca-Cola's first non-US bottling plants were built in Panama, Cuba and Canada in 1906. During, and immediately after, World War II the company spread to Europe, Africa and the Pacific. Eastern Europe has been the target of the most recent period of expansion. When the Berlin Wall was demolished in 1989, Coca-Cola rushed trucks of Coke into East Germany to claim the market ahead of its rival Pepsi.

When the first red and white Coca-Cola truck rolled into Warsaw, the capital of Poland, in the early 1990s, some of the locals stood by the side of the highway and applauded. They were not necessarily applauding Coca-Cola per se, but rather what the trademark represented to them: the life, colour and energy of Western commerce that could now be found in their rather drab environment.



10.2.16 Starbucks: the global reach of US fast-food culture. Largest foreign markets (by number of stores as of mid–2017)

Today Coca-Cola sells more than 450 brands and 3000 beverage products in over 200 countries, seen in Figure 10.2.18. Consumers drink 1.6 billion of the company's beverage servings a day. In 2016, Coca-Cola had global revenues of US$41.9 billion and a gross profit of US$8.5 billion. Coca-Cola is the best known of all the global brands. The company has 123 200 employees. Australia's Coca-Cola Amatil is one of the world's largest bottlers of Coca-Cola.

10.2.18 Regional share of Coca-Cola sales (as measured by total case sales, 2015)

Activities

Understanding the text

1 **a** Outline how McDonald's promotes fast food in developing countries.

b Outline the extent to which McDonald's adapts its products to meet local cultural traditions.

Working geographically

2 Study Figure 10.2.11. Using data from the graph, describe the trend in McDonald's revenues since 2005.

3 Study Figure 10.2.13. Identify those parts of the world where McDonald's does not yet have much of a presence. Speculate on the reasons for this absence. Identify the six countries with the largest number of McDonald's outlets outside the USA.

4 Outline the scale and global extent of Domino's business. In which parts of the world does it not operate? Identify the three biggest markets outside the USA.

5 Using the text and Figure 10.2.16, describe the global reach of Starbucks' operations. In which countries does it have the largest number of retail outlets? Explain why Starbucks has been largely unsuccessful commercially in Australia.

6 **a** As a class, discuss the claim that Coca-Cola represents the 'life, colour and energy of Western commerce'. What does this say about the willingness of people to adopt elements of Western popular culture?

b Study Figure 10.2.18. Describe the spatial distribution of the consumption of Coca-Cola unit sales.

7 Working in groups, list other consumer products that enjoy an international profile similar to that of Coca-Cola. Where do each of these products originate? What types of images are used to promote each product?

CASE STUDY

Iconic Australian brands, global presence

The global board sports market is dominated by three brands: Billabong®, Quiksilver™ and Rip Curl. While Quiksilver is now a US-listed public company, based in California, all three companies have their roots in the Australia.

Annual worldwide retail sales in the sector are now estimated to exceed US$5 billion. Billabong, Quiksilver and Rip Curl target the lifestyle-brand-conscious consumers in the 12- to 30-year-old age bracket, seen in Figure 10.2.19.

Billabong

Since its founding in 1973, Billabong International Ltd (a publicly listed Australian company) has grown into one of the world's leading designers, producers and distributors of apparel and accessories for surf and board sports. Billabong's products are sold in more than 90 countries by its directly controlled operations in Australia, New Zealand, North America, Europe, Japan and Brazil and through licensed operations and distributors in other regions.

As the demand for Billabong branded board shorts increased, a factory was first established at North Burleigh and then a larger one built at West Burleigh. During the 1980s Billabong went international when it began exporting clothing to California, Japan, New Zealand and Europe.

The company's strategy has been to gain worldwide exposure by having surfers endorse its products. Other brand-building strategies include promoting and sponsoring board sport events around the world.

Today, Billabong remains focused on the marketing, distribution, wholesaling and retailing of apparel, accessories, eyewear, wetsuits and hardgoods in the board sports sector under the Billabong, RVCA, Element, Von Zipper, Honolua Surf Company, Kustom, Palmers Surf and Xcel brands. After a series of financial losses and aborted takeover attempts, the company returned to profitability in 2015.

10.2.19 The original Billabong store in Surfers Paradise, Queensland

Quiksilver

In 1970, Australian surfers Alan Green and John Law formed a company, which they named Quiksilver.

By the mid-1970s, a small office/warehouse/distribution centre was opened in Newport Beach, California. McKnight and Hakman built up their business using word of mouth and their extensive personal contacts with the owners of surf shops. In order to raise capital, Quiksilver undertook an initial public stock offering on the New York Stock Exchange in 1986. Green and Law continued to play a role in the company's Australian-based operations until 2002. In that year they sold the last of their rights to the Quiksilver name for $125 million to the US operations. Today, the publicly listed US company's annual net revenue exceeds US$2.4 billion. It now controls a range of well-known brands, including Roxy.

A big key to the success of Quiksilver, seen in Figure 10.2.20, has been its roots in surf culture and its sponsorship of top surfers, snowboarders, skateboarders, and surfing events. In order to maintain its 'edgy' brand image, the company has gone to great lengths to distance itself from mainstream retailing and advertising campaigns.

10.2.20 Quiksilver retail outlet in Times Square, New York City

10.2.21 Rip Curl store in San Clemente, California: an iconic Australian brand with a worldwide presence

Rip Curl

Rip Curl was founded in 1969 by Doug Warbrick and Brian Singer at Torquay and is now a major Australian manufacturer and retailer of board-wear. From its initial focus on surfboards the company quickly identified the potential of adapting diving technology into a wetsuit suitable for surfing. Today Rip Curl produces not only surf gear but also apparel, mountain-wear, eyewear, watches, footwear, bags and DVDs. Rip Curl has become one of the largest board-wear brands in Australia, Europe and South America and is growing rapidly in North America, seen in Figure 10.2.21. Rip Curl remains a privately owned company.

Activities

Working geographically

Identify another popular brand you identify with and investigate its origins and global spread.

UNIT 10.3

Factors affecting cultural integration

When cultures interact they influence each other. Sometimes this occurs in quite subtle ways that do not enter the public's consciousness. On other occasions, the change may be more profound and become the focus of widespread community debate and protest. Any process that facilitates increased interaction between people will contribute to the process of cultural integration.

Factors affecting the rate and nature of cultural integration include technological change, the emergence of the global economy, TNCs, the liberalisation of world trade, the development of global media networks, and the actions of government.

The global economy

Economic activity forms an integral part of any culture. For this reason, it is important to gain an understanding of contemporary economic change and how it impacts on the lives of people.

The period from the end of World War II (1945) to about 1970 is often referred to as the 'long boom' because it was characterised by relatively high rates of economic growth in the countries of the developed world. Most of this growth, which peaked in the 1960s, was based on the production of consumer goods by multi-plant (multi-factory), multi-product firms.

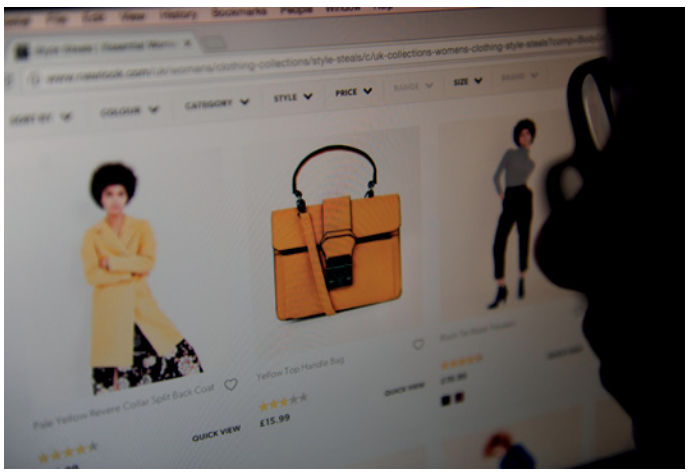
In the 1970s, ways of operating began to change. Firms endeavoured to expand by diversifying (that is, increasing the range of products they produced) or by increasing their market share. Mergers and corporate takeovers were common. By the late 1980s these processes had come to an end. In the 1990s, firms tended to concentrate on those core activities with which they had long-standing experience and left the non-core activities to specialist providers.

These changes occurred against a background of increasing international competition brought about by the emergence of the global economy: a system of interdependent national economies. The global economy is characterised by a system of production, marketing and finance that uses international trade and communication to move goods, money, information and people from one country to another.

Features of the global economy

The global economy has several features:

- It operates at a global scale. Money no longer respects borders. With the tap of a keyboard, US$5.4 trillion worth of foreign currencies is traded worldwide each day. The figure only appears as a blip on a computer screen but has the power to cause the downfall of an economy and, with it, the immediate plunge of millions of people into poverty.
- It is networked. Shoes from Italy and shirts from Hong Kong can be ordered and paid for online (see Figure 10.3.1). In terms of health issues, illnesses in Manila can be diagnosed by a doctor in Edinburgh and a second opinion obtained from a doctor in New York, all within hours of initial contact being made.
- It is based on information. In today's knowledge-based economy, intellectual capital drives the value of products. Therefore, rather than people manufacturing goods, more people are employed in service industries, particularly those involving IT.



10.3.1 Clothes from the other side of the world can now be ordered and paid for online.

- It decentralises power. The internet enables anyone to publish, email, create or download information anywhere in the world. However, access to these services is confined mainly to Western countries and a limited number of wealthy people in developing countries.
- It rewards openness. The fact that it is basically a censorship-free zone, where information and ideas can no longer be repressed with ease, can be both a positive and negative aspect of globalisation.
- It is becoming more specialised. Goods can be ordered online directly from the producer, cutting out the wholesaler and retailer. Websites can be used to 'customise' a product; the consumer can select from a range of features, which the manufacturer then incorporates during the production process.
- It is difficult for governments to regulate. Laws in place to protect consumers in one country may not exist in another country.
- It can be manipulated. Some of Australia's biggest companies have had their share price drop dramatically due to market rumours on social media and in particular Twitter™.

These changes and the impacts they have on people are the result of a set of processes generally referred to as economic restructuring: the significant and enduring changes in the nature and structure of the economy brought about primarily by the emergence of the global economy.

Economic restructuring

The impacts of economic restructuring can be observed at a variety of geographical scales, from the global to the local. Economic restructuring has led to the rapid movement of money and other resources into and out of industries and sectors. Within the countries of the developed world, it has often involved the development of new conditions under which work is carried out and rewarded.

Rapid technological change and ongoing economic restructuring threatens to increase inequality and contribute to the development of a two-tier society. Workers who lack the necessary skills run the risk of being left behind. This will open the way for increased social disruption caused by retrenchments, factory closures and changes to the way production is organised. As the shift from the industrial era to the digital age continues to take place, this will become an all too common feature of our society.

Some commentators refer to the structural changes occurring, mainly in the countries of the developed world, as 'de-industrialisation'. De-industrialisation is defined as the relative or absolute decline in manufacturing employment. It is sometimes associated with a process known as 'jobless growth', where production increases without an increase in employment. A characteristic of the post-industrial society is the increased demand for services, resulting in the service sector becoming the dominant form of employment (see Figure 10.3.2).

ICT Development Index

Each year the International Telecommunications Union publishes the ICT Development Index (IDI) which provides a comparison of the state of the ICT development across various countries around the world. The report comprises 11 indicators. These are grouped into three sub-indices—access, use and skill. The ICT Development Index is an important tool for governments, researchers and development agencies as it enables them to measure the digital divide or compare the ICT performance within their nation or across the world. The index has taken into account 175 countries which have scored between the range of 0 and 10: 0 is the worst, while 10 is the best.

10.3.2 Services, such as physiotherapy, are increasingly becoming the dominant form of employment in a globalised world.

SPOTLIGHT

The digital divide

ICT Facts & Figures 2016 shows that developing countries now account for the vast majority of internet users with 2.5 billion users, compared with one billion in developed countries. But internet penetration rates tell a different story, with 81 per cent in developed countries, compared with 40 per cent in developing countries and 15 per cent in the least developed countries. By the end of 2016, more than half of the world's population—3.9 billion people—were still not yet using the internet. Almost one billion households in the world now have internet access (of which 230 million are in China, 60 million in India and 20 million in the world's 48 least developed countries). However, figures for household access reveal the extent of the digital divide, with 84 per cent of households connected in Europe, compared with 15.4 per cent in the African region.

The components of the ICT Development Index and weightings		
Criteria	**%**	**Weighting (%)**
ICT access		
1 Fixed-telephone subscriptions per 100 inhabitants	20	40
2 Mobile telephone subscriptions per 100 inhabitants	20	
3 International internet bandwidth (bit/s) per internet user	20	
4 Percentage of households with a computer	20	
5 Percentage of households with internet access	20	
ICT use		
6 Percentage of individuals using the internet	33	40
7 Fixed-broadband subscriptions per 100 inhabitants	33	
8 Active mobile-broadband subscriptions per 100 inhabitants	33	
ICT skills		
9 Adult literacy rate	33	20
10 Secondary gross enrolment ratio	33	
11 Tertiary gross enrolment ratio	33	

10.3.3 The components of the ICT Development Index and weightings

Details are outlined in Figures 10.3.3 and 10.3.4.

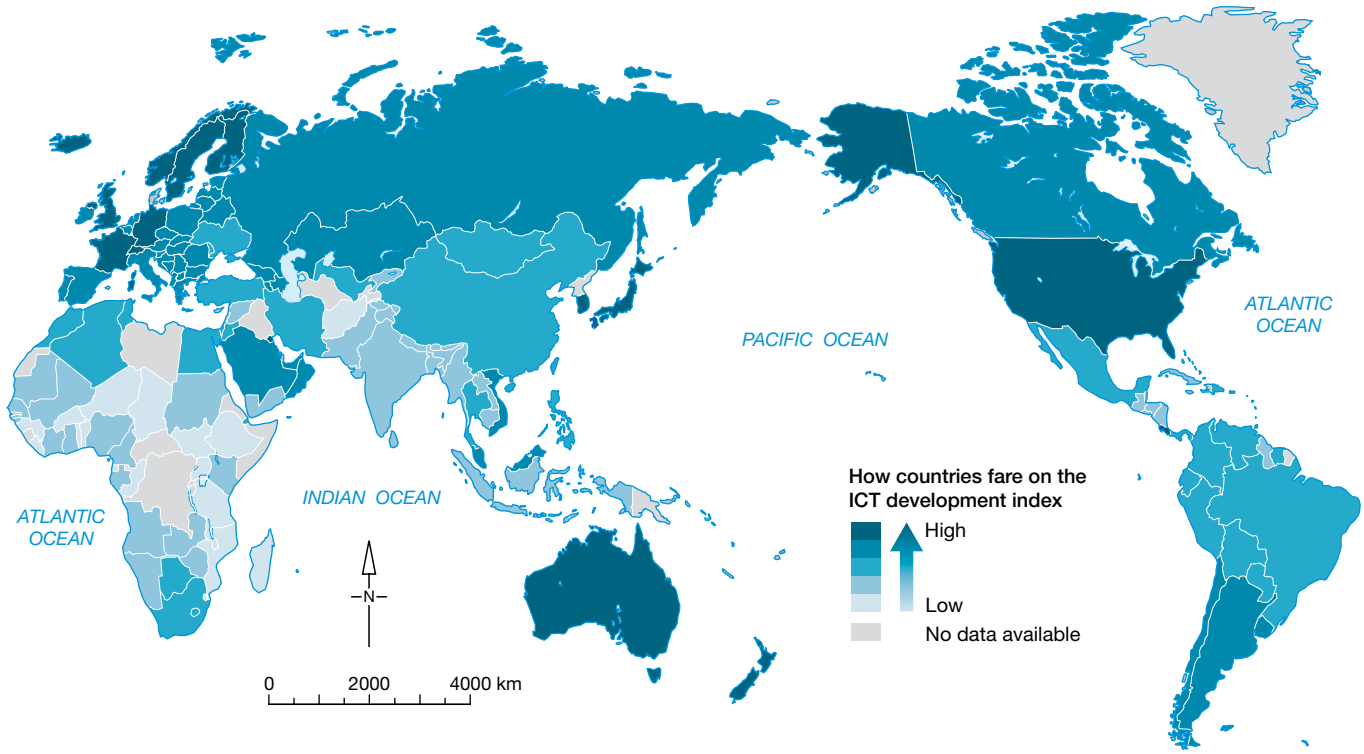
New technologies, new crimes and less privacy

While there are many positive aspects associated with new technologies, their negative aspects are not always immediately clear. Two such aspects are the rise in new types of crime, and the potential threats to security and privacy; both are a consequence of these new global technologies.

Crime

Computers do not necessarily increase crime, but they do allow for new methods of committing crime. Because money can be moved about electronically, thefts can be committed without leaving any physical evidence.

Theft of knowledge and data is even easier. The speed and ease with which electronic data can be accessed makes it difficult to enforce copyright and patent laws. (A patent is a document granting an inventor sole rights to their invention.) New knowledge can be stolen as fast as it is uploaded. In addition, the owners of such intellectual property have little or no way of controlling or even knowing who is using their property. International copyright laws grant and protect creators' exclusive rights to publish and sell literary, musical or artistic work. These laws have been under scrutiny recently because of software piracy in South-East Asia and China. Piracy involves illegally duplicating software for commercial or personal use.



10.3.4 ICT Development Index, 2017. The index measures a country's ICT capabilities in terms of access, use and relevant skills.

Types of computer crime include:

- **Hacking:** This involves gaining illegal entry to electronic networks and the data contained therein. These data may be 'stolen', have their copyright infringed or used illegally to gain a commercial advantage.
- **Virus creation:** These are self-copying programs that, in general, are designed to create a nuisance, disable or even destroy computer systems and data.
- **Slicing:** This is the accumulation of the various fractions of a cent from account transactions in banks or retail stores. Fractions of a cent are normally rounded up or down but can instead be 'siphoned' off into a criminal's account.
- **Creation of false records:** Examples are creation of fake IDs, forgeries and false financial transactions, which might involve huge amounts of money.

Due to the widespread availability of computer technology, every task or purpose to which computers can be put legally can also be used for illegal purposes.

Privacy

Databases exist today that store information about every person who has ever made an application for a loan, caught the attention of government security organisations, opened a savings account, applied for a passport or gained a driver's licence. If your name has been recorded for any purpose, chances are that you are in at least one database. Concerns about security and privacy of databases have further intensified now that databases have recently become commercial products. Databases may store information about a person's credit limit (from credit card records); address (from a phone directory on the internet); buying history (from any credit card transaction throughout the world); assets (from banking records of money lending); criminal records (from police files); and education (from school examination results and university records). All these details provide organisations and other people with a considerable amount of knowledge about individuals. This can often be accessed without the person's permission.

Many of these databases are freely bought and sold between large corporations. In the United States, these 'mailing lists' can sell for more than US$100 000 and the practice has begun in Australia, too. People are placed on mailing lists for 'junk mail' on the basis of their socioeconomic status, family size and age group. Certain companies make use of this information to sell particular products to selected individuals. Some organisations know more about your financial activities than you do.

The computer has also become the heart of police and military intelligence and surveillance systems due to its capacity for information storage, seeming infallibility, extensive search facilities and access to other computers.

SPOTLIGHT

Smartphones

In 2007, the first smartphone was released by Apple: the iPhone. Since that time technology companies have created new 'must-have' features in order to encourage consumers to update their phone rather than continue to use their existing one. Ten years later in 2017, Apple released the iPhone X (see Figure 10.3.5). The smartphone now has high-res, edge-to-edge screen technology as well as facial recognition.

10.3.5 Apple CEO launches the iPhone X in September 2017

SPOTLIGHT

Social media's role in the 2016 US presidential election

Following the 2016 US presidential election, authorities expressed alarm at the influence of social media, and specifically 'fake news', on democratic processes.

Recent studies have shown that 62 per cent of US adults get news from social media sources. It has also been shown that fake news stories were more widely shared on Facebook than the most popular mainstream news stories. Many people who see fake news stories also report that they believe them.

'Fake news' (see Figure 10.3.6) is a form of disruptive journalism or propaganda that consists of deliberate misinformation or hoaxes published most commonly on social media. Fake news is designed to mislead in order to damage an opponent and/or make a financial or political gain. It results in sensationalist, exaggerated or patently false headlines that grab attention. A number of commentators and political scientists have suggested that Donald Trump would not have been elected president were it not for the influence of fake news.

10.3.6 This fake news story posted on the internet falsely claimed a presidential candidate sold weapons to the terrorist group ISIS.

The world's top 30 economic entities		
Rank	**Entity**	**Revenue (US$ billions)**
1	United States of America	3251
2	China	2426
3	Germany	1515
4	Japan	1439
5	France	1253
6	United Kingdom	1101
7	Italy	876
8	Brazil	631
9	Canada	585
10	Walmart	482
11	Spain	474
12	Australia	426
13	Netherlands	373
14	State Grid Corporation of China	330
15	China National Petroleum	299
16	Sinopec Group	294
17	Korea, South	291
18	Royal Dutch Shell	272
19	Mexico	260
20	Sweden	251
21	Exxon Mobil	246
22	Volkswagen	237
23	Toyota Motor Corporation	237
24	India	236
25	Apple	234
26	Belgium	227
27	BP	226
28	Switzerland	222
29	Norway	220
30	Russia	216

* Only 20 of the world's top 30 largest economic entities in 2016 were countries. The rest were corporations.

10.3.7 The world's top 30 economic entities (countries/corporations), 2016*

Transnational corporations (TNCs)

Central to the development of the global economy has been the emergence of TNCs, which are businesses that operate internationally. The production and distribution of goods and services is increasingly dominated by these corporations, most of which are based in the developed world.

Although the earliest TNCs date from the mid-nineteenth century, it was not until the 1950s that their numbers began to increase significantly. As they grew, their economic dominance increased rapidly.

Most TNCs are very large. Of the world's 100 largest economic entities, 72 are corporations (72 per cent). Walmart, State Grid, China National Petroleum, Royal Dutch Shell, BP, Exxon, Volkswagen, Toyota Motor Corporation and Apple all rank in the 25 largest entities in the world, above countries such as Belgium, Switzerland, Norway, Russia, Finland and Ireland. In 2016, only nine countries in the world had revenues larger than the world's largest TNC: Walmart of the United States.

Another way to look at the power of TNCs is to recognise that sales of the world's 10 largest companies exceed the combined gross national product (GNP) of the world's 100 economically least developed countries, including all the countries in Africa. The 300 largest TNCs own or control at least one-quarter of the entire world's productive assets, worth about US$5 trillion. As Figure 10.3.7 shows, only 20 of the world's 30 largest economic entities in 2016 were countries. The rest were corporations.

Growth of TNCs

Most TNCs started out as small enterprises producing goods for sale in their domestic markets. Initially they used their profits to expand locally, often taking over other businesses within their particular industry. Before long some firms outgrew their domestic market and sought to expand overseas. Usually this involved the establishment of an overseas subsidiary through direct investment. During the 1960s and 1970s, many developing countries that had been a target of direct TNC investment tried to exercise some control over TNC activities by insisting on a degree of local equity (ownership and control) in such investments.

Partly in response to these restrictions, TNCs have developed systems of corporate control that, while not requiring direct ownership of capital (such as factories), still enable them to exercise control over the production, marketing and distribution of products, just as they did during the colonial era. To achieve this, they retain the ownership of a product, usually by a patent. Most TNCs now operate through a combination of joint ventures, licensing and franchise agreements, production agreements and subcontracting. This combination of processes, which is similar to those of the computer industry, is sometimes referred to as 'networking'.

Method of operation

The main goal of a TNC is to generate a profit, which can then be reinvested with the aim of accumulating additional capital (wealth available to a business, in the form of money or assets). By minimising the costs of production and by creating a worldwide demand for their products through global marketing campaigns, TNCs are often able to generate massive profits and minimise the amount of tax paid (see Figure 10.3.8). These profits are then returned to the parent company based in a developed country or 'parked' in a low taxing jurisdiction such as the Irish Republic. Very little of the profits ever reach the poorly paid, low-skilled workers of the developing world.

The proliferation of TNCs and the growth of the global economy has, to some extent, diminished the sovereignty of the individual nation-state. Decisions made by TNCs are usually for the good of the company worldwide and may not be in the best interests of the individual countries in which TNCs operate.

10.3.8 Many people are critical of the actions of large TNCs, especially those related to tax minimisation.

Decisions made in the boardrooms of New York, London and Tokyo, for example, can affect employment opportunities throughout the world. Individual national governments may be unaware of these decisions until after they have been made.

Small firms going international

Many experts, speculating about the future of large TNCs within the global economy, believe that the influence of these corporations will diminish. They believe this will occur as a growing number of small- to medium-sized firms take advantage of the growth and accessibility of the global economy. Factors enabling small- to medium-sized firms to go international include those listed below:

- Trade barriers have been removed. This has enabled small firms to gain access to markets that were once the preserve of the large corporations.
- Access to computer and telecommunications technology is no longer restricted, because of cost, to large firms.
- Financial markets have been deregulated. This has given small- to medium-sized firms access to capital investment.
- Consumer tastes have converged across borders as global TV and online marketing campaigns promote an ever-increasing range of lifestyle products and options.
- There is access to, and replication of, quality around the world. Smaller firms are often better placed to respond to changes in the patterns of consumption because they are better able to adapt production to shifts in demand.

The benefits that large corporations derived from economies of scale are no longer apparent in a global marketplace that demands innovation and responsiveness. Trade data from the United States confirm this trend. There is evidence from the United States that small businesses send their exports to a greater diversity of countries compared with medium-sized and large firms. One explanation for this is that small firms are more flexible and therefore better equipped to take advantage of small export markets. These markets may not be attractive to larger businesses that focus on reducing costs through economies of scale.

SPOTLIGHT

Sydney's 'global arc'

When work on IT, or 'micro-electronics' as it was then called, first began in the United States in the 1960s, it began in a place known as 'Silicon Valley'. Silicon Valley is located on the west coast of the United States, in the San Francisco Bay area. Today, versions of Silicon Valley are emerging all over the world. In Sydney, an 18-km stretch between Macquarie Park and Sydney airport, taking in North Sydney and Sydney's CBD, has become the new 'high-tech heartland' of the city. It is also commonly referred to as 'global Sydney' because it houses the offices of many of the corporations that are key players in the global economy.

Activities

Understanding the text

1 Explain how new technologies have transformed the ways in which cultures interact.

2 Outline how the behaviour of firms changed in the 1970s and 1980s.

3 Explain what is meant by the term economic restructuring. Outline some of the impacts of economic restructuring.

4 Outline the role played by TNCs in the global economy.

5 Explain the concept of 'networking' when it is used to describe the manner in which TNCs operate.

6 Explain how TNCs respond to attempts by certain developing countries to exercise some control over their activities.

7 List the factors that have enabled small- to medium-sized firms to go international.

Working geographically

8 As a class, discuss the reasons for the increasing international dominance of English.

9 As a class, discuss the view that the internet is a 'culture killer'. Is the description justified?

10 a Working in groups, list the technological innovations that have been introduced in your lifetime. How have these innovations changed the way people and cultures interact?

b Identify the criteria used to develop the ICT Development Index.

c Study Figures 10.3.3 and 10.3.4. With the aid of an atlas, describe the global pattern of digital opportunity expressed in terms of access, use and relevant skills. Outline the extent of the 'digital divide' in the world today.

11 a Explain why copyright and patent law are difficult to enforce.

b List the types of computer crime. Explain each. List any others that you can think of.

c Outline the privacy concerns associated with the new information technologies.

d Write a report outlining the costs associated with the introduction of the new technologies, particularly as they relate to crime and privacy.

12 As a class, discuss the potential dangers you can see if security breaches continue to occur in global computer networks.

13 Conduct a class debate. Topic: 'National security agencies should have access to companies' computer files.'

14 As a class, discuss what precautions, if any, could be put in place to protect database information. Consider why this is such a difficult undertaking.

15 Investigate the role of social media in the 2016 US presidential election. To what extent was the nature of social media used by those who sought to disrupt and/or influence normal democratic processes?

The liberalisation of world trade

Central to the growth in the international movement of goods and services and the emergence of the global economy has been the liberalisation of world trade and a reduction in the costs of transport. Liberalisation of world trade is the removal of obstacles to free trade, such as:

- quotas (maximum or minimum amounts of a product a business is allowed to produce)
- tariffs (nominal and effective rates of protection)
- exchange controls (government restrictions on the movement of currencies between countries).

The ability to move goods and services rapidly has been largely dependent on the removal of trade barriers.

The World Trade Organization

The World Trade Organization (WTO) is the international body that oversees the measures designed to reduce levels of protectionism and foster an expansion of international trade. Increasingly, the WTO is the focus of protests by those opposed to the process of globalisation. Meetings of the Group of Seven (G7) regularly attract violent demonstrations, shown in Figure 10.3.9. The G7 is an international forum for the governments of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

10.3.9 Anti-globalisation protest in Turin during the G7 meeting in Italy, 2017

Trade agreements

Trade liberalisation has also taken place via regional trade agreements. These agreements aim to facilitate the movement of goods and services between member states. The most notable international trade-based groupings include the European Union (EU), North American Free Trade Association (NAFTA) and Asia-Pacific Economic Cooperation (APEC). Of these, the EU is the most advanced. The EU's function now goes well beyond trade-related issues. It has introduced its own currency (the euro) and the movement of people across international borders has been deregulated.

The European Union

The European Union (EU) is the world's most powerful trading bloc. Formed in 1957 as the 'European Community', it currently has 28 member countries with a combined population of more than 490 million people. Among the goals of the EU are economic and political integration. There is free trade between member states, and common labour and industrial laws now apply.

In the late 1990s, the EU (except for Britain, Denmark, Greece and Sweden) voted to introduce a single currency: the euro. Nineteen countries now share the single currency. This has made travelling between countries easier. It has also done away with the systems of currency that were once unique to each country. This is not just a technical change of currency; it is the creation of a new economic bloc (known as the Eurozone).

In June 2016, citizens of the United Kingdom voted to leave the European Union. In March 2017, the UK formally notified the European Council of its intention to leave. The lengthy negotiations needed to bring about the break are underway.

SPOTLIGHT

Protests and popular culture in response to the WTO

The anti-globalisation movement has influenced popular culture in a variety of ways. Several punk rock bands, for example, have aligned themselves with the movement. Bands such as Anti-Flag (whose song 'Seattle Was a Riot' was inspired by the 1999 Seattle protests against the WTO), Pennywise (who wrote the song 'WTO' in protest to the actions of the WTO) and Against Me! (the chorus to their song 'Baby, I'm an Anarchist' refers to the Seattle riots).

Rage Against the Machine used footage of the protests and subsequent police actions in their music video 'Sleep Now in the Fire'.

Other protests have taken inspiration from the WTO (anti-globalisation) protest movement. One of the most newsworthy was the Occupy Wall Street protest movement that began in late 2011 in Zuccotti Park in New York City's financial district. The protest gained international attention and resulted in a worldwide movement against economic inequality.

Criticisms of trade liberalism

Trade liberalism has not been without its critics. Those adversely affected by the economic restructuring initiated by the removal of protectionist policies often feel alienated from political processes. In the USA, those affected by manufacturing job losses in the old industrial 'rust belt' states of the north-east were instrumental in electing President Donald Trump. Trump appealed to those who felt alienated by promising to scrap or renegotiate trade agreements such as NAFTA.

As a result of the expansion of world trade, many corporate executives of large TNCs claim that their firms have grown beyond a narrow national interest to become more global in their outlook. All of this is done in the name of advancing global competitiveness. Many people, however, question the cost of these changes, especially in terms of their impact on people and the environment.

DID YOU KNOW?

In a recent survey of young Australians aged eight to 16, roughly one-third indicated that they felt they could distinguish fake news from real news. One-third felt they could not make this distinction. The other third were uncertain about their ability.

Global media

The media, in all its forms, remains the single most influential promoter of cultural integration. In light of the emergence of fake news it is important to understand the changes taking place within the industry, most notably the shift from national to global media networks and the rise of social media.

Until the mid-1990s, electronic media was dominated by free-to-air broadcasters, operated by both the public and private sectors at a regional and national scale. The regulation of these broadcasters centred on the notion of 'public interest', a belief that broadcasters should promote cultural and political unity.

The mechanisms used to regulate the industry included control over the granting of broadcasting licences, restrictions on foreign content and rules limiting the concentration of media ownership. In the mid-1980s, the major commercial operators were able to negotiate a regulatory framework less reliant on the principle of public interest and more accommodating of commercial considerations. These operators had been encouraged by a shift in government policy towards deregulatory models of economic management. Viewers were no longer seen as members of a particular community, but as members of a consumer market. In Australia, as elsewhere, regionally based TV stations were progressively absorbed into national networks in a process known as aggregation. This process has now gone one step further. We are now seeing the increasing dominance of global media organisations who utilise new forms of delivery.

Evolving media technologies

Over the past two decades, the entertainment and telecommunications industries have replaced the military as the driving force behind technological innovation. Billions are being spent on research and development. New technology-based products are released onto the market every day, many of which are superseded within months by faster, more powerful models. Technologists are working overtime to keep up with global demand.

Many of the technologies are converging. This means that they can perform an increasingly sophisticated range of functions. TV and internet technologies have, for example, merged as a result of digitisation.

Digital TV has a range of advantages, including the following:

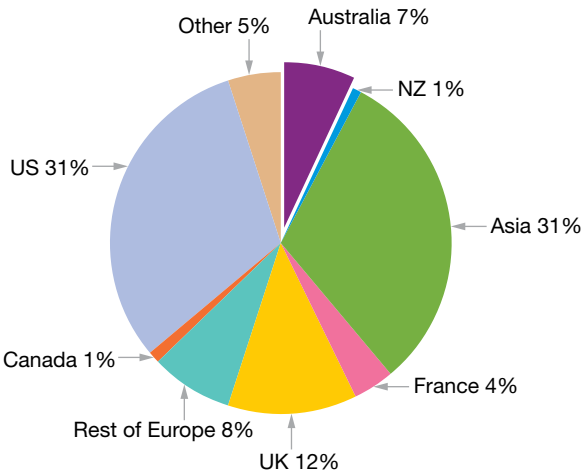
- Superior image resolution improves the quality of TV viewing. High-definition digital TV (HDTV) has enabled further gains in this area.
- Digital TV facilitates multi-channelling, whereby broadcasters provide more than one channel at the same time. For example, a cooking show may offer online shopping of ingredients in real time and in conjunction with a how-to-cook segment.
- Digital TVs are internet-connected. Shopping, banking, gambling, or simply ordering take-away—everything achievable online can also be achieved via your digital TV set; the line between distinct technologies are increasingly becoming blurred.

Cultural imperialism

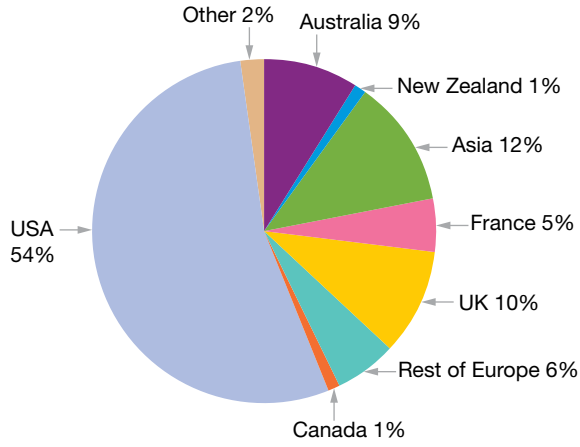
American fast food, fashion, music, TV, books, magazines and especially movies are universal elements of the emerging global culture. Their dominance is so widespread and pervasive that critics now refer to the process as cultural imperialism: the dominance or hegemony of one culture over all others.

Television and cinema

In the case of television and cinema, there is plenty of evidence to support suggestions of cultural imperialism. US-based media organisations, for example, produce over 75 per cent of the TV programs shown around the world. In Australia, the cultural presence of the United States is particularly strong. Australian TV has a heavy reliance on US-produced programs. The same can also be said for Australian cinema. The vast majority (some 54 per cent) of films screened in Australian cinemas over the past three decades have come from the United States. In contrast, local titles over the same time period account for just 9 per cent of all films. The US dominance is even greater when it comes to box office earnings: over 80 per cent of tickets sold in 2016 were for US-produced films.



10.3.10 Origin of films screened in Australia, 2016



10.3.11 Origin of films screened in Australia, long-term average, 1984–2016

Worldwide cinema revenues are projected to grow from US$38.3 billion in 2016 to US$49.3 billion in 2020. In 2016, box office revenues in North America reached US$11.38 billion. Apart from North America, some of the leading box office markets worldwide include China, Japan and India. The origin of films screened in Australia in 2016 is shown in Figure 10.3.10 with the 1984–2016 average shown in Figure 10.3.11.

There are those who regard the process of cultural integration as far more complex than simply the spread of American popular culture. They argue that globalised culture is really a hybrid culture: the result of the intermingling of cultures. This is most noticeable in countries with a multi-ethnic mix, such as Australia. In such a context, American popular culture becomes just one of many elements contributing to cultural change.

Actions of governments

The difficult task of managing economic globalisation while maintaining some degree of social cohesion and cultural identity is common to all countries. On one hand, many governments have actively promoted the process of cultural integration. They have done this by deregulating their economies, encouraging the introduction of new information-based technologies, supporting immigration programs and promoting multiculturalism. Other governments, while generally welcoming the perceived benefits of economic integration, fear that the introduction of American popular culture and excessive commercialism will destroy local cultures.

In particular, the countries of Europe and Asia have sought to protect themselves against the influence of American values and attitudes. In Europe, for example, governments have imposed quotas and local content targets to nurture local film industries and preserve local cultures.

Some countries, including Vietnam, have taken a more aggressive approach and banned the importation of 'reactionary, depraved or superstitious cultural products or those harmful to aesthetical or personality education'. This includes films, magazines and videos deemed to feature 'unwholesome' content. The government blocks access to politically sensitive websites and requires internet cafe owners to monitor and store information about users' online activities. It also outlaws the posting of internet content that opposes the Vietnamese government, national security, public order, customs and traditions, or national unity; that offends the reputation of an individual or group; or transgresses a number of other ill-defined areas of concern.

The French have been particularly conscious of the impacts of cultural integration. The government goes to considerable lengths to protect the integrity of French culture. It has used both restrictive legislation and incentives to restrict English language material in France, especially US computers and software. Rather than allow the French language to absorb or adopt words from other languages, the French create new French words.

In some cases governments, most notably North Korea, have used authoritarian measures to isolate their people from outside cultural influences. These measures include political repression, control of the media, limited access to communications technology, and restrictions on travel to and from the country.

SPOTLIGHT

Technology shaping culture in North Korea

North Korea has a centralised government under the rigid control of the communist Korean Workers' Party and Supreme Leader Kim Jong-un (see Figures 10.3.12 and 10.3.13). One of the key policies of this regime has been to strictly limit access to foreign media and Western cultural influences. Few North Koreans, for example, have access to the internet. Only those with special authorisation are permitted to use it.

10.3.12 North Korean military parade, April 2017. The North Korean government attempts to prevent its people accessing Western cultural influences.

10.3.13 North Korea's repressive Supreme Leader Kim Jong-un, September 2017

While some North Koreans gain access to smartphones smuggled through northern China, the North Korean government attempts to block their access to information via sophisticated filtering and blocking systems. These systems block access to websites containing information considered detrimental or hostile to North Korea's regime.

Despite such measures, three million North Koreans now have mobile-phone subscriptions using North Korean devices. While users can access and trade information within the country, blocking devices are used to prevent access to information from across the country's borders. Foreign films and TV shows, all of which are banned in North Korea, are sometimes smuggled into the country on USB sticks.

Activities

Understanding the text

1 Outline the changes that have taken place in the media since the 1970s.

2 Describe the factors that have contributed to the emergence of global media networks. What is the objective of global media networks?

3 Outline the impact that the internet and smart TVs are having on the way people interact with the media.

4 Explain what is meant by the term cultural imperialism.

5 Outline evidence to support the view that the world's cultures are threatened by US cultural imperialism.

6 Outline the problem that governments face when trying to manage economic globalisation.

7 Explain the conditions under which a hybrid culture develops.

8 Outline some of the ways countries have sought to protect local cultures.

Working geographically

9 Explain the purpose of trade agreements made at a regional scale.

10 As a class brainstorm the ways in which smartphones have redefined how we interact with others and access information. In what ways have they affected our behaviour?

11 Collect news articles relating to technological change. Write a synopsis of each and use the information to enhance your written responses to assessment tasks.

12 Investigate the impacts of economic restructuring in your local community.

- a Have any businesses closed? If so, what reasons were given for the closure?
- b Have any new industries been established?
- c How has employment in the local area been affected?

13 Use the media and internet to collect information relating to economic restructuring. Outline the social costs of economic restructuring.

14 Write a discussion. Topic: 'The benefits of economic restructuring outweigh the social costs.'

15 Use the internet to investigate the opposition to the activities of the WTO. Why do many developing countries and human rights groups oppose the WTO's decision-making processes?

16 Study Figures 10.3.10 and 10.3.11. Identify the principal source of films screened in Australia in 2016. How did this vary from the long-term average (1984–2016)?

CASE STUDY

Global media networks

The process of globalisation is transforming the global media industry. This transformation is being driven by technological innovation, deregulatory economic policies, global economic integration and the emergence of a transnational corporate culture. The process of change has resulted in an industry dominated by a handful of large, principally US and Western European corporate players: Time Warner, News Corporation, the Walt Disney Company, Bertelsmann, CBS, Viacom, Vivendi and Netflix.

These corporations have set about constructing a global media market. Their objective is to ensure their products (and those of their advertisers) reach the largest possible number of consumers. They regard international borders as arbitrary obstacles to this objective. The result has been a standardisation and homogenisation of world markets, which are characteristic of cultural integration.

Motivated by the pursuit of profit and accumulation of capital, the major media players have sought to expand vertically. They extend their control over all aspects of programming (that is, production, film archives), distribution and transmission. These companies are also at the forefront of technological innovation. They have taken advantage of the convergence of entertainment, information and telecommunications technology to move beyond mass media and into that of personalised media and greater individual choice. They are, for the most part, providers of the new media services; that is, streaming and other telecommunication services. These services utilise new delivery systems (that is, satellites and cable) and new forms of payment, such as subscription.

The development of global news providers (such as CNN, seen in Figure 10.3.14; BBC World Service; Fox; Reuters; and Sky News) has the potential to increase the amount of information available, as does the proliferation of smaller web-based providers. The latter has increased the range of perspectives available to the public.

The 'CNN effect'

Increasingly, the media is becoming detached from the restraints and influences of place and culture. Until the 1997-launch of CNN's Spanish language news network, CNN en Español, the CNN News Group largely ignored regional and local differences by providing a global English news service that had the same content, regardless of which country viewers live in. (CNN News Group is now owned by Turner Broadcasting, a division of Time Warner.)

This concentration of views has become known in media circles as the 'CNN effect', where audiences worldwide are presented with sober assessments of 'the facts' from a CNN perspective. Despite claims to the contrary, rarely does the CNN news reports examine an issue from a range of perspectives. US conservatives rail

10.3.14 CNN World Headquarters, Atlanta, Georgia

against the organisation. President Trump dismisses the broadcaster as 'fake news'. Fox News, on the other hand, is stridently conservative and pro-Trump. Progressive Americans decry it as a threat to national unity.

Australian media

In Australia, the commercial media is said to be in the hands of too few people. In fact, in no other democratic country is the media dominated by only two key players: News Corporation and John Fairfax Holdings. Many people believe that the increasing concentration of media ownership leads to a narrowing of information sources. Recent changes to the Federal Government's foreign ownership laws, along with the purchase of Channel 10 by America's CBS, is likely to significantly alter the Australian media landscape over the next decade. There will be an increase in cross-media ownership (for example, newspapers buying an interest in TV and radio stations) and a growth in online media.

Al Jazeera

Al Jazeera, Arabic for 'The Peninsula', is a TV network based in Doha, Qatar (see Figure 10.3.15). First established as an Arabic news and current affairs satellite TV channel, the organisation has since expanded into a network of several specialty TV channels.

10.3.15 The newsroom of Al Jazeera in Doha, Qatar

Al Jazeera's willingness to broadcast dissenting views created controversies in the Arab Gulf States and the United States. The station gained worldwide attention following the September 11 attacks when it broadcast video statements by Osama bin Laden and other al-Qaeda leaders. The network again came to prominence when it reported claims of torture against prisoners at the infamous Abu Ghraib prison and massacres allegedly committed by US troops in Afghanistan and Iraq during the conflicts there.

Al Jazeera's 'independence' is resented within parts of the Middle East. In June 2017, the Saudi, Emirati, Bahraini and Egyptian governments demanded the closure of the news station as one of thirteen demands made to Qatar. Qatar rejected the demands of its neighbours.

The Walt Disney Company

The Walt Disney Company is a US$92 billion media conglomerate. It may just be the single most powerful and influential force in the globalisation of Western culture. In this century, the real power to promote and consolidate consumer capitalism will not be held by the International Monetary Fund (IMF) or global brands, such as Nike or McDonald's. Instead it will lie with control over the 'infotainment' industry: film, TV, music, ideas and information.

Disneyland in Orlando, Florida, contains four separate theme parks. In addition, there are Disneylands in Anaheim (California); Hong Kong; Tokyo; Shanghai; and outside Paris, France. Disney theme park attendances are shown in Figure 10.3.16. In 2016, 140 million people visited the company's amusement parks.

Besides film production and distribution, the company is also involved in book, magazine and newspaper publishing; cable TV; music recording; live stage shows; real estate development; major league baseball and ice hockey; video production and sales; retail stores; product licensing; and computer software and online services. The revenues from these activities are shown in Figure 10.3.17.

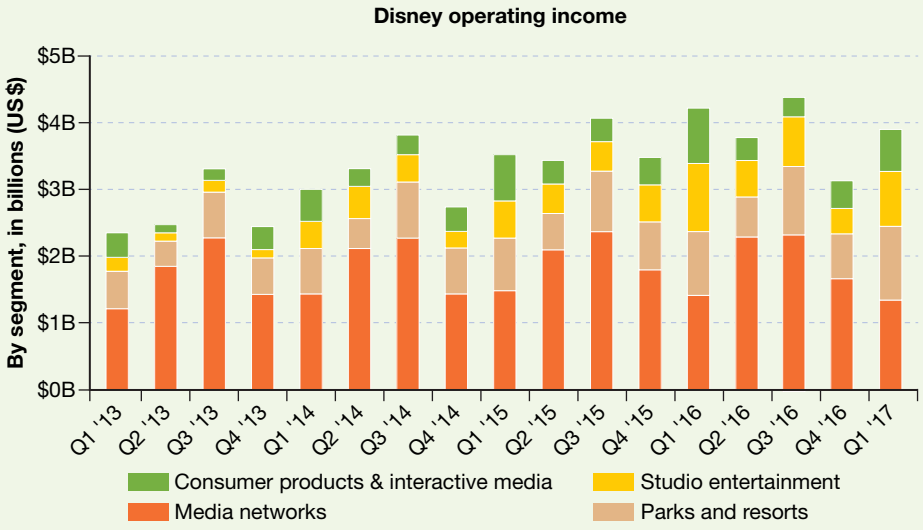
In 1996, Disney signed a 10-year deal with McDonald's giving the fast-food chain exclusive rights to promote Disney products. Under the terms of the agreement McDonald's paid US$100 million in royalties and conducted 11 promotions a year for Disney films, videos and TV shows, with seven aimed specifically toward the young Happy Meal consumers. Disney also agreed to let McDonald's set up shop inside its theme parks. The agreement was not renewed when it expired in 2006.

Walt Disney Studios produces and distributes motion pictures from its own divisions and the company's subsidiaries—Walt Disney Pictures, Lucasfilm, Pixar, and Marvel Studios.

Disney theme park attendances, 2016

Theme Park	Attendance
Magic Kingdom® (Walt Disney World®)	20 395 000
Disneyland®, Anaheim, California	17 943 000
Tokyo Disneyland	16 540 000
Tokyo Disney Sea	13 460 000
Epcot at Walt Disney World	11 712 000
Disney's Animal Kingdom®	10 844 000
Disney's Hollywood Studios®	10 776 000
Disney's California Adventure	9 295 000
Disneyland Paris	8 400 000
Hong Kong Disneyland	6 100 000
Shanghai Disneyland	5 600 000
Walt Disney Studios at Disneyland Paris	4 970 000

10.3.16 Disney theme park attendances, 2016



10.3.17 Disney revenues, Q1 2013 to Q1 2017

Activities

Understanding the text

1 Explain what is meant by the statement 'the media is becoming detached from the restraints and influences of place and culture'.

2 Explain the 'CNN effect'.

Working geographically

3 Use the internet to investigate one of the global media corporations mentioned in this section of the text. Present an oral report outlining the results of your investigations.

4 Outline the nature and scope of the Disney Corporation's commercial interest. Which theme parks achieved the highest attendance numbers? Which section of the business generated the greatest share of revenues in the first quarter of 2017? How did this compare with other quarters?

UNIT 10.4

The impacts of cultural integration

Globalisation has brought about a vast expansion of economic, social and cultural interactions. These interactions affect some places (and people) more than others. While nation-states continue to exert considerable influence, the process of globalisation makes it increasingly difficult for the state to control economic activity. States have responded in different ways, with some embracing globalisation and others seeking to insulate themselves from the global economy. The system of nation-states is unlikely to disappear, but any 'new world order' is likely to be one in which the spatial distribution of power is much more complex than suggested by the traditional map of nation-states.

Homogenised urban landscapes

In a world that is constantly changing, the places where people live and the ways they interact with each other have become increasingly important. Whether it is the local village or a large urban centre, where we live, work and interact determines our access to the important social, economic and political networks. As globalisation continues, the landscapes and streetscapes that once helped define countries and cities are no longer unique. Icons of cultural integration are everywhere, from advertising billboards to neon signs for McDonald's and KFC, and these serve to make cities more similar. These symbols of Westernisation, or Americanisation, are the new landmarks of a consumer generation, and they are multiplying fast. The symbols can be read two ways: first as a sign of industrialisation, and second as the end of individuality and the beginning of a monoculture.

10.4.1 The Chinese-born US architect Ieoh Ming Pei designed the famous glass pyramid at the entrance to the Louvre museum in Paris.

Architecture

Increasingly, the architectural diversity that once enriched cities is being replaced with the international style: 'Manhattanisation'. A newly-built tower in Sydney is often much the same as one built in Manhattan in New York or one in Tokyo, Cairo, Bombay or Cape Town. The typical office tower rarely owes anything to the cultural or physical context in which it is located.

Another trend in some parts of the developing world is satellite developments that mimic the city layouts and building designs of major Western cities, including London, Zurich and Venice.

There are, of course, exceptions to this homogenised design. Some internationally renowned architects who are leaving their creative mark on some of the world's great cities include Renzo Piano, Ieoh Ming Pei (see Figure 10.4.1) and Norman Foster (see Figure 10.4.2).

10.4.2 Examples of the architectural genius of Norman Foster can be found in many of the world's great cities: **A** the interior of the Reichstag Dome, German Parliament, Berlin, and **B** the Reichstag Dome exterior; **C** the interior of Deutsche Bank and **D** the Deutsche Bank exterior, Sydney.

Australia's suburban architecture also illustrates the impact of cultural integration. Successive waves of immigration have left their mark on the suburban streetscape. Each group of immigrants brings elements of its own architectural and cultural heritage. This is often reflected in the dwellings they build.

SPOTLIGHT

The fate of place?

10.4.3 Western-style shopping malls, such as this one in Dubai, contribute to the creation of homogeneous urban landscapes. Christmas is not a tradition in the Muslim United Arab Emirates, but in the cosmopolitan Gulf emirate of Dubai, it's an occasion for lavish decorations and elaborate celebrations, not to mention shopping.

John Casey, in his book *The Fate of Place*, describes a growing trend towards a global monoculture in which technology, physical mobility, and the increased speed of global social and economic exchange converge to overwhelm traditional regional differences. Cities fall prey to increasing uniformity of architectural structures and commercial institutions; skyscrapers and McDonald's can be found from Santiago in Chile to Kuala Lumpur in Malaysia.

Economic exchange makes it possible to access the same goods in multiple countries while decreasing the diversity among businesses from which we buy. Electronic technology makes it possible to connect with individuals across the planet while simultaneously permitting users to mask or reconfigure their own identities into online persona. The overall result of globalising influences is to cultivate an overwhelming sense of human anxiety regarding 'placelessness', or the inability to forge identity based on a sense of local or regional belonging. (See Figure 10.4.3.)

SPOTLIGHT

Renzo Piano

Italian-born Renzo Piano is one of the world's most innovative architects. He first came to international attention with his radical design for the Georges Pompidou Centre in Paris. Since then he has been responsible for a number of imaginative projects in New Caledonia, Japan, the United States, Germany, Italy and France.

With offices in Paris, Genoa and Berlin, Piano's 100-person architectural firm manages as many as a dozen world-class projects at a time. Piano's recent projects include a performing arts complex in Rome, a pilgrimage church in southern Italy, a combination store and artisan's studio for the luxury goods maker Hermès in Tokyo and the Shard in London (see Figure 10.4.4 B). Piano's first Australian commission was a 38-storey office tower and adjacent apartment building in Sydney's Macquarie Street. The striking building, seen in Figure 10.4.4 A, is enveloped in a massive translucent glass 'sail'.

Piano also oversaw one of the most politically and symbolically important building projects in post-war Europe: Berlin's Potsdamer Platz. Spanning an area the size of 100 football fields, this high-rise complex of offices, residences, shops, theatres and cinemas is intended to capture the pre-war vibrancy of the city's central business district. See Figure 10.4.4 C.

10.4.4 **A** Renzo Piano's Aurora Place office and apartment towers, Sydney; **B** The Shard, London, UK; **C** Office tower in Potsdamer Platz, Berlin, Germany

Economic dominance and dependence

The rise of the TNC and the increasingly dominant role played by the world's major economic powers has increased global inequalities and made many of the world's poorest countries increasingly subject to decision-making processes beyond their control.

As the activities of TNCs have become more global, so too have the industries that service them. These include banking, management consultancy, accounting, law, insurance and advertising. Globalisation is most advanced in the world's financial markets. Large financial institutions speculate on movements in exchange rates and interest rates, and firms now have access to a global pool of investment capital. London, Tokyo, New York and Hong Kong are the most important financial centres in the new global economy.

With a technologically linked global capital market, consumers are now able to benefit at a local level. Services once only offered at a bank can now be had from a variety of vendors, such as hotels, supermarkets, retail stores, service stations and post offices. Many are also available on app-based platforms available on smartphones. This increased level of access has contributed to a major rise in the mass consumption of goods and services. As expected, much of the benefit derived from this technology and increased consumption initially occurred in the developed, rather than the developing, world. More recently, however, the rapidly growing middle classes of the newly emerging economies (most notably China and India) have become keen participants in the mass consumer culture.

SPOTLIGHT

The global city: facilitating economic and cultural integration

The term 'global city' is used to identify cities that have a global, as well as national, importance. They are centres of global finance which house the headquarters of many of the world's largest TNCs. Decisions made in these cities affect the livelihood and wellbeing of people all around the globe. World cities are the nodes (or central cores) in a web of long-range communications and are dependent on local, regional and global markets for their inputs of food, energy and raw materials. The profits generated by turning these inputs into goods and services contributes to their economic dominance and to other countries' economic dependence upon them.

Global cities, such as New York City shown in Figure 10.4.5, are also centres of cultural dominance. The cultural innovations and trends that take place within them are transmitted, via the media, to communities around the world. Some of the innovations and trends interact with local culture, which is modified to varying degrees, by this interaction.

The recent quantum leap in the ability of transnational corporations to relocate their facilities around the world in effect makes all workers, communities and countries competitors for these corporations' favour. One of the consequences of this process has been a 'race to the bottom' in which wages and social conditions tend to fall to the level of the most desperate. 'Competitiveness' is at the centre of the new global economy. Companies, both large and small, compete against each other as they try to survive. As contracts become more difficult to obtain, some companies will resort to using child labour, others will reduce wages, while others will operate in unsafe conditions: all to ensure that their businesses stay profitable. With millions of people desperate for any kind of work, there will always be competitors in the marketplace willing to go just that little bit further.

10.4.5 Global cities, such as New York City, are centres of economic and cultural dominance.

Formal and informal economies

While working conditions in developed countries are sometimes poor, particularly among migrant workers, they are often substandard in the developing world. In many developing countries two economic systems exist that influence patterns of employment: one is the informal economy, the other the formal economy. Often these economies occupy the same geographical space (that is, exist in the one location) but the links between them are poorly developed. Features of the informal economy in developing countires include the following:

- The informal economy is labour intensive, usually small and locally owned.
- It exists to serve the needs of the urban and rural poor and tends to be outside the control of authorities (see Figure 10.4.6).
- Jobs in the informal sector have the potential to foster self-reliance, personal autonomy, self-identity and the development of personal skills. However, they can also be prone to worker exploitation and higher rates of workplace injuries.
- Employment numbers in the informal sector are usually greater than in the formal sector. If given the opportunity, however, most people would opt for work in the formal sector.
- At the community level, small self-help groups cooperate to improve living conditions. Community-based groups build schools and health clinics and provide basic infrastructure, such as communal taps, toilet blocks and waste collection. Much of the work performed within this context occurs on a reciprocal or unpaid basis.

Features of the formal economy in developing countries include the following:

- The formal economy generally involves large-scale manufacturing, most of which is foreign-owned or controlled.
- Goods are often produced for export markets.
- The formal economy often has very high levels of unemployment and underemployment.
- Jobs are often poorly paid and trade unions are suppressed.
- Working conditions can sometimes be hazardous and workers are sometimes dismissed if they seek to organise and campaign for improved work conditions.
- Local wealthy elites and an expanding middle class use cheap labour and imported technologies.
- The formal economy includes jobs associated with government activities.

Employment conditions for workers employed by TNCs is not the same across the world. In developing countries there is often exploitation of labour. This is now the focus of a major international campaign by human rights organisations.

10.4.6 Indian women selling flowers for celebratory religious garlands

Land ownership

Land ownership is a strong indicator of levels of inequality in society, particularly when most of the available arable land in the world is owned by less than 0.5 per cent of the population. Access to arable land is critical because it enables people to meet their own basic needs. Arable land refers to land suited to crops, and it is not a resource in abundant supply. Only approximately 22 per cent of the planet's land surface is arable and more than half of this is already utilised. As a result, the world's food supply is less secure than at any other time in recent history.

Often in developing countries, the rich and powerful minority of landowners, including foreign corporations, occupy most of the productive land. The poorer majority are forced to make do with what is left. This is rarely enough to feed their families and, as a result, most are forced to live in poverty. As landlessness increases, many drift off to the already crowded cities in the hope of finding paid employment. Most end up living in squatter settlements and relying on the informal sector for a living.

In circumstances where developing countries have struggled to meet the repayments of their foreign debt, they have been encouraged by their creditors, and institutions such as the IMF and World Bank, to grow export crops (such as sugar, coffee or flowers) instead of food for local consumption.

The IMF and World Bank solution of 'export or perish' all too often becomes a case of 'export and perish', as some countries struggle to repay previously accumulated debts. In some cases, the IMF and World Bank interfere directly in the affairs of countries. In return for financial support, governments are required to deregulate their economy and cut government spending in order to attract foreign investment and reduce debt. Those most affected by spending cuts are the very poor.

10.4.7 The icons of Western consumer culture are everywhere.

Threats to cultural diversity and sovereignty

Cultural diversity is what makes each country different. In a globalised world, differences in culture can be seen as irrational and backward looking. Corporations spend vast amounts of money trying to standardise consumer markets (see Figure 10.4.7). International bodies such as the WTO seek to regulate the operation of the global economy. While some countries are happy to go along with this, others are fighting to retain what national sovereignty and cultural identity they can. They fear that Westernisation will not only rob them of their identity, but also the values, faith and languages that have long been part of their culture.

The backlash to Western cultural influences include a variety of responses: banning films, protests and government legislation to protect cultural icons.

The 'Hollywoodisation' of the world

Around the world many young people are influenced by the Hollywood marketing machine and the stereotyped images they present of youthful beauty, adventure and romance. These ideas promote values and attitudes that are Western (American) in origin and portray lifestyles that are unattainable for the vast majority of the world's people.

This billion-dollar industry single-handedly controls more than 70 per cent of the film content seen in some countries and its power to influence people's way of thinking is enormous. Elsewhere, the opposition comes from those whose livelihood is threatened by the importation of American movies.

The loss of languages

Five languages—Chinese, English, Russian, Spanish and Hindi—are spoken by 50 per cent of the world's population, even though the planet is home to more than 6000 languages. More than half of these languages could well die out within the next 100 years as their last remaining speakers die.

About one-third of all the world's languages are now spoken by fewer than 1000 people and linguists fear that many speakers may succumb to the pressure to speak a mainstream language, such as English. To some, including the media magnate Rupert Murdoch, the loss of languages is inevitable and not necessarily a matter for regret. He argues that, 'The homogenisation of language is a force for global harmony and economic efficiency'. To reinforce this view, his satellite networks in India only produce programs in English and Hindi, ignoring the language diversity of the subcontinent. In China, Mandarin is spread across the country by the electronic media it dominates. Again, this ignores the linguistic diversity of the country. What this approach fails to recognise is that when we lose a language we lose a whole way of perceiving the world. Some people believe that language and culture are so intimately entwined that they are almost one and the same thing.

Dark truth of Disney's Frozen

By George Knowles and Tracy You

In Qingxi Town in southern China, 900 workers toil 11 hours a day, six days a week, to make toys for Disney Corporation's theme parks and toy retailers such as Amazon and Toys R Us. The workers, many of who are women aged 18 to 30, work illegally long hours, earn a miserly A$8.50 a day and live in sweltering hot, overcrowded dormitories.

The Hong Kong-owned Zhenyang factory is one of a network of low-cost factories in China used by Disney to make merchandise for its stores and theme parks worldwide (see Figure 10.4.8). Ironically, the factory making *Frozen* toys is in a sub-tropical region known as China's frying pan because of its high humidity and searing summer temperatures which reach the high 30s Celsius.

Among the toys made at the factory are an 'Elsa Music Snow Wand' which retails for A$22.00 and the 'Do You Want to Build a Snowman?' Jewelry Box which sells at Toys R Us for A$34.00—almost a worker's weekly wage at Zhenyang.

Workers are drawn from China's poorest provinces and leave families and children behind to spend 50 weeks a year on the production lines, only returning home for a fortnight during the Chinese New Year holiday.

A UK's Daily Mail online newspaper investigation spent two days interviewing some of the 900 workers from the factory along with an undercover investigator from the US-based pressure group China Labour Watch who spent a week on production lines in May.

Their investigation of the Disney-commissioned factory found:

- With basic pay at just A$8.50 a day, and even by working six days a week and taking every available overtime shift at peak season, workers struggle to earn A$512.00 a month.
- Employees do 100 hours' overtime a month to make ends meet, nearly three times China's legal maximum of 36 hours.
- Workers sleep up to 12 in small basic dormitory rooms with no air conditioning despite stifling summer temperatures.
- Bosses fine workers who turn up one minute late for their shift up to half a day's pay and hand out New Year 'bonuses' of just 85 cents per employee.

10.4.8 *Frozen* merchandise on display in a Disney store

- Workers are set 'impossible' production targets with some assembly lines ordered to turn out 1200 princess figures in one hour.
- Workers complained of filthy, overcrowded toilets and canteen meals so poor they were forced to buy food outside.

China Labor Watch, which lobbies for better worker conditions and pay, estimates each worker in China earns less than two US cents for each toy he or she makes. In some factories they earn only one 2000th of the retail price of the toys they make.

In a response to the Daily Mail's investigation, Disney said 'some but not all of the allegations' were substantiated by its auditors and that it had set the factory a target for improving conditions. The factory would lose the right to make Disney-branded toys if it did not comply.

Meanwhile, the country's economic boom has pushed many manufacturers to countries like Bangladesh, Indonesia and Vietnam where wages and costs are significantly lower. Five years ago, there were 150 000 migrant workers in Qingxi Town but today there are only around 30 000 left.

Despite the exodus of manufacturers from China, however, China remains the global hub for toy manufacturing with an estimated 75 per cent of the world's toys made in the country.

Adapted from 'Dark truth of Disney's Frozen fairytale', Daily Mail Australia website, 15 June 2016

English as an agent of cultural integration

The role of the English language as an agent of cultural integration is of particular concern to many governments:

- More than 1 billion people now speak English.
- Sixty per cent of the world's radio broadcasts are in English.
- Seventy per cent of the world's mail is addressed in English.
- Eighty-five per cent of international phone calls are in English.
- Eighty per cent of the material available via the internet is written in English.

Many countries are introducing policies aimed at protecting their languages. Iceland has a committee that uses existing Icelandic words and sounds to create new words, rather than simply adopting the English equivalent. In Russia, the government passed a law requiring all stores and businesses to display signs in Russian and the Russian signs must be bigger and more prominent than those in English.

In French-speaking Quebec, Canada, the parliament enacted a French-only sign law and appointed so-called language police to ensure there were no signs in English. Following a legal challenge, the law was changed to permit non-French words, but only if the French words were at least twice as big.

Other countries see lack of proficiency in English as limiting their economic potential. Many countries now promote English as a second language as part of their education system.

Time–space compression

The term time–space compression refers to a set of developments that have dramatically changed the way we think about time and space. Central to this idea is a reduction in the importance we attach to distance when a technology makes it cheaper and easier for people or goods to move from one place to another.

New forms of economic activity have also helped to compress time and space. Innovative forms of production methods have opened up new markets and brought places closer together in terms of time and space. Fluctuations on the New York stock market are mirrored in other stock exchanges within minutes; marketing campaigns can rapidly turn a product innovation into a fad in far-flung corners of the globe; and flowers picked in Sydney today can be decorating Japanese homes tomorrow.

The internet

The rise of the internet has accelerated the rate of time–space compression. Its role in reducing the importance of distance is yet to be fully realised, but will be substantial. Anyone with a computer and network connection can establish a website and advertise a good or service to a global market. Alternatively, they can access information, purchase goods and services or communicate, in real time, with friends and colleagues anywhere on earth.

The internet, as with most technological innovations, has the potential to reinforce existing inequalities. The geographical distribution of network connections closely mirrors the map of 'haves' and 'have-nots'. At the global scale this means that developed countries will continue to exert a disproportionate influence on internet-based economic innovations. It also means that the traditional centres of economic and political power, especially large cities, will strengthen their position relative to areas that are less well off.

The advent of mobile phones and the internet has also improved access to communication and information for many people in developing countries. In Bangladesh, for example, where more than 31 per cent of the population (50.5 million people) live below the national poverty line of US$2 per day, sales of mobile phones are booming. In 2017, 85 per cent of the population owned a mobile phone. This is in stark contrast to the situation a decade ago where villagers were buying mobile phones to sell 'call-time' to their neighbours, providing up to 1000 people with access to a telephone. The country now has more than 143-million-plus mobile phone users.

DID YOU KNOW?

- In 1858, the first trans-Atlantic telegram from Queen Victoria to then US president James Buchanan took 16 hours to arrive.
- The cost of a three-minute phone call from London to New York has decreased from US$60 in 1960 to 40 US cents today. Over the same period, the average price of a computer dropped from US$1.8 million in 1960 to less than US$1000 today.

Critics of globalisation

People opposed to globalisation resent the growing gap between the rich and poor and the way it shifts jobs from high-wage countries to lower-wage countries. Some do not like it because it exposes them to all sorts of global forces and influences that leave their children alienated from their own cultural heritage. Some do not like it because of the impact it has on the environment. Others are concerned about the exploitation of workers in developing countries. Many resent the power exercised by TNCs and international bodies, such as the WTO, IMF and World Bank. Meetings of the WTO have become a popular rallying point for those opposed to globalisation.

Nationalist political movements, human rights activists, protectionists and environmentalists are just some of the groups protesting against the excesses of globalisation.

Right-wing political activism

Throughout the developed world, there has been a rise in the number of right-wing political movements. Examples of these right-wing elements in Australia include Pauline Hanson's One Nation and Senator Cory Bernardi's Australian Conservatives. One Nation's policies include the rejection of Islam, multiculturalism and the slashing of Australia's immigration intake. They also claim that climate change is a hoax, aim to promote the protection of Australian manufacturing, and are committed to protecting Australia's cultural identity and 'traditional' family values.

Support for such views—despite coming from a minority—has encouraged the emergence of a number of extremist, ultra-nationalist, right-wing political groups. These include Reclaim Australia and the United Patriots Front. Both groups are anti-immigration, anti-multiculturalism and anti-Islam (see Figure 10.4.9). Similar right-wing movements have emerged in Germany, France, Austria and the United States. In some instances such groups have had a significant political impact. In the 2017 German federal election, for example, the Alternative for Germany (AfD)—a far right-wing populist/nationalist political party, which had previously been unrepresented in the German parliament (Bundestag)—became the third party in the Bundestag with 12.6 per cent of the vote.

In Australia, the conservative or right-wing worldviews promoted by Hanson's One Nation and Bernardi's Australian Conservatives are actively promoted by a small group of right-wing radio 'shock-jocks' and conservative television presenters. In Sydney, the shock-jocks of Radio 2GB (Alan Jones, Ray Hadley, Chris Smith, Ben Fordham and Andrew Bolt) are among the most ardent promoters of conservative worldviews.

The rise of right-wing political groups is often countered by progressive (left-wing) activism. In some instances competing protests result in violent clashes. (See Figures 10.4.10 and 10.4.11.)

10.4.9 Reclaim Australia activists staged a protest in Sydney's Martin Place, July 2015.

10.4.10 Anti-racism activists staged a counter protest, November 2015.

10.4.11 Rival anti-racism and Reclaim Australia activists clashed in the streets of Melbourne, November 2015.

Activities

Understanding the text

1 Outline the impact of globalisation on the world's urban landscapes.

2 Explain how Australia's immigration program has affected the streetscape of its suburban areas.

3 Explain, in your own words, the concept of economic dominance and dependence.

4 Explain how consumers have benefited from the technological developments within global capital markets. Have these benefits been equally shared? Explain your answers.

5 Outline the features of the informal economy. Give examples of the types of activities you would normally associate with this sector.

6 Explain why access to land is so important for the wellbeing of people in developing countries. Explain how the actions of the IMF and World Bank have reduced the amount of arable land available for food production.

7 Describe how the IMF and World Bank respond when countries are unable to repay debt or experience economic difficulties. Explain who usually suffers as a result of such interventions.

8 Explain why some countries are concerned about the loss of cultural diversity and sovereignty.

9 Explain how the internet has contributed to the compression of time and space.

10 Explain how the internet reinforces existing inequalities.

11 Outline the issues that concern those who are opposed to globalisation.

12 Explain the link between globalisation and the resurgence in right-wing political activism.

Working geographically

13 a What is meant by the term monoculture?

b What evidence is there for the existence of this monoculture?

c What factors have contributed to the emergence of a global monoculture?

14 Write a report outlining the impact that globalisation has had on the role of the nation–state.

15 Use digital photography to illustrate the view that our urban landscape is increasingly dominated by the icons and symbols of a 'global culture'. Mount a wall display.

16 Identify elements of the streetscape in your local area that reflect the cultural heritage of particular immigrant groups.

17 Define the term global city. What functions do these cities perform?

18 Write a report outlining the differences between the informal and formal economy.

19 As a class, discuss the reasons why the majority of workers in the developing world would opt for employment in the formal economy rather than the informal economy even though work conditions are often worse in the former.

20 Why do you think that TNCs do not spend more of their profits on improving working conditions in developing countries? In your opinion, should they? Why or why not? Share your opinion with others in the class.

21 Study the entertainment guide of a daily newspaper. Count the number of movies showing. Calculate the proportion of movies made in the United States. As a class, discuss the possible reasons for the results of your survey.

22 Collect data relating to the TV-viewing habits of Australians. Describe where the programs are sourced from; use statistics in your response.

23 Write an exposition. Topic: 'The homogenisation of language is a force for global harmony and economic efficiency.'

CASE STUDY

Protests and activism

Community-based protests against globalisation

The speed and spread of global flows, particularly the flows of information and finance, are extraordinary. This threatens the capacity of people and governments to regulate, resist or even fully comprehend the local impact of changes that result from actions and decisions taken on the other side of the world. The autonomy and sovereignty of governments is increasingly constrained by the mobility of capital and the power of international financial institutions, credit-rating agencies, TNCs and global institutions, such as the IMF, the World Bank and the WTO.

Governments have responded to these challenges in different ways. Most have recognised the inevitability of the globalisation process and tried to position their countries to maximise any economic advantages while minimising the social impacts of change. Most governments have, however, proved ineffective in dealing with the social impacts of globalisation. Inequalities between and within countries persist. Globalisation has created winners and losers, and the cultural heritage that once helped to sustain countries is threatened by forces that many cannot comprehend and few understand. As a result, the backlash against globalisation is becoming more apparent and widespread, see Figure 10.4.12.

Much of this backlash stems from the insecurity and alienation that people experience in times of rapid economic and social change. An increasing number of people fear that they do not have the knowledge, skills and resources to adapt to the changes taking place. Even those with jobs feel insecure because the jobs they have are being rapidly transformed, downsized, streamlined or made obsolete by globalisation and technological change. The same global competition is forcing governments to downsize and streamline. The government services that people once took for granted are being rationalised, some have been withdrawn and others are now only available via technology. People living in regional areas have been affected more by these changes than those living in large urban centres.

10.4.12 G20 protests in Hamburg, Germany, 2017. The anti-globalisation movement opposes TNCs, trade agreements and deregulated financial markets. While the majority protest peacefully, a small radical element often resorts to violent protests.

Human rights activists

Some of the most effective opposition to the excesses of globalisation has come from human rights groups. These groups have focused on the exploitation of workers by TNCs operating in developing countries. TNCs in the footwear and clothing sector have been accused of allowing their products to be manufactured in sweatshops, where workers are forced to work in dangerous conditions for long hours at low rates of pay. (See Figure 10.4.13.)

Through the effective use of the media and internet, these groups have had some success in encouraging TNCs, such as Nike, to address the conditions under which their products are manufactured.

10.4.13 Protesting garment workers in Dhaka, Bangladesh

Human rights groups include:

- CorpWatch (United States)
- Clean Clothes Campaign (Europe)
- Oxfam (Australia)
- FairWear (Australia)
- United Students Against Sweatshops (United States)
- Campaign for Labor Rights (United States)
- International Trade Union Confederation.

Oxfam campaign to pay factory workers a living wage

Oxfam has launched a tracker to guide consumers on retailers' progress. This is to ensure that the clothes people purchase come from safe factories and the workers are being paid a living wage. A living wage is different from a minimum wage in that it is a wage that is enough to cover essentials like decent housing, food, and healthcare.

To support the launch, Oxfam released a report with Deloitte Access Economics called What She Makes: Power and Poverty in the Fashion Industry. The report estimates that on average in countries that pay:

- the legal minimum wage (China and Indonesia) only 4 per cent of a garment's price sold in Australia is paid to the factory worker who made the garment. That means for an item of clothing costing $10, the factory worker makes 40 cents.
- below the legal minimum wage (Bangladesh) only 2 per cent of a garment's price sold in Australia is paid to the factory worker who made the garment. That means for an item of clothing costing $10, the factory worker makes 20 cents.

Oxfam is urging retailers such as Target, Kmart, Big W and Specialty Fashion Group, whose brands include Katies and Rivers, to ensure factory workers are being paid a living wage. The report notes that an increase of price for a $10 T-shirt by 1 per cent, or an extra 10 cents per garment to the garment workers would make a big difference in their lives. Alternatively, the garment could stay the same price and the manufacturers, wholesalers and suppliers in the billion-dollar fashion industry could absorb the costs.

THE GARMENT WORKERS

The report notes that the majority of the poorly paid workers are young women, with little power to challenge or change their conditions. Figure 10.4.14 shows Anju, who works for as little as 37 cents an hour to sew jumpers for Australian retailers. Her wage does not even cover the basic costs of living—food and accommodation. Like many women in the industry, Anju and her husband have sent their children away from the city, and only see them a couple of times a year.

PROTECTION OF WORKING CONDITIONS

In April 2013 the Rana Plaza factory in Bangladesh collapsed, killing 1129 people. In response, an Accord on Fire and Building Safety in Bangladesh was completed and signed by unions, non-profit groups and industry to ensure factories were safe in Bangladesh. Many Australian brands signed these agreements. The working conditions are being protected; however, action to improve the level of wages is still required.

Activities

Working geographically

1. Gather information related to community-based responses to globalisation. Share these with the rest of your class.
2. Outline the concerns of human rights activists. How are they seeking to influence TNCs?
3. Access the internet site of a group involved in human rights issues. Use the following points to help you prepare an oral report:
   - name the organisation
   - state where it is based and who it represents
   - briefly outline its objectives
   - describe the nature of its campaign
   - list some of its achievements.

10.4.14 Bangladeshi garment sewers work inside a factory at Ashulia, in Dhaka, Bangladesh.

Exam-style questions

Extended responses

- What is cultural integration? Outline the factors affecting the nature and rate of this process.
- Explain how the diffusion, adoption and adaptation of mass consumer culture is reflected in THREE of the following: media, fashion, brand images, sport, music or religion.
- Analyse the role played by the media in the process of cultural integration.
- Examine the role of government in the process of cultural integration.
- Explain the contribution of technological change and TNCs to the process of cultural integration.
- Analyse the view that cultural integration increases economic dominance and dependence.
- Explain how cultural integration has contributed to the development of homogenised landscapes.

Glossary

deregulation the process by which governments remove, reduce or simplify restrictions on the movement of goods and people

economic restructuring the significant and enduring changes in the nature and structure of the economy brought about, primarily, by the emergence of the global economy

free trade unrestricted access to international markets; advocates of free trade argue that by gradually removing barriers to the free international movement of goods and services it is possible to boost global economic growth and the prosperity of individual countries

global village a term used to describe how the world appears to be getting smaller through the accessibility of technology, especially those that facilitate the transfer of information; thus, the actions that occur in one corner of the globe can rapidly and significantly affect people elsewhere

globalisation the integration of the world's economy through the mass consumption of mainly Western culture, technology and trade; globalisation affects economic, political, social, cultural and environmental decision-making

high culture incorporates elements of lasting value, such as art, literature, theatre, ballet, opera and classical music; some critics consider its content to be 'highbrow' or 'intellectual' when compared with 'popular culture'

homogenised in relation to culture, a state where one culture becomes similar to another

intellectual capital using ideas, knowledge or inventions as a means of gaining material wealth through a business enterprise; specialised knowledge of a product creates jobs in areas such as information technology (IT) support

multiculturalism the official Australian Government policy of encouraging immigration from diverse ethnic backgrounds; it also refers to the promotion and encouragement of the retention of ethnic languages and cultures within Australian society

popular culture considered to be more mainstream than 'high culture'; it is associated with 'lighter' forms of entertainment, such as sporting events, TV programs, comic strips and rock concerts

protectionism the practice adopted to protect local industries from foreign competition by imposing import quotas, tariffs and subsidies

rationalisation the elimination of what is considered unnecessary, in order to make it more efficient

sovereignty the supreme, unrestricted power to govern a state

transnational corporations (TNCs) large international companies whose operations take place in both developed and less developed countries; their headquarters are usually located in developed countries

World Bank an international organisation made up of three United Nations agencies; it provides less developed countries with technical assistance and finance for reconstruction and development

CHAPTER

11 Political geography

The twentieth century was the most violent and conflict laden in human history. Two world wars ravaged countries across the globe and took an unimaginable toll on human life. By the end of the century, it was believed that the process of globalisation and the revolution in information and communications technologies would bring the peoples of the world closer together; but the opposite appears to be happening. While global economies are converging, cultures appear to be diverging.

Widening cultural and ideological differences are leading us into a period of heightened social conflict, growing inequality and increased segregation. We have seen a resurgence in racist ideologies, the renewed threat of nuclear war, increased nationalism, the rise of radical religious groups and a growing mistrust in democracy.

This chapter examines the nature of power and conflict, the changing role of the nation–state, the causes and geographical outcomes of political tensions and warfare, and the resolution of conflict.

> **There was never a good war, nor a bad peace.**
>
> **Benjamin Franklin, one of the founding fathers of the United States**

11.0.1 Military parade, Pyongyang, North Korea

선군혁

UNIT 11.1

Political geography, or geopolitics

Political geography, sometimes called geopolitics, looks at the interrelationships between politics and the geographical context in which politics takes place. Geopolitical inquiry attempts to see all the forces at work in political processes and outcomes as being interconnected and taking place within a particular spatial or geographical context. These social, economic and cultural forces include resources, environments, ideology, ethnicity, class, culture and religion.

The primary objective of political activity is to gain and exercise power. Much of political thinking, activity and conflict are directed towards the control of land, and its resources and people. The geographical location and resources of countries and regions have a significant influence on political activity and power. In turn, political power results from the control of land, resources and people, on a local as well as a global level. The exercise of political power often has a profound influence on the geographical environment.

SPOTLIGHT

The Clash of Civilisations

The political scientist Samuel P. Huntington in *The Clash of Civilizations and the Remaking of World Order* (1996) argued that future conflict will occur most frequently and violently along cultural instead of ideological lines. Writing on the same theme in 1993 he posited:

> It is my hypothesis that the fundamental source of conflict in this new world will not be primarily ideological or primarily economic. The great divisions among humankind and the dominating source of conflict will be cultural. Nation–states will remain the most powerful actors in world affairs, but the principal conflicts of global politics will occur between nations and groups of different civilizations. The clash of civilizations will dominate global politics. The fault lines between civilizations will be the battle lines of the future.

Samuel P. Huntington, *Foreign Affairs*, 72(3), 1993, p. 22

Power and conflict

Politics is more than the wielding of power or the administration of people and resources. For genuine politics to exist there must also be some public debate and argument. This implies disagreement, as well as a spread, or sharing, of power to make decisions and some degree of openness in decision-making. This is often referred to as transparent government (see Figure 11.1.1).

Without debate and disagreement, politics doesn't exist. In a purely totalitarian country there is no politics because debate is prevented (see Figure 11.1.2). Politics seems to be a normal part of people's social existence, even if it is driven 'underground' by repressive governments.

Since politics involves disagreement, there will also be tension. The extent to which tension becomes conflict depends on the particular causes of tension and the possibility of resolving the tension peacefully. The extent of violent political conflict that the world has experienced for thousands of years and still experiences today demonstrates the volatility of politics and the political nature of human society.

11.1.1 True politics exists when there is opportunity for open dissent. Pro-independence Catalans rally in Barcelona. In 2017, Catalans mounted a campaign for independence from Spain.

11.1.2 The Nazi Party ruled Germany between 1933 and 1945. Under this totalitarian regime, debate was not permitted and therefore true politics did not exist.

In the twenty-first century, most politics takes place within and between nation–states. The characteristics of these nation–states and their role in causing and controlling tension and conflict is one of the major issues in geopolitics. Another significant area of interest is the question of whether nation–states will survive the new processes of globalisation.

States and communities

Much of political activity is consciously directed towards the governing of states and communities, and the relationship that states and communities have with each other.

A state or nation–state

A state (also referred to as a nation–state or country) is a territory that is autonomously (independently) governed. It has a boundary that is defined by laws and regulations that are policed by legally established powers. Each of the world's nation–states has a government that has the power to make and enforce laws. The government also has the power to determine movements of people and things, and control transactions of goods and money within and across its borders.

States officially recognise each other's existence and deal with each other in official ways. States conduct international relations with each other. Today there are nearly 200 states or countries that are officially equal in autonomy and legal power to govern their territories. Almost all countries belong to the United Nations (UN) organisation. In 2011, South Sudan was admitted to the UN, making it the 193rd member state. In reality, the relative power of states in the world geopolitical system is very uneven and this is a major cause of tension.

Community

A community is much smaller than a state and consists of a group of people with some degree of common interest (see Figure 11.1.3). Often a community also shares a geographical space, although the emergence of digital or virtual communities has made this less so. Examples include an urban-based community of a town or suburb, and a group of people who communicate regularly about a shared concern or activity, such as the work of a school or a club. For a genuine community to exist the members must, as the name implies, communicate.

Communities usually have a geographical basis to their communication, such as having transport, telecommunications, media or other infrastructure that enable them to interact. There may be a high degree of tension in a community about the control and governance of the geography of the community, such as the urban infrastructure, and about the spatial distribution of the economic system. Local politics can be just as intense as national and international politics, and just as interconnected with geographical factors. Geographical factors will often motivate members of a community to unite to protect the welfare of individuals and the community. This can be seen with community action groups that form to deal with specific geographical issues in local communities. For example, the action group Residents Against Polluting Stacks was formed to protest against exhaust stacks associated with road tunnels that affect local communities in Sydney.

11.1.3 Communities are formed when people come together with a shared interest; for example, these Dutch football fans.

11.1.4 Nation–states have defined borders, such as here at the border between India and Pakistan.

11.1.5 Long lines of traffic wait to cross the border between the USA and Mexico in San Diego, California. Illegal crossings of the border by economic refugees is a major political issue in the USA. President Donald Trump famously promised to 'build a wall' if elected.

States, nations and nationalism

A fundamentally important issue in geopolitics, and one that lies at the centre of much political conflict in today's world, is the relationship of states with nations. States are defined more or less by their territorial borders (see Figures 11.1.4 and 11.1.5) and their systems of government.

Nations

Nations, or nationalities, are defined more by shared ethnic features, such as language, race, religion and culture. Some states contain multiple nations. For example, Canada has three distinct nations within the one state. The First Nations of the Inuit and American-Indian people are the indigenous populations of Canada. There is a significant French-speaking minority centred on the province of Quebec. The third nation consists of the majority of the population, who are English-speaking and of Anglo heritage.

11.1.6 This image from 1972 shows British troops manning barricades to keep pro- and anti-independence supporters apart in Belfast, Northern Ireland.

For centuries, people of many nations have had a strong desire to break away from nation–states and form independent nation–states. This often led to violent and long-lasting conflict, as in the case of Ireland where conflict took place for centuries between those seeking independence and those loyal to Britain. Throughout much of the twentieth century Northern Ireland experienced extreme violence, known as 'The Troubles'; this led to segregation of those wanting independence from Britain and those who were loyal (see Figure 11.1.6). Other examples include the former Yugoslavia where a series of bloody civil wars in the late twentieth and early twenty-first century saw the country split into several smaller countries based on distinct ethnic and religious lines.

Nationalism

Nationalism is the political world view that sometimes accompanies the emergence of a nation (or nation–state). Nationalism is defined as the loyalty and devotion to a nation or ethnic group that places emphasis on promoting the interests, cultural and social values, or religion of one group above all others. Another issue arises when a group of people identify themselves as a nation but its members are not all located within a single nation–state. Two examples of this are the Sami and the Kurds.

The Sami people occupy the frozen arctic regions of Norway, Sweden, Finland and Russia. Being spread over multiple nation–states has made it difficult for the Sami people to exert their rights.

The Kurds' traditional lands are found in Iraq, Iran, Turkey and Syria. As a minority in each of these countries, the Kurdish people have suffered considerable discrimination and in some cases have resorted to acts of terrorism to advance their political aims. Kurdish forces have been a major force in the conflict in Syria and Iraq against radical Islamists, where they have gained support from the US and its allies. In 2017 these forces announced an independent Kurdish nation in northern Iraq, after holding a successful independence referendum. The Kurds had been fighting the Islamist terrorist organisation ISIS who had seized control of parts of the country from the Iraqi government. Iraq refused to recognise the referendum and the Kurds remain in a limbo.

Australia

One of the major issues in Australian politics today involves the question of the nature of the Australian state. Should Australia be a multi-ethnic and multicultural country? Does it make sense to say that a country can have many cultures? Is Australia, in fact, a unified country at all? It is unified in the sense that there is a single official language and a single government, yet in terms of culture, religion, beliefs and use of minority languages there is enormous diversity, which comes from being an immigrant country. What is the future of the Australian nation and state if it becomes a republic and moves economically and politically closer to our Asian and South Pacific neighbours? Although Australia is geographically located in the Asia–Pacific region, and surrounded by Asian and Pacific cultures, the culture is mainly European. The possible contradiction between Australia's location and culture has been a cause of contention and of possible future conflict.

Activities

Understanding the text

1. Define the term geopolitics.
2. Explain the concept of 'true politics'.
3. Explain why an understanding of geography is important when looking at political processes and their outcomes.
4. Explain why true politics cannot exist in a totalitarian government.
5. Explain why some political disagreements (tensions) result in conflict when others do not.
6. Describe the characteristics of a nation–state.
7. Outline the concept of a community.
8. Distinguish between a state and a nation.
9. Explain why Canada can be said to be a nation–state with multiple nations.
10. Explain the relationship between nationalism and the potential for conflict.

Working geographically

11. Access online newspapers and digital archives and collect a media file of ethnically-based tensions in Australia or another country. Analyse the articles and write a brief report outlining the main issues involved.
12. Locate an atlas published recently and another published in the 1980s or earlier. Compare the map of Europe in each atlas. Outline the changes that have taken place.
13. Conduct research into the Sami people of Lapland. Where are their ancestral homes? Describe aspects of Sami culture and outline the challenges they face. Present your findings as an oral report.
14. On a map of the Middle East, show the location of Kurdistan (the traditional lands of the Kurdish people). Write a report outlining the nature of the conflict that has developed between Kurdish minorities and the nation–states in which they live.

UNIT 11.2

The changing role and nature of the nation–state

The nation–state is a relatively new concept and continues to evolve.

Origins of the nation–state

Imperialism

Imperialism is the imposition of power over a society, region or country by the rulers of another country; it also denies the colonised country any independence or democracy.

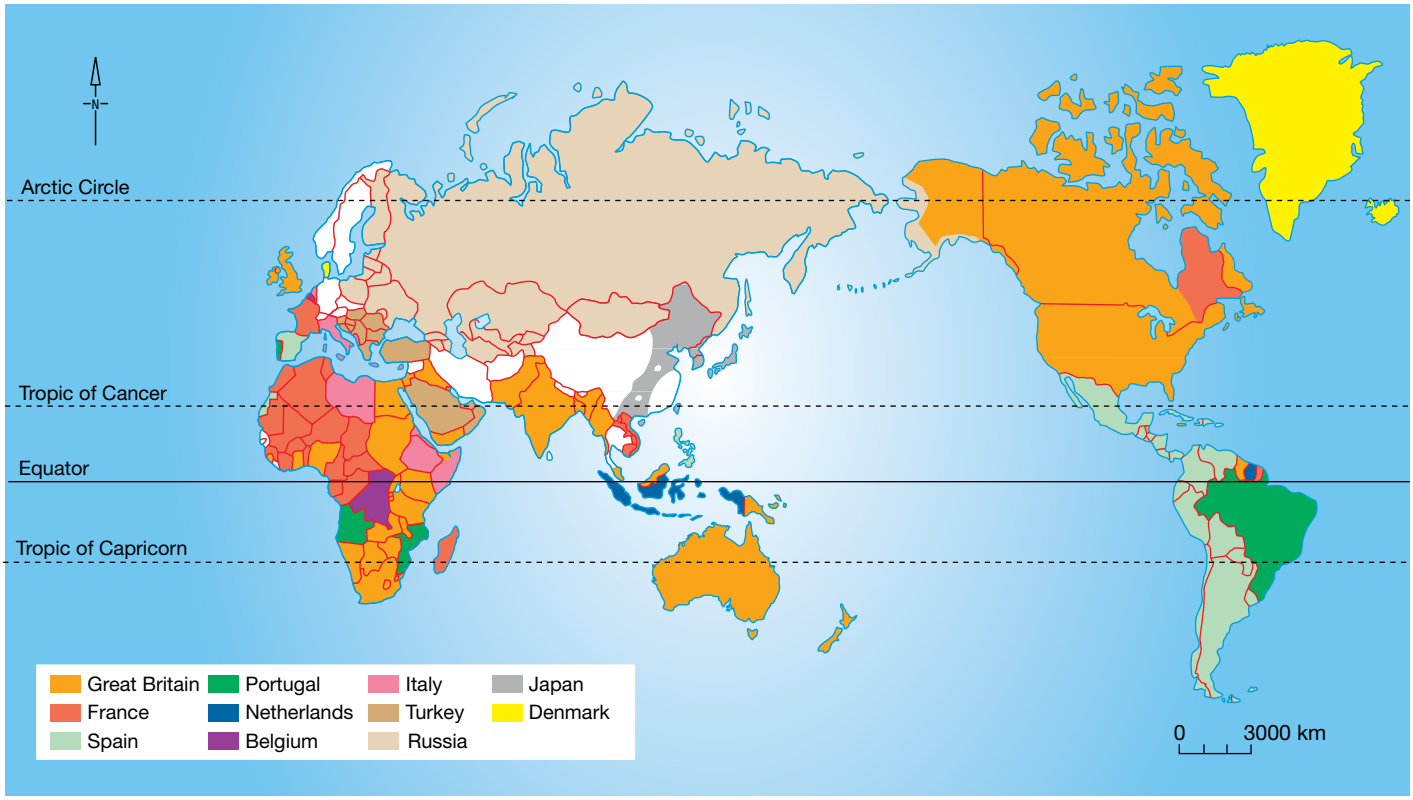
Until the nineteenth century, the main form of government was the empire, ruled by a small number of monarchs and nobles. These empires were the outcome of conquests. They usually contained many different ethnic groups or nations. Because they were so large they were loosely governed from the centre, with local rulers or agents of the emperor given a lot of autonomy.

During the nineteenth century and early twentieth century, this age-old system began to be transformed rapidly in Europe into a system of nation–states. During the twentieth century, nation–states emerged throughout the rest of the world so that today virtually everyone lives within, and is a member of, a nation–state.

The forces leading to nation–states

During the colonial era, the governments of empires had little interest in national identity or unity. By the middle of the nineteenth century, in Western Europe and North America the stirrings of democracy were beginning to unleash the forces that would totally transform the nature of states. These forces were the notions of freedom and democracy. At the same time, the European-based empires of Great Britain, France, Germany, Austria, Russia, Portugal and the Netherlands were being consolidated throughout the rest of the world.

By 1900, almost all the world had been divided up among European empires (see Figure 11.2.1.) or had become independent from former imperial rulers. A number of South American countries had gained independence from Spain. In Europe and North America in the nineteenth century there existed three forces: democracy, imperialism and nationalism. These forces were to be crucial in bringing about today's world system of nation–states.



11.2.1 Most of the world was divided into European empires from the mid-sixteenth century until the early 1950s. This map shows the extent of the empires in 1950.

Democracy and nationalism

Democracy

Democracy is the idea that representative government and the sharing of power among the people is the only system that makes leaders responsible to the people. Imperialists reject the idea of democracy for colonised people because those people would then demand political independence. The movement for independence for each colony or country of the world is known as nationalism, but not all nationalists want democracy.

Broad nationalism

Nationalism exists in both broad and specific forms. Broad nationalism is the movement for independence of each colony or country in the world. It is also the movement to strengthen countries that are already independent, especially when they are in rivalry with other countries. Broad nationalism is focused both inward and outward. It is inward in that it attempts to achieve and build an autonomous and unified country. Its outward focus is to succeed in competition against other countries, even to the point of warfare. Colonies and countries, whether independent or not, can have within them several nations. Examples include Indonesia, Great Britain, Mexico, Nigeria and Russia.

Specific nationalism

Specific nationalism is a movement for independence of a specific ethnic or national group within larger countries.

11.2.2 In 1996 the city of Grozny, in the Russian province of Chechnya, was surrounded by Russian forces and largely destroyed after nationalists within Chechnya attempted to gain independence.

11.2.3 In 2014 a referendum was held to decide whether Scotland should become independent from the United Kingdom. The vote was unsuccessful.

Many multi-ethnic or multinational states are facing growing demands from the forces of specific nationalism. There are numerous examples of nationalism that threaten the cohesion (internal unity) of large, multi-ethnic states. They include the wars in the former Yugoslavia; the Russian war against the Chechens, shown in Figure 11.2.2; the independence movements in the Indonesian provinces of Aceh and West Papua; and the civil war for independence by the Tamils within Sri Lanka. There has also been recent conflict in the Philippine province of Mindanao which has a majority Islamic population in the otherwise predominantly Christian country.

There is a strong independence movement within Quebec (which has a majority French-speaking population) for separation from Canada and an independence movement within Scotland wanting to break free of the United Kingdom. In 2014, the British Parliament approved a referendum asking people of Scotland whether they wanted independence. Strong arguments were put forward by both those seeking to remain in the United Kingdom and those seeking independence, seen in Figure 11.2.3. More than 3.6 million people voted, with around 55 per cent electing to stay in a unified Britain. However, following the 2016 decision for Britain to withdraw from the European Union, known as Brexit, there have been renewed calls for Scottish independence.

All large states today face these kinds of forces. Specific nationalism is likely to cause conflict and reshape national borders in the early twenty-first century. Even in Australia there has been some movement within Western Australia for independence. This is centred on the fairness of the distribution of federal funding to the states. Western Australia argues that it contributed significantly to the Australian economy through its rich resources, but does not receive a fair share of resources back.

Nationalism is still one of the most important political forces shaping the geography of the world and has some distance to go before it achieves the goal of a separate state for every nation on earth. This goal may never be achieved, because one of the basic problems when creating a nation–state is in deciding how to define and separate each nation from other nations.

Federations

Federations are nation–states made up of territorial components that have joined together. Federations have peculiar difficulties of sovereignty for there are two, often conflicting, sources of sovereignty: the historically older constituent elements, generally called states or provinces, which join together to form a larger, newly sovereign entity (country). The new federal government acquires much of the sovereignty of the older constituent parts. The sharing of power in federations is a major source of tension, especially if wealth and prosperity are unevenly distributed between the states (or provinces) and if there are major ethnic and cultural differences.

There are numerous examples of federations around the world, including Australia, Malaysia, Canada, Germany, Switzerland and the United States of America. Federations where the population has considerable shared values, language and culture have tended to endure and thrive. These federations have also usually been formed by peaceful mutual agreement, such as Australia. However, other federations, such as the now disbanded Yugoslavia, were created more out of political and ideological forces. As the two following examples demonstrate, where significant differences exist federations are at risk.

The United States of America

The United States of America was formed as a federation of 13 colonies following their revolt from Britain in 1776 and the successful War of Independence, led by George Washington. The US federal constitution does not allow for secession; that is, for the states to break away in order to become independent. However, in 1861 most of the southern states attempted to leave the federation over the issue of slavery and associated cultural, economic and geographical differences with the northern states. The US was, in effect, two quite different societies, economies and cultures, and the southern one feared domination by the larger, richer north. The rebellious Confederate States of America (CSA) was formed from the breakaway southern states.

11.2.4 A bitter civil war between Confederate and Union forces raged from 1861 to 1865. The war saw more than 600 000 soldiers killed and many civilians as well.

The Civil War

The CSA hoped that their new country would be recognised by the outside world as well as by the United States. Instead, the remaining states (usually called 'the Union') refused to allow the southern states to leave legally and so war broke out, as seen in Figure 11.2.4. The first shot was fired by the southerners. The northerners prevailed in the ensuing civil war due to their far greater resources and stronger personnel base. These enabled them to wear down and destroy the south's economy. In this case, the geographical and economic bases of the war were the decisive factors.

Today, the legacy of the civil war continues. For example, protests erupted in 2017 when statues celebrating pro-slavery confederate generals were removed from Charlottesville, Virginia, and other cities across the southern states (see Figure 11.2.5). These protests led to a clash between those protesting for and against the removal of the statues, and coincided with a white supremacist driving a car into a crowd and killing a pro-diversity protester.

11.2.5 White supremacists led protests against the removal of Confederate generals in Charlottesville Virginia in July 2017, highlighting divisions in the USA.

There are also ongoing challenges to the very fabric of the US federation, with some calling for the secession of California from the United States. California is by the far the most populous of the states and has a large Hispanic population. Moves to limit Hispanic migration by the Trump administration have angered many in the state, prompting calls for independence. This move is unlikely, but shows that all federations face challenges.

11.2.6 Yugoslavia, before the collapse of the federation: this map shows the ethnic and cultural diversity of the region.

The former Yugoslavia

The Yugoslav federation was formed in the years immediately after World War I, and was supposed to unite all the South Slavic peoples. However, the new federation included two peoples—the Croats and Serbs—who had been engaged in a struggle for control of the Balkans for hundreds of years. (The Balkans consists of the countries in the Balkan Peninsula, including Bosnia and Herzegovina, Croatia, Macedonia, Slovenia, Romania, Bulgaria and Albania.) Although having a common ethnic and linguistic background, the Croats and Serbs have distinctive religious and historical traditions. Past experiences have kept them apart and antagonistic (hostile) towards each other. Figure 11.2.6 demonstrates the diversity of the Balkans region from which the Yugoslav federation was formed.

The historical tensions in the region were made worse by atrocities committed by Croatia's puppet fascist government during World War II. The Bosnian Muslims—who are ethnically, linguistically and historically South Slavs—were despised by the other two groups because of their historic conversion to Islam and because they collaborated with the Islamic Ottoman Turkish Empire during its occupation of the region from the fourteenth century until 1908.

Adding to the region's ethnic and cultural diversity are the Kosovars, another Islamic nation occupying a large part of Serbia. The Kosovars speak Albanian and, in terms of cultural heritage, they have much in common with the people of Albania.

The Socialist Federal Republic of Yugoslavia was established immediately after World War II. Its president—Josip Broz Tito—ruled in a repressive manner. Tito suppressed nationalist insurrections and this maintained unity throughout the country. In essence Tito used force, repression and fear to maintain the federation.

Disintegration and war

In the 1990s, after the death of Tito, the Yugoslavian federation started to disintegrate with secession by Slovenia, Croatia, Macedonia and Bosnia. There were violent attempts by elements of the remaining Serbian-dominated federal government to prevent the break-up. When that failed, Serbia tried to retain as much territory as possible. In particular, this was at the expense of Bosnia and Croatia and denied any autonomy to the Kosovars. At the heart of the conflict was the intermingling and mutual hostility of Croatian, Serbian and Bosnian peoples within the official borders of Croatia and Bosnia; attempts by the government of Serbia–Montenegro to support the Serbs within Croatia and Bosnia; and the specific nationalism of the Kosovar people.

As part of the disintegration of the former Yugoslavia, the Republic of Bosnia–Herzegovina experienced three years (1992–95) of bloody inter-ethnic war between Bosnian Muslims, Croats and Serbs. The war left the country's infrastructure and economy in tatters. Around 2 million people—about half the population—were displaced from their homes. In 2006, Montenegro seceded and in 2008 Kosovo declared its independence; see Figure 11.2.7. The war crimes trials that followed the conflict saw a number of Bosnian Serbs face the International War Crimes Tribunal in The Hague. The accused were charged with murder, torture and rape of Muslim and Croat civilians.

Characteristics of nation–states

Nation–states (or countries) combine features of both nations and states. Nations are defined by shared features of language, culture, religion and traditions. States are defined by government of territory and by the powers, or sovereignty, that governments have within their territories. One way to describe a state is to say that it is a centralised government that has been able to gain 'a monopoly of violence' within a specific territory and to use that monopoly to impose its control over the people of the territory. This control of law and order then enables the government to prevent violence within the population and to make and implement laws for peaceful behaviour. Laws are the rules about social behaviour: what is permitted, what is not and what must be done by the people so that society can operate in an orderly and prosperous fashion.

Nation–states today all have a high degree of centralised authority rather than the devolved authority that existed a century or more ago. Devolved authority is where local or regional governments hold most of the power rather than a central national government. The transport and communications revolutions of the past half century have enabled states to develop more powerful and effective ways of governing the lives of their citizens. At the same time, there have developed new theories and ideas about what governments should do. The governments of states wish to actually govern their territories rather than have decisions imposed on them by others; for example, by an imperial power. The governance of states is now a highly developed and effective process compared with the imperial era of 100 years ago. All governments are now able to affect the lives of their citizens through economic and social policies that centre on the processes of taxation, expenditure and economic management.

As a general rule, the more developed a state is, the more effectively it will be able to use these policies. For example, governments of less developed states in parts of Africa, Central America and South Asia have far less power to improve the lives of their citizens. During times of conflict this type of centralised rule often breaks down altogether. This was the case in the east African nation of Somalia that for many years was considered a 'failed state'. Power tended to be held by warlords with armed gangs who engaged in drug, people and arms smuggling, piracy and other crimes. Today Somalia's central government is somewhat more stable, although this is fragile. For example, in October 2017 a huge truck bomb was exploded by Islamist terrorist group Al-Shabab killing more than 300 people and leading to countless casualties.

11.2.7 Yugoslavia disintegrated into a number of smaller nations following a series of bloody conflicts in the twentieth century.

SPOTLIGHT

The rule of law

A feature of effective government is the rule of law. This is where authorities act to control law and order and do so in a transparent, open and fair way. Key features of countries that have a high degree of the rule of law include an absence of corruption, an equal application of the law for all, and the situation where no individual or group is considered to be above the law.

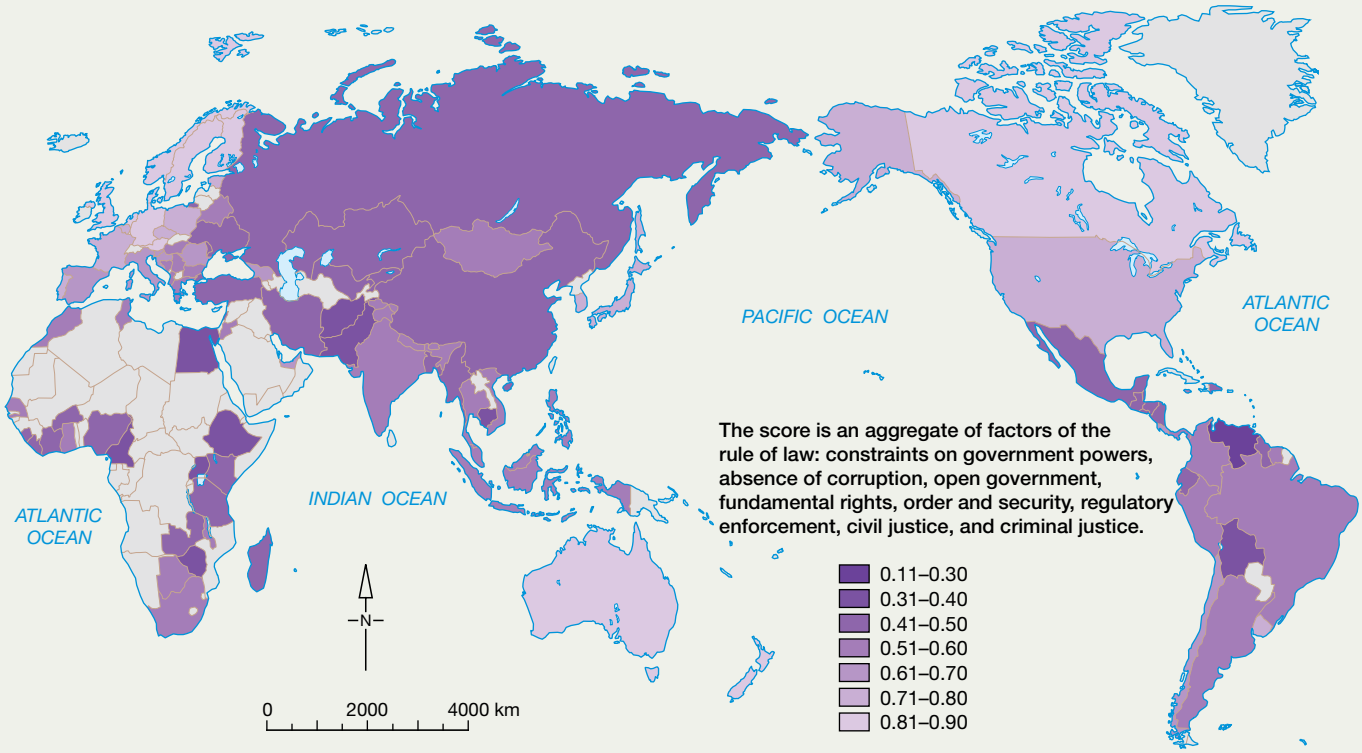
The World Justice Project (WJP), a global non-governmental organisation, whose board includes globally recognised legal academics and lawyers, regularly reviews the way that countries apply the rule of law. From these reviews they produce a report rating for countries. A perfect score is 1, with scores being reduced below that based on corruption, lack of transparency and other factors.

In 2016, the WJP researched 113 countries (see Figure 11.2.8). Importantly, the WJP was unable to access many countries due to conflict and refusal of governments to participate, including many in Africa and the Middle East. In the 2016 report, European nations dominated the top performing nations. Australia was ranked 11th with a score of 0.81, Norway with a score of 0.89 was the highest performer.

Venezuela, with a score of 0.28, was the lowest ranked of the countries studied. Located in South America, Venezuela is one of the world's most oil-rich nations but has borrowed heavily from international sources.

11.2.9 Corruption and a failure to provide even basic services has led to massive protests across Venezuela, a country rich in oil. This protestor's shirt reads: 'There is no food'.

Critics of the government have argued that this was to 'buy' support from key parts of the population. While oil prices were high in the first decade of the twenty-first century, the government could afford to repay these debts; as oil prices plummeted following the global financial crisis of 2008–09 the country was left with massive unpaid debts and has been unable to provide basic services. By 2017, food and basic medicine were in short supply and huge protests erupted across the country, shown in Figure 11.2.9. Corruption has now become endemic in the country and the government has turned to repression to deal with growing discontent and protest.



11.2.8 The World Justice Project's rule of law index

National or state sovereignty

To understand political action and conflict, sovereignty in national politics needs to be addressed. Sovereignty means having autonomy, or independent power, to achieve desired outcomes, such as the power to make laws that can be implemented in an efficient way.

A ruler or government of a country has a greater or lesser degree of sovereignty to govern. The degree will depend on the political constitution of the nation–state, the extent of the citizens' acceptance of the government and the influence that international organisations and treaties have over the nation–state. Popular sovereignty first emerged at around the time of the French Revolution and is the notion that the people provide a mandate to the government to rule. A mandate is the authority given by the people to their rulers to lead them, and this mandate can be withdrawn at the next election. This means that ultimate power rests with the people (see Figure 11.2.10).

11.2.10 In democracies such as Australia, the right to rule, or a mandate, comes from the people through free and fair elections.

The extent to which a country is truly democratic is determined by the extent to which sovereignty or power is shared with the people and the various organisations to which they belong. In states that are totalitarian dictatorships, very little power is shared. In mature democracies (such as Australia and the countries of Western Europe and North America), power is dispersed among many organisations and groups. However, international forces are challenging the sovereignty of nation–states. Furthermore, many forces within nation–states are also attempting to gain greater power from central governments.

Lack of sovereignty

State sovereignty is at the core of being considered a nation–state. There are numerous examples of regions that are not nation–states because they do not have sovereignty. For example, Somaliland occupies a slice of Somali territory on the southern shores of the Gulf of Aden. It has virtually all the hallmarks of a country: a functioning government, police force and military, and the region is generally peaceful. This is all very different to Somalia, where the central government is extremely fragile.

However, Somaliland is not a country despite calling itself one—to the rest of the world Somaliland is a self-governing autonomous region within Somalia. One of the key aspects of being considered a sovereign state is that other countries recognise your independence and state sovereignty. In the case of Somaliland such recognition would first come through its neighbours, and this in turn would lead to other countries recognising it. Most of these neighbouring countries are members of the African Union (AU), a large regional inter-governmental organisation. The AU has stated on several occasions that recognition of Somaliland could only come about with the consent of Somalia. However, a bitter civil war has raged across Somalia for more than 25 years and it is feared that recognition of Somaliland would create further division in the country with other regions, such as Puntland, Jubaland and Hiranland, pushing for independence. Essentially, the national government of Somalia is exerting its right to sovereignty in not allowing Somaliland to break away and form its own nation–state.

Impact on international relations

State sovereignty can hinder international relations and allow countries to act in their own interests. An example of this can be seen in the attitude of the United States towards climate change. In 2016, 197 countries agreed to make changes to help reduce the impact of climate change.

The United States is the biggest producer of the greenhouse gases that are the cause of climate change. In 2016 the then President of the United States, Barak Obama, signed the agreement but it was not ratified by the US Congress, meaning that it had not been approved by the parliament to become law within the US. In June 2017, the new President Donald Trump announced that the US would withdraw from the agreement. (See Figure 11.2.11.)

11.2.11 Although attracting protests from many in the US, President Donald Trump announced the withdrawal of the US from the Paris Climate Agreement in 2017, citing sovereignty as the key issue.

SPOTLIGHT

Brexit

In 2016, Britain held a referendum on whether the country should continue to be part of the European Union (EU). The EU developed in the years following World War II and was originally an organisation that promoted trade, known as the European Economic Community (EEC). Britain did not join the EEC until 1973 but soon became one of the leading members.

Over time, the EU become a powerful force across Europe, not just with free trade but also with free movement between countries. This helped to create a more unified Europe, but for nationalists it meant that nation–states began to lose sovereignty to the EU and its European Parliament. Against this backdrop, the United Kingdom Independence Party (UKIP) began to lobby for Britain to leave the EU (see Figure 11.2.12). A key argument put forward was that Britain was no longer in control of its own decisions and had to do what others, such as the European Parliament and its agencies, dictated.

In June 2016, the country was given the chance to decide in a referendum. The country divided into 'remainers' (those who wanted to continue in the EU) and 'leavers' (those wishing to exit the EU). Thirty million people voted or 71.8 per cent of eligible voters. The referendum was very close: 51.9 per cent voted to leave and 48.1 per cent voted to stay.

Voting patterns were different across the UK. Within London, with its extensive global networks and financial employees, there was strong support to remain. In industrial areas with higher unemployment, the exit vote was far stronger.

Brexit highlights the counter forces acting against geopolitical tensions. On one hand there is greater convergence, with moves towards increased globalisation of culture and trade. However, there is also a counter force of nationalism and isolationism that seeks to separate.

11.2.12 A pro-Brexit voter

In making the announcement, he cited sovereignty as one of the key reasons for his decision. 'Our withdrawal from the agreement represents a reassertion of America's sovereignty,' he said in an address to the media. He later said in the same speech that the agreement would '…weaken our sovereignty…'. Like all international agreements, the Paris Climate Agreement relies on nation–states to act for the wider global good. In this instance, the concept of state sovereignty has allowed the United States to place self-interest ahead of global needs.

Regions, supra-regions and supra-states

Regions

The term 'region' refers to two kinds of places: intranational regions, such as south-west New South Wales, and international regions, such as the Middle East.

Intranational regions

Intranational regions are parts of a nation or country that have a particular form of natural cohesion or identity that sets them apart, perhaps only slightly, from the rest of the nation or country. In Australia, this term has been applied to parts of the country that have some special geographical, economic, social and cultural features that provide the people with a sense that they have a unique identity. The people of such regions as North Queensland, New England, Hunter, Illawarra and Western Sydney identify themselves, to some extent, as belonging to these places because of certain features that they share.

The existence of these regional identities does not mean that people think of themselves only as belonging to these regions. Most people feel they have several overlapping identities, or senses of belonging. For example, they may feel they belong to Australia, New South Wales and Sydney (or Newcastle or New England) and then perhaps to their locality, such as a town or suburb.

International regions

International regions are areas that span more than one nation. Some international regions have a natural existence due to a shared culture, religion or language. For example, the Middle East consists largely of Arabic-speaking Islamic cultures. There are important exceptions to the degree of integration. Within this region there are conflicting elements: such as Israel (a largely Jewish, Hebrew-speaking state), Turkey (a Turkic-speaking, Islamic state), Iran (a mostly Persian-speaking, Islamic state), marked differences between and within Sunni and Shia denominations of Islam, and very significant disagreements over borders and control of resources. Many of the state boundaries in the region are colonial creations dating from early in the twentieth century when most of the region was parcelled out among the British and French empires. Tensions over borders led to several conflicts between countries in the second half of the twentieth century, several of which continue today.

Supra-regions

Western Europe is an increasingly integrated supra-region in spite of major ethnic and linguistic differences among its people. A common cultural heritage dating from the Roman imperial and early Christian times has always been a unifying force in this region. Europe has had a degree of economic integration since the late medieval times. Language has been a uniting element among the educated elite to some extent, whether it was Latin in medieval times, French in early modern times or English today. Economic forces and the desire to avoid another disastrous war like that in 1939–45 have pushed the countries closer together in recent decades.

Supra-state

The formation of the European Union (EU) was a major step towards turning the region into a supra-state; that is, a political federation of several states. Recent forces of nationalism have seen some of this cohesion fall away, most notably with the decision of the United Kingdom to withdraw from the EU, known as Brexit.

In today's increasingly integrated world there are powerful forces pushing some international regions towards ever-greater integration, such as the European Union, despite Brexit; and parts of Asia, through the Association of Southeast Asian Nations (ASEAN).

This growing integration is nevertheless creating powerful tensions at a more local level, indicating a two-level process at work. At the international level the forces are making for greater integration, often leading towards political federation, including the creation of supra-states made up of several states. However, at the intranational, or community, level there are opposing forces of specific nationalism or localism. These forces are pushing for the break-up of existing large states into smaller mini-states (or large communities) and a wish to gain ethnic or regional autonomy within the much larger international grouping—for example, moves towards Scottish independence.

Activities

Understanding the text

1 Outline the key differences between empires and nation–states.
2 Define the term democracy.
3 Distinguish between democracy and imperialism.
4 Differentiate between broad nationalism and specific nationalism.
5 Explain how nationalism impacts on nation–states.
6 State what a federation is.
7 Outline the challenges faced by federations.
8 Differentiate between devolved and centralised authority.
9 Define, in your own words, the terms sovereignty and popular sovereignty.
10 Describe the way in which sovereignty (or the power to make decisions) is maintained in a totalitarian regime.
11 Explain how state sovereignty has impacted on Somaliland.
12 Differentiate between intranational and international regions.
13 State what a supra-state is.
14 Outline what the Brexit vote involved.

Working geographically

15 Prepare a short report and a timeline outlining the origins of the nation–state.
16 Conduct research into the Scottish independence movement. Outline the arguments for and against independence.
17 Write an extended response on the challenges faced by the federations of the United States and Yugoslavia.
18 Prepare a summary of the key characteristics of nation–states.
19 a Define the term rule of law.
b Examine Figure 11.2.8. Describe the key patterns shown on the map. Which areas have no data? Why do you think there is a lack of data in these regions?
c Consider the data in Figure 11.2.8. As a class discuss whether there are links between economic development and the rule of law.
d Using the internet, conduct research into the current situation in Venezuela. What are the challenges facing this country?
20 Hold a class debate. Topic: 'State sovereignty should be abandoned.'
21 Write a short report on the forces working for and against supra-states.

UNIT 11.3

Challenges to nation–states and their sovereignty

Nation–states face a range of complex pressures that, in extreme cases, can lead to their collapse. Broadly, these pressures are divided into two types:

- internal pressures: those that result from problems and issues within the nation–state
- external pressures: those that result from forces beyond the nation–state.

Internal pressures

In many nation–states there are movements within regions, communities, subcultures and political groups seeking to gain power over decision-making. In an extreme form, this could result in a collapse of central authority within the state in favour of local authorities. For example, in some parts of the United States there is strong support for a less centralised form of government and for greater power to be handed over to state governments and even smaller county authorities. In Australia, there has been some support for a similar notion; although, in recent years, power has become even more centrally controlled by the federal government.

Specific nationalists within some multi-ethnic states may fight for the establishment of autonomy (independence) for their own smaller states. This has been seen in the former Yugoslavia, which fell apart into ethnically-based new states; Indonesia, where Timor-Leste (formerly known as East Timor) gained independence in 2000, and the long-standing conflicts found in the Aceh region and the province of Papua (formerly known as Irian Jaya).

External pressures

External factors are those that are beyond the direct control of the nation–state. Factors such as globalisation, the policies and operations of large transnational corporations, non-governmental and inter-governmental organisations, as well as the actions of other countries all create pressures on nation–states and limit their sovereignty.

International organisations

Ever since the formation of large scale global organisations, such as the League of Nations (the forerunner to the United Nations, which was formed in the years following World War I), there has been the notion of a world or global government. As the world has become increasingly globalised, international organisations have played ever greater roles in governance. The second half of the twentieth century saw the creation not only of the United Nations, but also many other associated agencies, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the World Bank and many more. There has also been the creation of global legal systems, such as the International Court of Justice, shown in Figure 11.3.1, to deal with disputes between nation–states and the International Criminal Court to deal with international crimes, such as genocide.

Through their focus on international relations and peaceful dispute resolution these organisations and the international laws and agreements that govern them have become powerful forces in controlling the actions of governments.

11.3.1 The International Court of Justice, which sits in the Hague in the Netherlands, is a special court that resolves disputes between nation–states.

For example, the International Atomic Energy Agency (IAEA), which regulates nuclear technology around the world, has played an integral role in limiting the opportunity for countries to build nuclear weapons.

Australian membership

Australia is party to around 1000 international treaties and agreements. Some of these are between Australia and just one other country, which are known as bilateral treaties. Others are between Australia and many other countries, called multilateral treaties. By joining these voluntary agreements Australia gains the benefits that flow from its membership. It also has to abide by the obligations laid out in the agreements. In this sense, these organisations can limit the power of the nation–state but there are also many benefits to be derived, which is why countries agree to participate and impede their sovereignty.

The Australian Department of Foreign Affairs and Trade makes the following point on its website about the benefits that flow to Australia by participating in international agreements and treaties:

> Australia participates in treaty making because it is in the national interest to do so. If the projection of military and economic power were the main means by which national objectives were pursued, Australia would be vulnerable. Our geographic isolation and small population would be seen as a weakness. Nations, particularly States with a relatively small population such as Australia, benefit from a world where interaction between countries takes place within a framework based on fair, agreed and transparent rules as agreed in treaties. Australia is not a member of any single rigid regional grouping; rather, we build global or regional alliances and through them, seek to influence the standards by which international relations are conducted.

Source: 'Treaty making process' on the Australian Government, Department of Foreign Affairs and Trade website

Member states and sovereignty

The expanding size and authority of international institutions, such as the EU and UN, raise a number of significant questions for the governments of their member states:

- Should states participate in the building of regional and international alliances?
- Does integration into regional and international organisations mean that countries will increasingly lose control of their own affairs?
- Can countries afford not to participate in international organisations in an era when the power of the state is giving way to the power of multinational arrangements and structures?

11.3.2 These demonstrators in Manilla, Philippines, are protesting against the World Bank and its policies.

Conflicting points of view exist concerning these issues. Some people believe that institutions such as the International Monetary Fund (IMF), World Bank and WTO have too much influence over the decision-making processes of governments worldwide (see Figure 11.3.2). They accuse these organisations of reinforcing the highly uneven global distribution of political and economic power. Others suggest that there is ample proof that membership of these international organisations provides a range of benefits for member states. They believe that being left out can have serious adverse consequences for a country.

Britain's decision to exit from the EU in 2016 provides an interesting case in point. The decision to exit has created many issues for Britain; for example, as an non-EU member it will need to negotiate separate trade arrangements with other countries rather than being able to use EU negotiated agreements. Many believe that this will impact negatively on British trade; certainly the pound, the British currency, fell considerably in value following the Brexit decision. There are others who point out that the decision will enable Britain to have a more independent voice in matters such as migration and foreign policy.

DID YOU KNOW?

In 2018, it was revealed that over 87 million Facebook users had their personal data leaked and used by a political consultancy group.

Transnational corporations

Many large corporations are now richer and perhaps more powerful than many countries. Transnational corporations (TNCs), which have separate branches and processes in a series of countries, are becoming increasingly globalised and are losing loyalty to any particular country. Global firms tend to demand the same sorts of laws, government policies, employment practices and social welfare provisions from all the countries in which they operate. This enables companies to standardise procedures and systems and consequently reduce their costs. The pressure that companies can apply is often enough to influence government decision-making and in this sense reduces the overall sovereignty of the nation–state.

Another issue that has become prominent in recent times is the way that TNCs manipulate their profits in order to reduce the amount of tax they need to pay. This has been brought into sharp focus in recent years with the rise of multibillion dollar technology firms, particularly those that are web-based platforms that don't produce physical products. The flexible and intangible characteristics of the services and products these companies offer have radically altered the relationship between nation–states and companies.

11.3.3 The emergence of web-based firms such as social media giant Facebook has radically altered the way governments deal with business.

Facebook

Facebook (see Figure 11.3.3) has come under intense criticism for the way it uses complex corporate arrangements to avoid national laws and taxation. In 2014, it was reported that Facebook paid £4327 (or around $10 000) tax for all its operations in the United Kingdom, despite a revenue of more than £105 million and paying its top staff more than £35 million in bonuses above their normal salaries.

In 2018 Australia, Britain and the USA launched investigations into privacy issues at Facebook. The company has also been the subject of legal action in Europe over privacy. France, Belgium and the Netherlands recently announced that Facebook has broken privacy laws in their countries and Spain and Germany have ongoing investigations. France issued Facebook with a fine of €150 000 (around A$175 000) the highest possible fine at the time. France is now looking to change their laws to implement fines of up to 4 per cent of a company's revenue. Facebook issued a statement saying it 'respectfully disagreed' with the decision and that, as its European branch was based in Ireland, it should only have to comply with Irish law. In other words, Facebook refused to accept the sovereignty of France in regards to this issue.

SPOTLIGHT

The Rohingya crisis

The Rohingya people are an ethnic Muslim minority who practise a variation of Sunni Islam. Around 1 million Rohingya people live in Rakhine State in Myanmar, accounting for about one-third of the population. The majority of Myanmar's population is Buddhist and the Rohingya differ ethnically, religiously and linguistically from the rest of the population.

The Rohingya have lived in Myanmar since the fifteenth century but in the second half of the twentieth century began to face increasing repression. The Rohingya people have not been recognised as citizens of Myanmar and are not entitled to the usual rights.

In 2017, reports began to emerge of a systematic campaign of violence against Rohingya communities in Rakhine State by the Myanmar military. These early reports were coming from NGOs operating in the communities who used their networks within both social media and traditional media to bring the situation to the world's attention. This sparked action from the United Nations and other countries to apply pressure to the Myanmar government.

11.3.4 By late 2017, more than half a million Rohingya had fled their homes in Myanmar following systematic violence by the Myanmar government.

By late 2017, more than 500 000 Rohingya had fled to nearby Bangladesh and a full-scale humanitarian crisis had developed (see Figure 11.3.4).

Uber

In 2017, the ride-sharing company Uber had its licence to operate in London revoked by local authorities because the company was not complying with local regulations. Authorities in Brazil took similar action around the same time. Uber admitted that it needed to change its practices. The issue continued in the courts throughout 2018, although Uber was allowed to continue to operate, but under strict conditions.

Governments responding

Many governments are attempting to reassert their sovereignty over large companies. France has passed legislation, for example, allowing it to issue very large fines to corporations.

In Australia the Commonwealth Government launched a program in 2016 called 'fair tax'. This program aims to reduce the ability of large corporations to avoid their tax obligations. Under the program companies that attempt to avoid their obligations by using complex international loopholes will be forced to pay a 40 per cent tax rate, instead of the normal 30 per cent. The Australian Tax Office released data in late 2017 showing that since its introduction in July 2016, the Multinational Anti-Avoidance Law had seen large corporations pay an additional $1.5 billion in tax to the Commonwealth Government.

Non-governmental organisations

Non-governmental organisations are organisations that operate as not-for-profit and aim to exert influence on nation–states around specific issues. They rely on individuals for support and membership; by definition, governments cannot become members of such organisations, although they often do support their work. Key areas in which they operate include:

- environmental protection and ecological sustainability (for example, Greenpeace, the World Wide Fund for Nature and the Australian Conservation Foundation)
- social justice and human rights (for example, Human Rights Watch, the International Red Cross and Red Crescent, and Amnesty International)
- development and disaster relief (for example, World Vision, Oxfam and Save the Children).

The strategies used by these organisations range from letter-writing campaigns to using their membership base to engage in protests, boycotts and other activities. In an increasingly globalised and connected world, NGOs have also turned to social media platforms to spread information and gather support.

Due to the diversity of their views, NGOs face limitations in their ability to lobby governments. Some NGOs are highly critical of foreign aid agencies while others are highly dependent on them for their financial survival. Nevertheless, NGOs are continually finding new ways to achieve their aims and convey their message. Some NGOs have, for example, recognised the potential of trade measures to influence environmental practices.

NGOs derive strength from having a formal role in multilateral bodies, such as the UN, the Organization for Security and Co-operation in Europe (OSCE) and the EU. Article 71 of the UN Charter says that the United Nations Economic and Social Council (ECOSOC) 'may make suitable arrangements for consultation with [NGOs]'. NGOs also make it possible for contact and information exchanges between conflicting parties to take place across borders without the involvement of governments. Already an accepted part of international relations, by influencing national and multilateral policy-making NGOs are becoming increasingly important.

Activities

Understanding the text

1 Differentiate between the internal and external pressures placed on nation–states.
2 Explain how international organisations can limit the power of nation–states.
3 Outline the benefits that countries gain from being members of international organisations.
4 What is a transnational corporation?
5 Explain the role of transnational corporations in limiting the sovereignty of nation–states.
6 Outline the criticisms in relation to Facebook's relationship with nation–states.
7 Define the term non-governmental organisation.
8 Outline the strategies used by NGOs to achieve their goals.

Working geographically

9 As a class, discuss the advantages and disadvantages of joining international inter-governmental organisations and agreements. Prepare a list of pros and cons. Using your list, prepare an argument on whether the benefits of joining outweigh the disadvantages.
10 Using the internet, conduct research into a large inter-governmental organisation. Prepare a digital presentation outlining the goals, structure, membership and work of this organisation.
11 In small groups select a large international web-based firm. Using the internet, conduct research into this firm. Where is its headquarters? How profitable is it? Are there any concerns relating to the way this company pays its taxes? Present your findings to the class.
12 Prepare a short report outlining the situation facing the Rohingya people and the role played by NGOs in bringing the situation to world attention.

UNIT 11.4

Causes of political tensions and conflicts

Political tensions and conflicts have many causes and operate at many levels. Tensions arise naturally out of political processes. Whether tensions become conflicts depends on the particular processes at work, and the kinds of problems and institutions that exist. Political processes are concerned with the power to govern and administer states or parts of states. The processes of government and administration are always contentious (controversial) because they involve certain basic aspects of human life, such as distribution of income and wealth; control of resources; access to education, housing and health care; criminal justice; control over culture and cultural institutions; and, ultimately, the life and death of individuals, groups and classes. Major problems can arise in these processes. In most places, institutions exist that are supposed to solve these kinds of problems, but often the institutions are inadequate or are bypassed. The extreme outcome of such a situation is armed conflict.

On another level, government is responsible for organising and ensuring the defence of the state against external and internal enemies. Some political theorists have argued that this is the prime duty of a government. However, the role of governments as defenders of the state against enemies is controversial. A bad government may see its own survival and prosperity as being more important than the prosperity of the state. This has been seen throughout history with dictatorial regimes, such as that in North Korea. This may lead it to attempt to stop internal critics and even start external wars of aggression to divert attention from internal dissent.

SPOTLIGHT

North Korea

North Korea has for decades been one of the most secretive and isolated countries in the world. In the chaos following World War II Korea was divided with the north adopting a communist regime. Between 1950 and 1953 a war was fought over the Korean Peninsula. The North received support from communist China while the South was supported by the US and its allies (including Australia). The war ended in a ceasefire rather than a formal treaty and thus technically continues today, although there has been no significant conflict since 1953.

After the Korean War the North's leader Kim Il-sung adopted a philosophy of Juche, or self-reliance. He emerged as a god-like figure and despite his death in 1994 still holds the post of President, a position assigned to him for eternity. Kim Il-sung's family have continued to rule over North Korea and its current leader Kim Jong-un is Kim Il-sung's grandson.

Like other totalitarian regimes, North Korea has an absence of true politics and dissent is dealt with brutally. The isolationist policies that help keep the population repressed have also meant that most of the population is extremely impoverished. The regime has created a mythology around threats to its existence, particularly from the US, Japan and South Korea. It has for decades sought to develop nuclear weapons as a sign of its national strength (see Figure 11.4.1).

11.4.1 Despite most people in North Korea living in absolute poverty, the country maintains a massive army of more than one million troops and has developed nuclear weapons.

From the beginning of the twenty-first century, North Korea has openly developed its nuclear weapons capability. In 2013 it tested a nuclear weapon, prompting sanctions from the UN. A series of missile tests were conducted from 2014.

The situation reached a new phase in 2017 when North Korea announced it now had missiles that were capable of carrying nuclear weapons as far as the US territory of Guam, north of Australia. When North Korea test-fired missiles across Japan, invading its airspace, further UN sanctions ensued. US President Donald Trump was heavily criticised after threatening to destroy North Korea and saying that diplomatic options would not resolve the dispute.

Internal dissent and external relations often have a strong geographical basis. The lack of homogeneity within the state in terms of ethnic distribution and local economic development may be a source of discontent. There are numerous causes of political tensions and these, from time to time, escalate into full conflict.

Material and human resources

The power to control and use resources has always been at the heart of political tension and conflict. Resources are things with particular attributes that make them useful to humans. Things are only resources if they are available for human use. Their availability depends on technology, organisation and ownership. The minerals in national parks or Antarctica, for example, may be abundant but they are not resources, as such, because national and international laws to preserve the wildernesses in a pristine (unspoilt) state prevent them from being exploited. In this case, it is the unspoilt wilderness that is the resource.

There are many types of resources, but the main types are capital, human resources, raw materials and material products.

Raw materials

Natural raw materials of the earth include minerals, soil, water, plants and animals. Water has increasingly become a source of tension and potential conflict. Countries that share water resources, for example from rivers that flow through multiple countries, can have competing demands on the use of the water.

Tensions over the Brahmaputra River have been growing between China and India. The river has its source high in the Himalayan Mountains in Tibet (a region controlled by China). With a length of nearly 3000 kilometres, the Brahmaputra River drains a catchment of almost 600 000 square kilometres across China, Bhutan, India and Bangladesh (see Figure 11.4.2). Both India and China have engaged in dam building along the river to provide hydro-electric power to their massive populations and growing industries. Both countries are also planning to divert water out of the river for irrigation and drinking water. In India alone there are more than 120 proposals for dams along the river and its tributaries. Both China and India dispute who controls the water in the river. The far less-powerful Bhutan and Bangladesh have largely been sidelined from any discussions.

11.4.2 The waters of the Brahmaputra are a source of tension between India and China.

Ownership and control of territory has been a fundamental cause of conflict throughout human history and continues to be one of the main causes of conflict in many places. Control of land is closely connected with wealth derived from productive production, such as agriculture and mineral resources. However, it cannot be separated from the historical and cultural considerations that impact on people's ownership and control of productive assets.

Capital resources

The most basic resource in the contemporary world is capital (mainly money and finance). Command over this resource gives power to control all other resources, including human resources. In an increasingly globalised world the ability to influence or control the financial and capital flows creates enormous power.

11.4.3 Cyber based conflict demonstrates the importance of human capital.

Human resources

Human resources are the productive capacities of people, which depend on their education and skills, their diligence and their human management. The emergence of cyber conflict demonstrates the importance of this human resource; without the necessary skills base in their human resources, a country will be unable to defend itself from cyber-attack. Cyber technology is prevalent in parts of society and has brought many benefits. However, it has also increased vulnerabilities. Consequently countries have invested heavily in cyber defence systems to protect their cyber assets as well as actively engage in cyber warfare to disrupt other countries; see Figure 11.4.3.

Material products

Material products of human economic systems include technologies, infrastructure (such as transport systems, education systems and buildings) and the other accumulated physical products of society. How these resources are owned and used is vital to social cohesion and conflict.

Land use and control of natural resources

Land is fundamental to human welfare. The control and use of land has been a powerful cause of political tension and conflict throughout human history. Control of and access to land have been essential to human survival ever since humanity evolved several million years ago.

Agricultural societies, which dominated the earth for the past several thousand years, rose and fell according to their ability to control large areas of territory. With territory came the potential for agricultural production, and the potential to produce more food than was required to feed the farmer's family. The surplus was used to feed the urbanised population and large armies. Territory also provided large numbers of people to work the land as slaves or peasants, pay taxes and be conscripted into armies. These age-old reasons for controlling territory remain a fundamental motivation of political tension and conflict in agricultural societies in the twenty-first century.

With the rise of industrial societies, territory took on other vital attributes in addition to agriculture. Land was now also the source of vital raw materials and energy: wood from forests for fuel and construction; minerals for industry; and fossilised hydrocarbon energy, such as coal and oil. In the beginning of industrialisation, during the eighteenth and early nineteenth centuries, raw materials were difficult to transport given the available transport technology. Early industry was located as close as possible to the raw material and energy supplies (such as iron ore, forests for fuel and running water for energy) and to transport arteries (such as canals and ports). As time went on, the dependence on physical location declined because of transport revolutions such as the invention of railways, the steamship, the internal-combustion engine and aircraft.

Access to resources

Secure access to raw materials for industry and energy is more vital than ever, and the controllers of strategic raw materials, such as gas and oil, are powerful in global geopolitics (see Figure 11.4.4). Modern industry needs vastly increased markets for its cheap products, so if the territories in which those consumers live can be controlled then competitors can be excluded. Thus, early industrialisation by Western European countries in the nineteenth century intensified the scramble by their governments to control the whole territory of the earth. The need for food, industrial raw materials and markets pushed the great empires of Europe, then the United States and more recently China to try to expand their control right across the planet, resulting, of course, in tension and conflict.

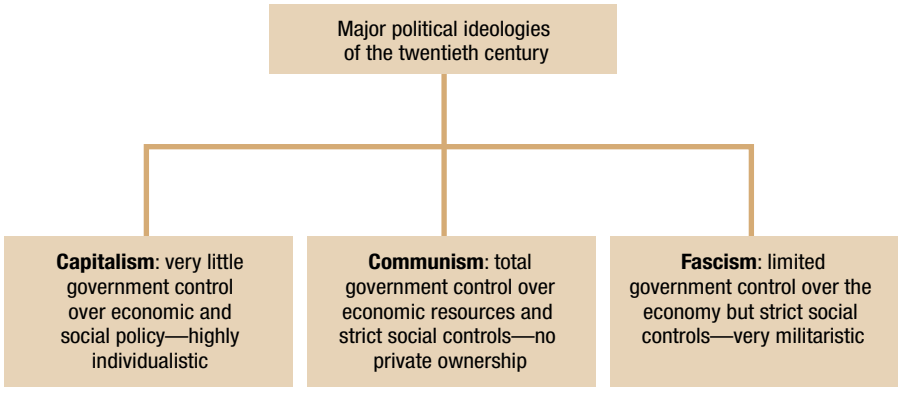
Access to secure food supplies is still a vital consideration for geopolitics. Hong Kong and Singapore, in spite of their lack of territory, have prospered through industrialisation due to their communications revolutions and, having an educated population, by being rich in human resources. However, they would be vulnerable if all external transport networks were cut. Even their water and electricity are imported. Similarly, access to land and water is fundamental for Israel, which has fought a series of wars to secure territory on which to actually build a state, grow food and house its rapidly growing population.

11.4.4 Since the late nineteenth century, control over oil resources has been a source of conflict in the oil-rich Middle East.

Ideologies

Ideology can be a prime determinant of political tension and conflict. An ideology is a system of ideas about how economy, society, culture and institutions function and/or should be organised. Most strong advocates of ideologies (called 'ideologues') have a rather utopian (idealistic) world view. They tend to believe that the world is a fairly simple place or that the real world is imperfect and needs to be reshaped to fit their ideological view of what the world should be like. In reality, the actual organisation and functioning of societies are more pragmatic (practical) than ideological. Societies usually combine elements of many organisational and ideological systems. The real world stubbornly refuses to adapt and fit into the simplified mould of an ideology. Nevertheless, some regimes try to implement their ideological view and, in doing so, tend to pressure the members of their society to conform to the dictates of the chosen ideology.

The most influential ideologies of the twentieth century were capitalism, communism and fascism, as illustrated in Figure 11.4.5. The conflict between these ideologies drove much of the tension and warfare of the twentieth century. Today these ideologies and the geopolitical legacy they created continue to shape tensions around the world.



11.4.5 Major political ideologies of the twentieth century

Capitalism

Capitalist ideology holds that all resources and productive activity should be privately owned and that the state should play a very limited economic role. Allocation of wealth, income and the products of the economy should take place in free markets, where purchasing power should be the sole determinant of the ability to buy and, therefore, consume. Emphasis is placed on individualism, rather than collective action.

Activities

Understanding the text

1. Outline the role of governments.
2. Write your own definition for what a resource is.
3. Differentiate between human and raw resources.
4. Explain what cyber conflict involves.
5. Explain why control of raw materials is such a significant source of conflict.

Working geographically

6. Using North Korea as an example, explain why totalitarian regimes are considered bad governments.
7. Write a short report explaining how resources can be a source of conflict.
8. As a class, discuss why water has become a source of conflict. Summarise your discussions in a graphic organiser.

11.4.6 Communist China's founder Mao Zedong is referred to as a demi-god. This huge portrait of him overlooks Tiananmen Square, Beijing.

Communism

Communist ideology maintains that all resources and productive activity should be collectively owned and controlled via the state, which is supposed to operate on behalf of the people. Private ownership of the means of production, including all capital, is abolished and labour is no longer exploited for profit by private capitalists. Wealth and income should be allocated according to needs rather than market purchasing power.

In time, communism became more focused on the individual leaders—this is sometimes referred to as Stalinism, after Stalin who led the communist Soviet Union in the style of a dictatorship. Similarly China's original communist leader Mao Zedong, often referred to simply as Chairman Mao, is still referred by many as a demi-god (see Figure 11.4.6).

Fascism

Fascist ideology combines an extreme form of nationalism with its own ideas about the role of the state and a desire for social harmony. Fascism, which emerged in Mussolini's Italy in the 1920s to 1940s, has had imitators in Latin America. Fascism advocated a powerful militaristic state that would subordinate all personal activity to the glory of the country. The economy and society were to be organised along supposedly efficient military lines and all dissent and disharmony were to be eliminated. More extreme versions of fascism, such as the German Nazi Party and Adolf Hitler (see Figure 11.4.7) had an avowedly racist social policy. This policy advocated the subordination and even extermination of all so-called 'non-Aryan' races. This idea of 'Aryan superiority' was one of the central myths of Nazism. Aryan was a term used by the Nazis to identify what they thought of as pure Western Europeans. The most hated of the non-Aryans were Jewish people, who the Nazis saw as sub-human. This led to the genocide of more than six million Jews, and more than a million other minorities (such as homosexuals and intellectually disabled people) and political dissenters in the Holocaust (see Figure 11.4.8.).

11.4.7 Under the leadership of Adolf Hitler, Germany's Nazi Party ruled Germany as a fascist country from 1933 until 1945.

Extreme nationalist ideology

Extreme nationalist ideology holds that the nation–state has a collective will and power, which should be superior to the will and power of individuals. People should be subservient to the collective welfare of the state. The notion of national superiority in nationalist ideology is racist in its extreme form. This is because extreme nationalism holds that the ethnic group that defines the state is culturally or racially superior to all other ethnic groups. Nationalists ruled Japan until its defeat by the Allies in World War II (see Figure 11.4.9). There are often strong parallels between fascism and extreme nationalism; other ideologies also borrow from nationalism when it suits their ambitions.

11.4.8 The twisted fascist ideology of the Nazi Party led to the death of more than six million Jews.

11.4.9 The US battleship USS Arizona burns and sinks in the Japanese attack on Pearl Harbour, Hawaii, on 7 December 1941. The attack by nationalist Japan saw the USA enter into World War II.

Religious ideology

Religious ideology is an extension of religious beliefs to include a system of ideas about how societies, economies and cultures should be organised. Most pure or fundamental forms of religion have an explicit, all-encompassing ideology based on what are believed to be divine teachings. Followers of the religion are led by these teachings when deciding how institutions and economies should function. What is 'good' and what is 'bad', and how to live every aspect of human life is religiously inspired and controlled in some societies, which tend to forbid many social practices and ways of life that would be tolerated in other societies.

Fundamentalist religion

While fundamentalist religion and its associated conflict is often viewed as a feature of Islam, this is far from accurate. The conflict and violence that gripped Northern Ireland for decades was fuelled by tensions between Catholic and Protestant communities. In the predominantly Buddhist Myanmar, the attacks on the Muslim Rohingya people is fuelled by religious intolerance. In India, Muslim and Christian minorities face considerable violence from fundamentalist Hindu groups and in the United States fundamentalist Christian groups have perpetrated attacks on homosexuals and those in favour of abortion rights. It is important to remember that in all cases, fundamentalists comprise a very tiny proportion of a population. Speaking in 2017 the head of ASIO, Australia's domestic spy agency that deals with terrorism in Australia, noted that less than 0.1 of 1 per cent of people of Islamic faith in Australia held any fundamentalist views.

Nationalist conflict

Nationalist-inspired tension and conflict in the world today take three main forms: conflicts between existing states; conflicts between ethnic groups within states; and economic nationalism.

Tension between states

Tension and conflict between independent, existing states can be inspired by national pride and feelings of ethnic superiority, by ethnic insults and even by ethnic phobia (an irrational, persistent fear). Examples include conflicts that begin as peaceful sporting events but turn into diplomatic or even military conflicts; attempts by states to redraw boundaries to better reflect ethnic borders; and tensions over immigration of certain ethnic groups.

Tension between ethnic groups

Perhaps the single biggest cause of conflict is nationalist demands by ethnic groups (or nations) that are part of multi-ethnic states. This form of tension is widespread. There are many examples from Africa, where most countries have within them several ethnic groups. The political borders of Africa, Asia and Europe do not often reflect ethnic boundaries, and many ethnic minorities wish for independence.

11.4.10 The Catalan region of Spain

In recent times the independence movement in Catalonia, Spain illustrates this tension. The Catalan region occupies an area of north-eastern Spain (see Figure 11.4.10). The people of Catalonia have a unique language and their cultural traditions are separate to those of the rest of Spain. Some parts of Spain, including Catalonia, are semi-autonomous with their own parliaments. In late October 2017 the Catalonian Parliament declared independence from Spain following a controversial independence referendum. The Spanish national Parliament in Madrid immediately suspended the Catalonian Parliament.

New elections were held in December 2017 and pro-independence parties won a majority. However, the single largest party to emerge was pro-Madrid. The situation created political gridlock in 2018, resulting in the Madrid government taking action.

Economic nationalism

Economic nationalism arises from a belief of governments and pressure groups that as the world economy becomes increasingly globalised, states lose economic autonomy or independence. They fear that with the decline of state economic control they will lose the power to intervene in the spending of money for social purposes, such as the redistribution of wealth. A consequence of globalisation of financial, agricultural and consumer markets is that some governments must remove subsidies, reduce taxes and welfare spending, and privatise government assets. Against this tendency, supporters of economic nationalism want governments to assert greater economic independence against the actions of the global financial markets. They also want governments to continue with existing welfare spending, employment structures and subsidisation of government-owned industries and services.

Ethnicity

Nationalism is closely connected with ethnicity. The definition of ethnicity is a highly controversial matter and this very controversy has been a prime cause of political tension within societies. Ethnicity is a combination of identifications, including race, language, geographical location, culture, cuisine, dress and general way of life.

Ethnicity has always played a significant role in conflict. Although globalisation has helped to promote greater understanding and tolerance, tensions based on ethnicity remain throughout the world. Two kinds of ethnic tension and conflict include:

- Ongoing historical tensions and conflicts can exist between ethnic groups in a particular territory—such as Northern Ireland, Yugoslavia, Catalonia, Rwanda, Sudan and Burundi.
- Immigration-induced tension can arise from non-traditional intermingling of people. This occurs when new immigrants move into a territory traditionally occupied by one race, such as West Indian immigrants arriving in Britain, Turkish immigrants in Germany, and Algerian immigrants in France. It can also exist within settler societies, such as Australia. In Australia, many ethnic groups have faced discrimination and harassment upon their arrival.

Social class

Social class is one of the elements that make up all societies and is a main cause of political tension and conflict. The division of societies into classes is closely related to geographical and economic considerations. The nature, strength and significance of classes has also varied enormously throughout human history. There are many theories about how classes are composed and about their power and significance.

The three main ways to define classes are based on occupation, cultural function and status, and relationship to property. However, these definitions do not take into account the crucial issue of social class-consciousness. Classes can exist as organised categories (such as occupations) without their members being conscious that they belong to a distinct class or deliberately acting in the interests of their class. Once a class of people recognises that they have a shared interest against the interest of another class and that they must defend their interest collectively, we can say that class-consciousness and class action occurs. Generally this only happens when large numbers of people are in close contact, have a strong sense of shared interest—especially a serious grievance about their quality of life—and are forced into concerted action.

Class and conflict in agricultural societies

In agricultural societies, the basic class distinction is between the rural agricultural population and the urbanised elite, or nobility, who live on the surplus agricultural products. The interests of the two classes are opposed; the latter dominates the former and often keeps them repressed. In addition to food, labour is extracted from the rural population, usually to build public buildings, palaces, roads and irrigation schemes. Within the elite class conflicting interests can arise between factions over their cultural role or position, the extent of state control and policies affecting accumulation of wealth.

SPOTLIGHT

Black Lives Matter

African-Americans make up around 14 per cent of the population of the United States. The majority of this population traces their heritage back to slaves who were transported there from western Africa in the eighteenth and nineteenth centuries. In the twentieth century, the civil rights movement saw greater equality for African-Americans, however, there remains considerable intolerance and inequality.

Following the acquittal in 2013 of a man who had shot Trayvon Martin, an unarmed African-American teenager, a posting on a site dedicated to ending violence against blacks ended with the words 'our lives matter'. From this posting, the Black Lives Matter movement developed (see Figure 11.4.11).

The movement has focused on the treatment of African-Americans by police in the United States. Statistics show that in 2015 for every 1 million African-American people in America, 7.13 were killed by police. This compares to 2.91 for Anglo-Americans. Tension has been growing between white supremacist groups and African-American groups, such as Black Lives Matter.

11.4.11 Black Lives Matter supporters at the Peoples' Assembly demonstration in the UK, July 2016. The movement started in the US, and has since spread worldwide.

Class and conflict in industrial societies

In the course of industrialisation, social classes change their character. A fundamental shift is brought about by the rise and complete dominance of capitalist manufacturing as the way of organising an economy and society. There is a tendency in the capitalist industrialisation process for the various classes of agricultural society to form a new society existing of only two classes. These two great classes—capitalist industrialists and workers—are opposed to each other in terms of their interests.

The greatest theorist of social classes, Karl Marx argued that this class division, or polarisation, would ultimately result in revolution–a peaceful revolution if universal suffrage (the right to vote) was achieved. In reality, true polarisation of classes has not occurred. Nevertheless, the underlying tension between capitalists and workers exists and is often reflected in conflict over wages and work conditions. Trade unions, employer organisations and political parties are the institutionalised forms of social classes in most industrialised societies. This can be seen in the basic divisions in Australian politics where the Labor Party is more or less representative of working-class interests, the Liberal Party is more or less representative of business interests and the National Party is more or less representative of rural interests.

Revolutions are one of the most significant outcomes of class conflict. A revolution is the complete overturning and replacement of the political and social structure of a whole society. A revolution occurs when a large proportion of a society is sufficiently angered by the political processes to rise up collectively against the ruling-class system.

There were many socio-political revolutions and near revolutions in the twentieth century. The most significant of these were the Russian, Chinese, Cuban and Iranian revolutions, all of which could be attributed largely to class conflict. No complete revolution has occurred in an advanced industrial society. All these revolutions or near revolutions came during the early- to mid-stages of industrialisation and could be seen as a result of the great upheavals caused by that process. Once industrialisation is achieved and societies begin to experience the benefits of growing affluence, the revolutionary impetus seems to pass. There is a significant absence of actual revolutions and even genuinely near revolutions in advanced industrial societies.

Class tensions and increased inequality in information societies

The rise of information economies, sometimes called 'post-industrial societies' or 'service economies', is a change as significant as the agricultural and industrial revolutions. Australia is becoming an information society. Several strong counter (opposing) tendencies are occurring in the economic and social organisation of these information societies (see Figure 11.4.12).

Capitalists/administrative elite	Retention and growth of power
Professional middle class	Growth in power through monopolisation of knowledge
Class of information/entertainment providers and controllers of information technology	Rise of a new class to significant power
Bureaucratic class	Decline in power with privatisation of public services
White collar administrative class	Decline to insignificance in numbers and organisations with rise of information technology
Small business/farmer class	Decline in power and increasingly dependent as franchisees/tenants of large capitalist corporations
Industrial working class	Decline to insignificance in numbers and power
Underclass of unemployed and semi-employed class	Growth in numbers but completely unorganised and the target of law and order campaigns as well as welfare groups

11.4.12 The class structure of modern industrialised societies

First, there is the rapid rise of the information sector in advanced economies. In terms of wealth generation, this sector is now one of the most significant. Information technology firms are today among the most profitable in the world. Yet they are not the largest employers. These industries are highly dynamic and constantly changing. Salaries tend to be large and there is usually a high degree of individual competition and job satisfaction.

Second, there is a correspondingly rapid relative decline in the economic significance of the industrial, manufacturing sector. Through much greater efficiency as a result of industrialisation, the agriculture sector declined as a proportion of employment. The growth of artificial intelligence and machine learning across the twenty-first century is predicted to lead to a further decline in employment (see Figure 11.4.13). Many roles are already beginning to become redundant, for example Sydney's north-west rail line is due to open in 2019 with driverless trains. Even occupations once thought of as immune from mechanisation, such as accountancy and legal professions, are already in decline.

11.4.13 Robots and artificially intelligent machines are replacing many forms of employment.

Third, growing affluence and education within much of the population in information societies have allowed for greater expenditure on leisure and culture. There has been a correspondingly rapid rise in the hospitality industry. This industry requires many semi-skilled, part-time workers. They are relatively poorly paid and often dissatisfied with their conditions. However, because the work tends to be casual or part-time there is little class organisation or consciousness.

This leads to the fourth tendency: growing social inequality between rich and poor, especially in countries where social welfare has been reduced. In post-industrial societies, there is a strong tendency towards the creation of an underclass of unemployed or partially employed people who have little, if any, prospect of ever gaining well-paid work. Among these people there is a feeling of hopelessness because of a lack of access to education, and limited future prospects.

Indigenous peoples

The relationship of a recently settled population with indigenous peoples is an ongoing and particular ethnic problem. It became much greater with the further spread of European empires after the fifteenth century.

In Africa and Eurasia, there have been large-scale movements of people into territories that had already been occupied by previously arrived people for many tens (perhaps hundreds) of thousands of years. The modern peoples of Africa and Eurasia are the result of the intermingling of people over many centuries. Nevertheless, there is a strong sense among many ethnic groups that they are the historic occupiers of certain territories. For example, the Celtic peoples of the western and northern fringes of the British Isles, and the Germanic peoples of north-west Europe believe themselves to be the indigenous populations of those regions. Whether they really are the original human inhabitants is unimportant in this context.

The situation in the rest of the world is a little different, where the first humans arrived much later than in Africa and Eurasia. Aboriginal Australians arrived in Australia at least 80 000 years ago. The Polynesians of the Pacific spread into their island territories during the past 5000 or so years and arrived in New Zealand about 1100 years ago. Native Americans first arrived in the Americas from north-east Asia about 12 000 to 14 000 years ago.

Colonisation and its impacts

The Europeans expanded overseas to the Americas, Asia, Africa, Australasia and Oceania from the late fifteenth century. In each of these places, they encountered local indigenous peoples. In many places, these indigenous people were conquered and sometimes enslaved. In the Americas, Australasia, Oceania and parts of Africa there was little or no recognition of native land ownership or native rights. The people were often treated as subhuman. Through a combination of violence, maltreatment, disease and starvation, their populations were decimated (largely destroyed). In some places they were exterminated (wiped out) completely.

In many occupied territories there was an influx of European land-seeking settlers. They, in turn, imported large numbers of slaves and contract labourers to replace the labour supply of the disappearing indigenous population. This led to the emergence, especially from the early nineteenth century, of a complex ethnic structure in many of these colonial territories.

Indigenous rights

Since the late twentieth century there has been a strong upsurge in demands by surviving indigenous people for the wrongs against them to be redressed and their rights to be upheld. These movements have taken many forms, and the form has depended on local social and political conditions. In South Africa, there was virtually a civil war waged by black groups against the white-settler apartheid regime. In the United States, Native Americans have agitated (mainly peacefully, but occasionally violently) for redress for past wrongs. In Canada, the native people have succeeded in gaining extensive land rights and a degree of political autonomy. The Assembly of Nations advocates on behalf of Canada's First Nations and liaises closely with government on indigenous issues in Canada (see Figure 11.4.14).

In Australia, there has also been growing recognition of the rights of Indigenous Australians. The 1988 Mabo decision by the High Court was a key advance. This decision recognised the rights of traditional owners and overruled the concept of terra nullius, which had been imposed on Australia by British settlers. Terra nullius—meaning land belonging to no-one—meant that there was no recognised owner of the continent and Britain could claim ownership. Despite these advances, considerable tensions remain in Australia over the rights of Indigenous Australians, and many face considerable disadvantage.

11.4.14 There has been growing recognition of the traditional peoples of Canada, known as the First Nations.

Economic instability

Economic security is essential if a country is to attract investment funds, sustain consumer confidence and reduce the potential for economic tensions. Governments seek economic stability through:

- promoting full employment and price stability; that is, keeping inflation low
- maintaining an acceptable level of foreign debt and boosting international confidence in the national currency
- encouraging economic growth; that is, the ability of a country to satisfy the material wants of its population over a period of time. A stable level of economic growth is required to improve the standard of living, increase employment opportunities and provide greater access to services, such as health and education.

The absence of economic stability can have disastrous consequences on the level of political tension within regions and individual nation–states.

For example, the 2008–09 financial crisis led to considerable tension across the world. In Greece, the economy fell into considerable decline. As part of the EU, Greece received assistance from other European nations, especially Germany; part of this assistance required Greece to agree to stringent restrictions on government spending. These policies became known as austerity policies; they led to widespread hardship for many Greeks. Protests erupted across the country and a new political party—Golden Dawn, which was an extreme nationalist party—emerged (see Figures 11.4.15 and 11.4.16).

11.4.15 This 2016 demonstration in Greece was protesting against austerity policies that have seen pensions slashed.

11.4.16 Financial instability saw the emergence of the far right Golden Dawn political party in Greece. Critics of the party claim it is a fascist neo-Nazi group.

Activities

Understanding the text

1 Explain what an ideology is.
2 Describe the features of Stalinism.
3 Outline the main aspects of extreme nationalism.
4 Describe the features of religious ideology.
5 Outline the features of nationalist conflicts.
6 Describe the concept of economic nationalism.
7 Explain how ethnicity can be a source of tension and conflict.
8 Describe how artificial intelligence and machine learning may lead to conflict in post-industrial societies.
9 Define the term economic instability.
10 Outline how the global financial crisis of 2008–09 led to increased geopolitical tensions.

Working geographically

11 Using Figure 11.4.5 and the associated text, briefly describe the features of each of the main ideologies of the twentieth century.
12 Write a short report explaining how ideologies can be a major source of conflict. Include specific examples to support your answer.
13 Conduct research into the independence movement of Catalonia. Prepare a short presentation on the current status of the movement and its key objectives.
14 Construct a table summarising the main types of social class in different types of societies.
15 Examine Figure 11.4.12. Write a short report on the main features of the class structure of modern societies.
16 Collect a media file of current geopolitical tensions and conflicts. Classify these conflicts and tensions by the main factors that cause them.

CASE STUDY

Religious fundamentalism and ISIS

Religion has always been a source of conflict. The Crusades of the Middle Ages brought centuries of war, destruction and misery to southern Europe and the Middle East. The tensions between Christianity and Islam that led to the Crusades are still present today and are a source of significant conflict globally.

Islamic societies within the Middle East were long ruled by European powers as part of their empires. Even after independence, many of these societies remained under the influence of the West. From the late 1970s, revolutions, insurgencies and civil wars broke out in many Middle Eastern countries, partly over the extent to which religious influences should dominate in government. The most famous example was the Iranian revolution of 1979, which overthrew the US-backed Shah and installed a fundamentalist religious government led by Ayatollah Khomeini. A complicating religious factor in the region is the schism, or division, within Islam between the Sunni denomination and the larger Shia denomination.

Western influence

The influence of the West remains a major source of tension. For many fundamentalist Islamists, Western culture is corrupting and against their religious teachings, and must be destroyed. This is coupled with another long-standing religiously based conflict—that of the status of Israel. Israel is a predominantly Jewish state and many in the Middle East oppose its existence on land whose ownership is contested by the majority Islamic Palestinians. Support for Israel in the West is very strong, particularly in the United States, which is Israel's key ally.

Today, fundamentalist religion is blamed for the extreme forms of terrorism that have emerged in the early part of the twenty-first century. The 2001 attacks on New York's World Trade Center (see Figure 11.4.17) marked a new wave of terror that has since continued. The attacks prompted the invasion of Afghanistan and subsequently Iraq by the US and its allies (including Australia), leading to further conflict which persists today. There have been attacks on Western targets in Bali in 2002 and 2004, the Madrid train attack in 2004, several attacks in the UK, including a major bombing in 2005 and numerous attacks more recently across Europe, especially France, Spain, the UK and Belgium, prompting massive security operations (see Figure 11.4.18).

The rise of ISIS

At the start of the twenty-first century, al-Qaeda and its leader Osama bin Laden were the main focus of attention in regards to radical Islamist terrorism; it was this group that perpetrated the World Trade Center attacks. Another group, originally associated with al-Qaeda, was to emerge by 2014 as a much greater force—ISIS.

ISIS, sometimes known as Islamic State (IS) or Daesh, sought to achieve more than spread terror. They wanted to create their own country based on strict Islamic laws that drew from an eighth century version of Islam, seeking to replicate a society based on these times. Brutal punishments, public executions and severe repression were features of ISIS control.

11.4.17 The 2001 attack on New York's World Trade Center marked a new wave of conflict.

11.4.18 Persistent terror attacks saw France and other European nations deploy thousands of troops across cities.

Iraq and Syria

ISIS saw an opportunity in the chaos of Iraq which had been invaded by the US in 2003 and where government control was tenuous and disjointed. Equally, across the border in Syria, a civil war between the ruling dictator (Bashar al-Assad) and a disparate mix of anti-regime forces, including well organised and equipped Kurdish rebels, created further chaos and opportunity for ISIS (see Figure 11.4.19).

ISIS forces were highly effective, especially in Iraq, seizing military bases and the weapons they contained. By 2014 they controlled a huge area of Iraq and Syria totalling more than 55 000 square kilometres; this included the large cities of Fallujah, Mosul and Tikrit. Hundreds of thousands of people were now under ISIS rule and it is estimated that about 4000, mostly girls from the Yazidi ethnic minority, were held as slaves. The rise of ISIS saw huge numbers of refugees flee, leading to the so-called refugee crisis in Europe.

ISIS was highly effective in using social media to attract fighters from around the world, including some from Australia. These fighters were lured by the promise of a paradise; most were quickly killed in bitter fighting, often with Kurdish rebels.

By 2016 the tide began to turn for ISIS as Iraqi forces, with the help of Western forces, began to retake territory. Similarly in Syria the hold of ISIS was weakened. In October 2017, Raqqa—the self-declared capital of the ISIS nation—fell to mostly Kurdish forces in northern Syria (see Figure 11.4.20).

By this time, ISIS had begun to resort to terrorist style activities as it became clear that they could not sustain a traditional war and hold onto their territory. They again turned to social media to encourage supporters to engage in high-impact, low-tech attacks, such as the 2017 truck attack in Barcelona, Spain, where ISIS supporters drove a truck into crowds killing 16 and injuring many more. A similar attack in Nice, France, in 2016 killed more than 80 people.

11.4.19 By 2014, ISIS forces controlled more than 55 000 square kilometres of territory in Iraq and Syria.

11.4.20 The Syrian city of Raqqa was left in ruins in October 2017 as Kurdish forces defeated the ISIS forces who held the city.

Activities

Working geographically

1. Outline the meaning of fundamentalist religion.
2. Describe the impact of fundamentalist religion on geopolitics.
3. Using the internet and other sources, conduct research into the current status of ISIS. Prepare a bullet point summary of its status.

UNIT 11.5

Geographical outcomes of political tensions and conflicts

One of the major consequences of political tensions and conflicts is the large-scale movement of people.

Migration and mobility of people

People are dislodged, displaced, ejected and generally forced into moving by geopolitical forces over which they have little or no control. Wars and famines are two of the main causes of dislocation, but poverty, persecution and economic opportunity are also major causes of the large-scale migration of people.

Forced migrations

Forced migrations of people take place before, during and after a war. The refugee problem has been one of the major global geopolitical issues since World War II. In the twentieth century, many wars were started with the express purpose of expelling and/or capturing large numbers of people with the goal to either 'ethnically cleanse' a territory or resettle a population. In recent decades, tens of millions of refugees have fled from conflicts and many of those people are unable or unwilling to return to their homelands. These displacements, in turn, often cause major humanitarian relief problems for aid agencies, host countries and the United Nations.

Voluntary migrations

After conflicts have been settled, many people remain dissatisfied with the outcome and look for ways to migrate to a new region. Even though these people were not displaced by the conflict, as such, their movement is a longer-term consequence of conflict. The migration of millions of Vietnamese and Cambodians to countries of South-East and East Asia and to Australia has been an enduring consequence of the communist victory in the Vietnam War.

Famines

Famines, diseases and other hardships often result from the socio-economic collapse that accompanies war. Sometimes more people die through these causes than through military activity. In some cases famine is used as a weapon against people. For example, there have been allegations that the dictatorial government of North Korea has deliberately created famine by denying aid agencies access to internally displaced persons in order to repress them.

War-related famines are typically seen in countries with considerable civil unrest and internal tensions. Governments in such circumstances are often ineffectual in supporting their own citizens and on occasions have actively used famine as a weapon against areas that they are seeking to repress. This was the case with a terrible famine that struck much of eastern Africa in the second decade of the twenty-first century.

The region known as the Horn of Africa is among the poorest on earth and drought is common in the semi-arid environment. A severe drought began in the area in 2011 and continued for years. While the drought caused great hardship, the famine and the misery and deaths it caused were made far worse by the region's geopolitical situation. Conflict and political instability characterise the entire region. South Sudan, the world's newest country, was forged in a bitter civil war that saw it break free from Sudan. Internal conflict continues as rival groups seek control. In Somalia, a 20-year civil war left the country with no effective infrastructure and a central government that is fragile at best.

The radical Islamist group Al-Shabaab, an affiliate of Al-Qaeda, has engaged in terrorist activities across the country, including a series of bombings in late 2017 in the capital Mogadishu that left hundreds injured. Against this backdrop of ongoing conflict, security aid agencies struggled to provide assistance to the starving millions of innocent civilians across the region (see Figure 11.5.1).

Genocide

Genocide is the most extreme consequence of war. It is the attempt to exterminate a whole ethnic population or class of people. The fascist Nazi party of Germany oversaw the killing of more than six million Jews during World War II. In Europe in the 1990s, there is evidence of so-called 'ethnic cleansing' activities in the wars that raged as Yugoslavia broke apart.

In Cambodia in the late 1970s the Khmer Rouge, who ruled Cambodia, engaged in the systematic killing of more-educated people across the country. According to the extreme communist ideology of the Khmer Rouge and their leader Pol Pot, the country needed to be cleansed of all capitalist influences which they equated with education and city living. The people were forced back to an agrarian subsistence lifestyle. In the four years of Pol Pot's rule up to two million were killed in the genocide (see Figure 11.5.2). After losing power in 1979, the Khmer Rouge continued an armed conflict in the jungles of Cambodia until 1991.

More recently, the killing and displacement out of Myanmar of over 600 000 Rohingya people has been described as ethnic cleansing.

11.5.1 A gravely malnourished child in South Sudan

11.5.2 These photographs of prisoners line the walls of a museum at the notorious S21 prison in Cambodia. A former school, the Khmer Rouge converted it into a torture and execution centre. Of the 14 000 prisoners who entered its gate only seven are thought to have survived.

Activities

Understanding the text

1. Outline the link between conflict and migration flows.
2. Differentiate between voluntary and involuntary migration.
3. Describe how conflict and political instability contribute to famine.
4. Define the term genocide.
5. Explain the link between ideology and genocide.

Working geographically

6. Undertake research into the famine in the Horn of Africa. Prepare an overview of the famine, its causes and consequences.
7. a Outline the nature of the conflict and tension that led to the Rwandan genocide.
   b Describe the role played by European imperialism in the genocide.

SPOTLIGHT

The Rwandan genocide

Before the outbreak of civil unrest, Rwanda was the home of nearly eight million people crowded into an area less than one-third the size of Tasmania. About 85 per cent of the population were Hutu and 15 per cent Tutsi.

In mid-1994, three months of fighting between the followers of the majority Hutu government and the minority Tutsi rebels of the Rwandan Patriotic Front (RPF) left at least half a million dead. Most of the victims were Tutsi civilians slaughtered by Hutu militia. Many of those who survived the genocide fled the country. A resurgent RPF gradually gained the upper hand and soon controlled much of Rwanda. This led to a second exodus of an estimated 1.2 million Hutu refugees, forced to flee for fear of retribution from the now victorious Tutsi-led rebels back in Rwanda and a second wave of violence rocked the country. By July 1994, more than four million people had fled the intertribal genocide that swept across their homeland. (See Figure 11.5.3.)

At the height of the crisis, international observers estimated that, in addition to the hundreds of thousands killed, more than one million people had crossed into Zaire (now the Democratic Republic of Congo) and a similar number into Tanzania and Burundi. Inside Rwanda there were as many as one million displaced people in a small area protected by French peacekeepers, and another half a million in camps in the rest of the country. A further half million roamed the countryside.

The number of refugees overwhelmed the authorities in neighbouring states and the resources of the international aid agencies. Refugee camps grew at an alarming rate. Outbreaks of cholera and other infectious diseases killed an estimated 100 000 people. Bodies could not be buried quickly enough, and the limited amount of water that was available quickly became contaminated by faecal matter and decaying corpses.

11.5.3 Victims of the Rwandan genocide

The cause of the conflict between the Hutu and Tutsi tribes has its roots in Africa's colonial era. Before Rwanda and Burundi were colonised by Germany, and then handed over to Belgium after World War I, the two tribes were clearly differentiated, even though they spoke the same language. Both the Germans and Belgians preferred the Tutsi, partly because they found them better-looking and partly because there were fewer of them; colonial powers usually lavish their favours on smaller and, in their opinion, superior tribes.

Over time the two tribes intermarried and the distinction between them has become almost entirely social and financial: if you have a car, an education or a larger house, you are a Tutsi. The outbreak of violence in 1994 was part of a deliberate attempt to stamp out an entire economic caste. This was fostered by the extremist Hutu leadership and enthusiastically followed up by elements in the army. It was the equivalent of Pol Pot's attempt to eliminate the Cambodian bourgeoisie. Hutu propaganda depicted Tutsi as gripping the throat of the country, stuffing their pockets with the state's money and carrying out murders.

By the end of the conflict, as many as one million people had died as a result of violence or disease in the refugee camps. Thankfully today, years of reconciliation and aid development (seen in Figure 11.5.4) have seen Rwanda emerge as one of the more stable and prosperous nations of Central Africa.

11.5.4 Australian military personnel served in Rwanda as part of a UN peacekeeping mission following the genocide there.

CASE STUDY

Syrian refugee crisis

Since 1971, Syria has been ruled by the Assad family as a totalitarian regime. The Assads did not advocate religious extremism but ruthlessly repressed any opposition to their rule. The 23 million people of Syria are ethnically and religiously diverse, but the country remained largely free of conflict due to the Assad totalitarianism.

Arab Spring and rising conflict

In 2011, protests began across many parts of North Africa in a movement known as the Arab Spring. These protests were against totalitarian regimes that dominated much of the region. In Syria a turning point came in April 2011 when government security forces opened fire on demonstrators. Very quickly the protests led to a full-scale armed rebellion.

By July 2011, the Free Syrian Army (FSA) had been formed. The FSA was initially made up of civilians who were opposed to the Assad regime, and deserters from the Syrian Army. Initially the goal was a democratic government to replace Bashar al-Assad, the dictator. Gradually, religious extremists began to infiltrate the FSA with the goal of a strict Islamic government; many of these fighters were non-Syrians. The bulk of the Syrian army remained loyal to the Assad regime.

Civil war

A full blown civil war developed with little regard for civilian casualties. As the Assad regime fought for survival they turned to chemical weapons and blanket bombing. Atrocities were also common from rebel forces. In the chaos that ensued ISIS, a well-organised Islamic fundamentalist group, joined the war and began to take huge areas of territory and implement a brutal and archaic society.

By 2013, more than 90 000 people had died in the conflict. As the war progressed the international community largely stood by. By 2015, the number of deaths exceeded 250 000 and millions of civilians had fled Syria, heading towards Turkey and other neighbouring countries. More than 5 million Syrians were refugees by the end of 2017 and another 6.6 million were internally displaced within Syria, meaning that nearly 50 per cent of the country's population had been forced into involuntary migration.

Syrian refugees

In 2015, many of these Syrians refugees made the perilous journey towards Europe in the hope of a better life. People smugglers offered trips in tiny boats to Greek and Italian islands off the coast of North Africa (see Figure 11.5.5), with thousands drowning at sea.

By mid-2015, more than 400 000 Syrian refugees had arrived in Europe, creating what was called the 'refugee crisis'. By the end of 2015 the number had increased to 1.3 million. Many people began to make the journey overland. The German government, under its Chancellor Angela Merkel, took the decision that it would resettle many of these refugees. In scenes not seen since the end of World War II, people began to walk across Europe, heading mainly northwards towards Germany, shown in Figure 11.5.6. Other countries in the region began to shut their borders to stem the flow and a political crisis developed in Europe.

11.5.5 Syrian refugees undertake the dangerous journey by boat to southern Europe.

11.5.6 Syrian refugees walk across Europe's Balkan region on their way to Germany.

Germany's response

The decision of the Merkel government to accept so many refugees was highly controversial within Germany. There was considerable support but also the decision saw a marked rise in anti-immigration nationalist movements (see Figure 11.5.7).

In the 2017 national elections in Germany the far-right anti-immigration party Alternative for Germany won almost 13 per cent of the vote. Indeed, across much of Western Europe there has been a rise in these parties, including some that are extreme in their views and could be considered neo-Nazi.

11.5.7 Anti-migration protests such as this one in Dortmund Germany by neo-Nazis have become more common since Germany provided sanctuary to hundreds of thousands of Syrians fleeing the civil war.

Activities

Working geographically

1. Briefly outline the political structure of Syria.
2. Describe the nature of the Free Syrian Army.
3. Write a short report on the consequences of the Syrian civil war.
4. Describe the link between the civil war in Syria and the rise of extreme politics in Europe.

UNIT 11.6

Outcomes of geopolitical tensions

All tensions and conflicts have outcomes that affect many levels of socio-political life to a greater or lesser extent. There are a number of potential outcomes.

Political outcomes

Almost all geopolitical tensions and conflicts result in political changes. Some may simply involve a change of government by a peaceful election, such as happened in Australia's constitutional crisis of 1975. Others may involve the violent overthrow of a government by a revolutionary upheaval.

Most recently, numerous governments across North Africa fell as a result of the so-called Arab Spring uprisings. In Libya, a popular uprising began in early 2011 following the arrest of human rights activists. Libya had been under the control of Muammar al-Qaddafi for decades. Like other dictators across the region he used violence and repression to maintain control. In response to the protests, there was violence and further repression by government forces and protests quickly developed into a full-scale armed rebellion (see Figure 11.6.1). By the end of 2011, Qaddafi had been removed from power by anti-government forces with the help of air power from Western nations.

11.6.1 In 2011, protests against government repression in Libya soon turned to full-scale conflict which eventually saw the fall of the dictatorial leader Muammar al-Qaddafi.

Constitutional outcomes

A constitution is the document that outlines the rules by which a country is to be run. In democratic nations, constitutions can be changed with the consent of the people through a special vote called a referendum. Throughout the twentieth century most nations underwent some form of constitutional change, often as a result of decolonisation and the gaining of independence. In other cases, such as Germany and Japan, new constitutions were developed after World War II that dealt with the country's wartime role. Australia is one of just a few countries that has had a very stable constitution since it was first written. There have been very few changes and it is notoriously difficult to achieve a successful vote in referenda. Resolving tensions through constitutional change has largely been an effective way to peacefully and stably resolve disputes.

11.6.2 Somaliland has been denied independence by Somalia.

Territorial outcomes

Since the end of the Napoleonic Wars in 1815, the big powers have been willing to intervene in the map of Europe, just as they have in the rest of the (colonised) world. On several occasions they have redrawn boundaries to try to accommodate ethnic distributions, national rivalries and aggressive national attitudes. These forced boundary redrawings have rarely succeeded in permanently solving such problems.

Generally, throughout the world today, there is a reluctance to redraw boundaries. This is even the case when those boundaries, especially if inherited from a colonial situation, are inappropriate on ethnic grounds.

Somaliland

The region of Somaliland has long sought independence. Somaliland occupies a slice of Somali territory on the southern shores of the Gulf of Aden (see Figure 11.6.2). As discussed earlier, Somaliland is not a country, despite calling itself one—to the rest of the world Somaliland is a self-governing autonomous region within Somalia. On several occasions, the African Union (AU) has stated that recognition of Somaliland could only come about with the consent of Somalia. The AU seems concerned that granting independence may result in further regions seeking independence across Africa, resulting in instability.

Resource allocation outcomes

The capture and defence of resources and/or their reallocation have always been a significant outcome of conflicts. Arable land, oil and labour were the most important resources at the heart of tensions and conflicts in the twentieth century. All instances of resource control and allocation are consequences of power. The role of OPEC (Organisation of Petroleum Exporting Countries) and the interventions of the Western powers in the Middle East during the past few decades have resulted in a continuation of the flow of oil to industrial countries. As discussed earlier, the control of water supplies is likely to become an important issue in resource conflicts and outcomes in the twenty-first century.

Environmental outcomes

Outcomes of geopolitical disputes can have significant environmental consequences, from air pollution caused by the lighting of oil wells at the end of the first Gulf War to the marine pollution caused by leaking World War II wrecks in the Pacific. Geopolitical disputes are also caused by environmental issues, and the greatest threat now identified is climate change. The effects of climate change will impact upon the whole geopolitical landscape (see Figure 11.6.3). It is being described as a 'threat multiplier', which means that it will accelerate threats already present.

In 2010, the Arab Spring, a series of protests and demonstrations across the Middle East and North Africa began. The cause of political unrest has been linked to the effects of climate change by some scientists and observers. In the mid-2000s, the region suffered a crippling drought, combined with a long-term decline in rainfall and increasing temperatures. Groundwater supplies dwindled. This in turn affected the food supply, and the cost of basic goods increased. The poor responses by governments made the situation worse, and the people began to protest.

Social structure

A reorganisation of social structures can occur as a result of a geopolitical crisis. In the case of some conflicts (particularly those resulting from inequality of social classes) there can be quite profound alterations in the class and family composition of societies. This is particularly the case following revolutions. Marxist-inspired revolutionary movements and upheavals (such as in Russia, China, Vietnam and Cuba) had great effects on social structure in the long run. Whole social classes disappeared, especially landlords and capitalists. New classes of bureaucrats and party officials rose to prominence.

With the demise of the communist regimes of Europe, the capitalist class has returned, but not the landlord class. The social structure of the former communist countries of Central Europe is today quite different from the more established capitalist societies of Western Europe. Across the communist nations of Asia, particularly China, tension has developed between the political ideologies of communism and a desire for economic development. This tension has led to a reinvention of communism towards greater acceptance of capitalist economic principles while also maintaining communist political principles. This shift has seen the emergence of a wealthy elite class of business entrepreneurs and a successful middle class in China (see Figure 11.6.4).

Cultural reorganisation

Cultural reorganisation can also be the outcome of a conflict. Sometimes cultures, or their key aspects (such as languages), are suppressed and even disappear because of the outcomes of geopolitical conflicts. The suppression of minorities and the banning of languages and other forms of cultural expression can be of lasting significance. In many parts of the world, ethnic cultures disappeared as a result of colonialism and/or policies of assimilation. Against this, indigenous peoples are today fighting back vigorously and policies of multiculturalism are common in many Western countries. In many developing countries there are still strong movements to suppress minority cultures.

11.6.3 Climate change and other environmental issues have become highly politicised.

11.6.4 Changing economic policies have seen the emergence of a very wealthy elite class in China.

Activities

Understanding the text

1. Describe the political and constitutional consequences of conflict.
2. Explain the concept of boundary redrawing.
3. Outline the link between resource allocation and conflict.
4. Describe how environmental factors can lead to increased tensions.
5. Outline how social and economic tensions have resulted in changes in the nature of communism in China.

Working geographically

6. As a class discuss the notion of boundary redrawing and why it is so rarely successful. Consider strategies that might improve its effectiveness.
7. Conduct research into climate change denial. Describe the link between political ideology and climate change denial.

UNIT 11.7

Resolving or preventing geopolitical issues

The resolution of political tension and conflicts takes place at many levels, involves many forces and can have many outcomes. A tension or conflict can only be resolved in a lasting manner by addressing and overcoming the deep-seated causes of the problem.

Many attempts to resolve conflict fail because of a lack of understanding of the causes. Adding to the complexity, many wars are deliberately started and pursued by leaders who have definite objectives in mind. Outside forces, such as the major powers (or the major powers acting on behalf of the United Nations), have often failed in their attempts to intervene in, or mediate, conflicts. This failure is a result of their inability or unwillingness to grasp the complex social causes involved and the deliberate motives of some combatants. The causes of conflicts are complex; so too are lasting resolutions.

Realpolitik

11.7.1 Despite social and technological advances, political violence remains common.

A traditional point of view on the resolution of serious political conflicts and wars is known by the German term realpolitik. This doctrine suggests that disputes and conflicts are inherent in human society and should be solved in a so-called practical, rather than moral or ideological, manner. A 'practical' solution often means that interests of a material (economic) and biological (racial) nature are more important than rationality and morality. Solutions should only take account of material and biological interests. In practice, this usually means that force prevails. This is achieved by using an external power to forcefully remove the causes of the dispute. It can also be achieved by allowing one of the contending parties to overthrow the other in the interests of removing the problem permanently.

In some cases, the application of realpolitik may also stem the degree of violence. For example, Saddam Hussein ruled Iraq as a violent and authoritarian dictator, but under his heavy hand he was able to keep the peace between the opposing Sunni and Shia Islamic groups, while also providing a counterbalance to Iran. In effect, he created a degree of stability in a region where stability is rare.

As realpolitik accepts, political violence often (but not always) works to the advantage of its perpetrators. The continuing examples of violence throughout history shows that the willingness to employ force has not diminished (see Figure 11.7.1).

Conflict and war

Carl von Clausewitz was an early nineteenth-century German theorist of the geopolitics of war. He also participated as an officer in the French Revolutionary and Napoleonic Wars, and wrote that:

> War is a clash between major interests that is resolved by bloodshed; that is the only way in which it differs from other conflicts. Rather than comparing it to an art we could compare it to commerce, which is also a conflict of human interests and activities; and it is still closer to politics, which in turn may be considered as a kind of commerce on a larger scale.

Elsewhere, he made the famous statement that, 'War is a continuation of politics by other means.'

Clausewitz seems to have been correct, at least in the case of some wars. Sometimes hatreds are deep-seated, and aggressive policies are firmly entrenched. In such cases there may not be sufficient common ground between conflicting groups, classes or states to resolve conflicts without one of the following occurring:

- the total destruction of one side by the other (or of both by each other)
- the total and permanent domination of one by another
- the total separation of the contending parties.

Even with the best will to solve tensions and conflicts by mediation, and even with an excellent understanding of the causes, there may be no other possible outcomes. On the other hand, many conflicts are resolvable before they become violent, and much violence can be ended through negotiation by employing third parties and sufficient power to enforce agreements.

A global government

Examining the tensions and conflicts in geopolitics seems to lead logically towards an argument in favour of some form of limited global governance. Such governance would be concerned with at least trying to prevent and then resolve violent disputes. Such thinking lay behind the founding of the League of Nations in 1919 and the United Nations in 1945, in which a significant role was played by Australia's then foreign minister, Dr HV Evatt. The possibility that such global governance would actually have an effect depends on:

- the willingness of states to surrender a little sovereignty
- the organisation having sufficient force and resources to command compliance with decisions and to finance whatever changes may be necessary, such as the resettlement of large populations
- the organisation having sufficient wisdom to understand and act on the causes of conflicts.

Together these three provisos (qualifications) amount to the beginning of global federation, something that member states have so far been unwilling to contemplate.

In the economic and environmental spheres there have been some limited steps towards global governance. In the sphere of geopolitics there are already many limitations on the powers of states to act independently of the international political community. As the pace of globalisation increases, the need grows for certain states to take joint environmental and defence measures against pollution, nuclear weapons and military aggression. As a result, further steps towards global governance will occur. Until then, there are a number of paths available for the attempted resolution of geopolitical conflicts.

Resolving tensions and conflicts

There are numerous paths towards resolution of conflicts, and usually a combination is employed to resolve a particular conflict. The civil war in Syria is a recent example of the great complexity of geopolitically inspired violence, the paths to its resolution and the possible outcomes. In this conflict there are multiple sides, each with specific agendas and ideologies. The war is not simply one of government and anti-government forces but instead a whole mix of disparate groups. The situation is further complicated by the involvement of Russian military on the part of government forces and a US led coalition (including Australia) whose aircraft are targeting ISIS militant fighters involved in the conflict.

SPOTLIGHT

Doc Evatt and Australia's role in the formation of the UN

Dr Herbert V. (Doc) Evatt (1894–1965) was an Australian jurist, politician and writer. Evatt was elected as an Australian Labor Party member for Balmain in the NSW Legislative Assembly in 1925. He served there until 1930. In 1930, the Scullin Labor (Federal) Government appointed Evatt as the youngest-ever justice of the High Court of Australia.

In 1940, Evatt resigned from the High Court to return to politics, and was elected federal MP for the Sydney seat of Barton. When Labor came to power under John Curtin in 1941, Evatt became attorney-general and minister for external affairs (foreign minister).

Evatt was a member of the diplomatic councils of the Allies during World War II. In 1945 he played a leading role in founding the United Nations. Australia is one of the 51 founding members of this body. Evatt was president of the UN General Assembly during 1948–49 and was prominent in the negotiations that led to the creation of Israel. He helped draft the United Nations Universal Declaration of Human Rights (see Figure 11.7.2).

11.7.2 Dr HV Evatt signs the UN Charter in 1948 on behalf of Australia.

Conquest, domination and flight

Conquest, domination and flight is the most extreme solution to conflict but it is sometimes the only one that works permanently, albeit unfortunately for the vanquished (defeated) or displaced people. Two major examples seem to confirm this.

Example 1: Germany

The two world wars were essentially two phases of one war of German aggression in Europe. Germany sought to dominate the European continent and to then dominate the world. The first war ended in 1918, almost in a stalemate of exhaustion in the sense that Germany was not conquered and invaded as a territory but surrendered before that happened. The subsequent peace treaty stripped Germany of control of some eastern and overseas territories. However, it left large German populations in the eastern territories in Czechoslovakia and Poland. The treaty also imposed major reparations (penalties). However, most of Germany was not occupied and German politics were left to run their own course.

11.7.3 Russian troops hoist their flag over the Reichstag, the German Parliament, in 1945 marking the total defeat of Nazi Germany.

In the 1920s and 1930s there arose in Germany a theory that the country had been betrayed in 1918. The Nazi government started the second war partly to seek revenge for the partial defeat in the first war. If Germany had been completely conquered, occupied and restructured after the first war, the Nazis may never have come to power.

In the second war, Germany was completely conquered, physically destroyed and occupied (see Figure 11.7.3). Subsequently, there was political restructuring; partitioning of the east and west until 1989; rehabilitation within new borders; and massive migration of Germans out of Eastern Europe back to Germany. All these actions removed any possibility of a major totalitarian resurgence and aggressive policy. Thus, from a realpolitik viewpoint (and confirmed by the subsequent history of peaceful European integration) a complete German defeat was not only necessary in 1945 but also removed the 'German threat' from Europe once and for all by the massive migration of German peoples.

Example 2: Yugoslavia

The ending of the Yugoslav wars of the 1990s only came about after implementation of the realpolitik solution of a more or less complete forced separation of the warring ethnic groups of Croats, Serbs and Bosnian Muslims, and a negotiated settlement on the basis of that separation.

International treaties

Often conflicts are resolved (or prevented) with treaties. Treaties are special agreements between nation–states. In order to be valid, treaties must be entered into voluntarily and require the parliament of a country to ratify them. This means that the parliament must pass a law accepting the conditions of the treaty.

11.7.4 Polish troops participate in joint NATO exercises. The NATO Treaty guarantees mutual security for members.

Treaties can prevent tensions from becoming conflicts. Australia has several treaties with its neighbours. These are designed to either prevent conflicts, as in the case of the Australia–Indonesia Treaty of 1995, or to enhance a country's security, for example the NATO Treaty, which many European countries belong to along with Canada and the United States (see Figure 11.7.4). This treaty means that an attack on one member is considered an attack on all. These treaties are often very important for smaller countries that may otherwise be more vulnerable.

Perhaps the most significant treaties made since World War II have been the various nuclear arms limitation and reduction agreements between the superpowers. These agreements were aimed at preventing deliberate or accidental nuclear war and became especially important after the Cuban missile crisis of 1961. More recently there have been threats to these arms reductions. In 2017, US President Donald Trump called for a significant increase in US nuclear weapons, drawing criticism from around the world, including many members of the US administration, such as the US Secretary of Defence.

International alliances

Alliances between various parties, especially states, involved in tensions sometimes have the effect of preventing tensions from becoming wars. This is achieved by deterring possible aggressors or by projecting such power that the will of the alliances can be imposed on another country. Most states join alliances as a means of gaining security against potential enemies. Because of this balance of power, conflict can be avoided.

On the other hand, the existence of two great alliances on the eve of World War I meant that when fighting did break out in the Balkans, most of Europe was drawn into a major war. Thus, alliances can both prevent wars or widen them when they do start.

The Cold War of the 1950s and 1960s never became 'hot' in a direct sense, although there were often real but 'proxy' wars. This is when two opposing nation states support opposing sides in a separate conflict. During the Cold War, the US and the USSR supported many 'proxy wars', including the Korean War.

DID YOU KNOW?

The concept known as MAD—or mutually assured destruction—may have prevented all-out fighting during the Cold War. This is the idea that neither the USA nor the Soviet Union would initiate a nuclear war as they understood that to do so would invite a retaliation that would lead to their destruction as well.

Partitions and separations

When tensions and conflicts are caused by inter-ethnic hostility or ideological divisions, the partition (division) of a territory and the forceful separation of potential combatants can prevent further violence and even produce a permanent peace. Throughout history there have been numerous examples of partitions.

Korea

Following World War II, Korea was partitioned into North and South Korea. North Korea became a communist state and the south became nominally democratic. The Korean War (1950–53) followed the invasion of the south by the north. When the war came to an end it was agreed that the partition would return to its original point, the 38th line of latitude. This is where the border remains today (see Figure 11.7.5). A demilitarised zone of around 4 kilometres wide along the border is maintained but both sides also maintain huge troop numbers on either side, and tensions remain.

11.7.5 South Korean (foreground) and North Korean (background) soldiers eye each other off at the border between the two countries, one of the most tense borders globally.

Cyprus

The island of Cyprus is located in the Mediterranean Sea, and has a long history of domination by various great empires. In the nineteenth century the Ottoman Empire took control of Cyprus, then Britain also became interested. The Greek population frequently clashed with the Turkish population and a series of partitions began. In 1960, Britain—along with Greece and Turkey—agreed to make Cyprus an independent nation–state. One of the key clauses in the agreement was that Cyprus would not be permitted to form alliances with any other country and it would not be partitioned.

Despite these agreements the longstanding conflict between Greek and Turkish Cypriots intensified. By 1963 open fighting broke out between the two groups. In 1964, the United Nations authorised peacekeepers to be sent to the island. Both Turkey and Greece threatened to invade the island, but the UN intervention kept them at bay. By 1983 the Turkish population had formed their own government and the island become unofficially partitioned with the formation of the Turkish Republic of Northern Cyprus. Turkey is the only country to recognise the legitimacy of this republic. Today Cyprus remains divided. UN peacekeepers still operate in the country in what has become one of the longest peacekeeping missions in history.

Czechoslovakia

Some separations have proved peaceful and successful. The so-called Velvet Revolution saw the non-violent collapse of communist rule in Czechoslovakia in 1989.

Czechoslovakia was an artificial creation of a country created at the end of World War I when the Austro-Hungarian Empire collapsed. After World War II, Czechoslovakia became a communist country under the control and influence of the Soviet Union.

The 1989 Velvet Revolution was followed by the 'velvet divorce' in 1993. By mutual agreement the country split into the two former provinces that it was once made from, becoming the Czech Republic and Slovakia. Today, both countries live as neighbours with shared interests. Both nations joined the European Union in 1994.

SPOTLIGHT

Regulation of war: the Geneva and Hague Conventions

One of the most famous international conventions (international agreements) are the Geneva Conventions. They are made up of four separate conventions that were agreed to over a period of more than 60 years. The first convention, the Convention for the Amelioration of the Wounded in Time of War, was enacted in 1864. All four conventions were last revised and ratified in 1949. The Geneva Conventions mostly deal with the treatment of non-combatants during war. These are people who are not directly taking part in the fighting, and include civilians, medical personnel and the wounded, shown in Figure 11.7.6. Also included in the conventions are laws relating to the treatment of prisoners of war. One of the interesting features of the Geneva Conventions is that they are governed not by the United Nations but by the International Committee of the Red Cross and Red Crescent (ICRC).

Although often seen as a failure, The Hague Conventions of 1899 and 1907 were important in terms of regulating war. They were the first real attempt to create a way of reducing the need for countries to resort to war. Importantly, these conventions led to the formation of the Permanent Court of Arbitration in 1899.

11.7.6 The first Geneva Convention relates to the treatment of the war wounded.

This was a special court for nation–states to peacefully resolve disputes. This court became the model for the International Court of Justice, which was established in 1945 and still exists today.

SPOTLIGHT

The Sea-Bed Treaty (1971)

As nuclear and military technology progressed in the years following World War II, fear of nuclear war increased. One of the most significant concerns was that countries would place nuclear weapons platforms in international waters near their enemies.

The spectre of nuclear missiles sitting just off the coast of countries was a very real concern. In response to this fear, and the arms race it would lead to, the United Nations sponsored the 1971 Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and the Subsoil Thereof (usually referred to as the Sea-Bed Treaty). The treaty prohibits the placement of nuclear weapons and other weapons of mass destruction on the sea-bed. Also banned are launching platforms and facilities for storing or testing weapons. The treaty only allows nation–states to undertake these activities within 21.5 km of their own shoreline. The treaty has been very successful in reducing this nuclear threat.

SPOTLIGHT

Creation of South Sudan

South Sudan is the world's youngest country, formed on 9 July 2011 as a result of a partition of Sudan. Sudan, like many countries in Africa, was a colonial invention developed to suit the empires of Europe with little regard for the cultural, ethnic and linguistic groups that it contained.

A largely Arabic speaking and Islamic north was coupled with more Christian and African tribal communities in the south. A number of intense and highly destructive civil wars were fought across Sudan in the twentieth and early twenty-first centuries. Most notably, a vicious campaign began in 2003 against tribal communities in the Darfur region by government-backed Islamist militias. This caught the world's attention and Sudan became subject to UN sanctions. A comprehensive peace agreement was brokered in 2005 and in early 2011 the 10 southern states were separated from Sudan to form South Sudan.

International agencies

There are two main types of international agencies whose task is to help prevent or resolve geopolitical conflicts:

- intergovernmental agencies, many of which are part of the United Nations
- nongovernmental organisations (NGOs), which are public, non-profit, cooperative agencies mainly relying on financial donations.

Intergovernmental agencies

The United Nations was founded as the principal international agency for promoting peace through civilian and military programs. Since World War II and the foundation of the United Nations there have been many instances of UN interventions in conflicts to try to bring about peace or, at least, prevent further conflict. There have also been several forceful military interventions on the side of one of the combatants to repel aggression, most notably in the Korean War of 1950–53 and the Gulf War of 1990. Peacekeeping work has greatly increased in recent years following the end of the Cold War and the United Nations gaining improved moral authority (see Figure 11.7.7). The success of peacekeeping has been mixed, but on the whole has had some success in recent years, such as in Namibia, Cambodia and the Iran–Iraq border dispute. There have also been some notable failures, such as in Somalia and Bosnia. It is often argued that UN peacekeeping only works when the warring parties want it to work.

The United Nations also engages in civilian aid work, notably in refugee assistance. The UN High Commissioner for Refugees (UNHCR) has had a huge task in recent years with the massive increase of refugees caused by the civil war in Syria and the drought and famine across the Horn of Africa.

11.7.7 The UN maintains peacekeeping missions around the world.

Nongovernmental organisations

There are many kinds of NGOs. Those providing relief (such as CARE, Oxfam and Médecins Sans Frontières) are not concerned with resolving disputes so much as alleviating their consequences (see Figure 11.7.8). This alleviation may, in turn, have the effect of preventing a further outbreak. NGOs can also play a key role in bringing geopolitical matters to widespread public attention, as was the case with the Rohingya crisis in Myanmar.

11.7.8 Non-government organisations are often the first to arrive at trouble spots delivering aid, such as food and medical supplies.

Political, constitutional and judicial interventions

Most geopolitical disputes and conflicts are, in principle, capable of legal resolution under local, national or international law. Laws govern all aspects of social life, including the conduct of war. Nevertheless, if legal procedures and judgements could always resolve tensions there would be no conflicts. Clearly the rule of law and the jurisdiction and power of courts are often ignored in international tensions. National and local tensions, on the other hand, are most often resolved by law. This is because courts and police forces within states have a legal monopoly of force, which is nearly absolute in the practical enforcement of decisions. Of course, throughout history, there have been many (illegal) rebellions against legally constituted power.

War crimes tribunals and the International Criminal Court

The establishment of war crimes tribunals has been a direct result of the Geneva and Hague Conventions about the conduct of war and statements of principles about human rights. The first tribunals were established in the years following the end of World War II. Tribunals were established in Nuremburg, Germany, and Tokyo, Japan, to deal with the war crimes committed during the war.

11.7.9 Former Serbian President Slobodan Milosevic on trial at the International Criminal Court for the former Yugoslavia

War crimes tribunals were established following the Rwandan genocide and the wars associated with the breakup of Yugoslavia. This court—the International Criminal Tribunal for the Former Yugoslavia (ICTY)—has been sitting since May 1993 in the Hague in the Netherlands. Since its inception more than 160 people have been prosecuted for war crimes. The case against the former Serbian President Slobodan Milosevic (see Figure 11.7.9) is the most famous. Milosevic was accused of ordering ethnic cleansing operations in the breakaway province of Kosovo. He died of a heart attack during his trial in 2006.

While war crimes tribunals are ad hoc courts, meaning that they are formed for specific purposes and then disbanded once this has been achieved, the International Criminal Court (ICC) is a permanent court that deals with war crimes, genocide and crimes against humanity not otherwise dealt with by a special court or tribunal. The court sits in the Hague in the Netherlands. Much of the work of the court involves investigating and researching offences. Since it began hearings in 2002 it has dealt with 24 cases, many of which have multiple defendants.

International Court of Justice

The aim of the International Court of Justice (ICJ), formed in 1946 by the United Nations, is to help maintain peaceful relations between nation–states. The court has two key functions. The first is to settle disputes between nation–states. The second is to offer advisory opinions to countries on matters relating to international law.

Only countries can take a case to the ICJ. It is not possible for individuals, companies or NGOs to use the court to settle disputes, even if they involve issues of international law.

The most common cases heard in the court are those concerning countries experiencing border disputes. This is where two countries are unable to decide where the border that separates their two countries lies. In the past, such disputes would have commonly been settled by war. The ICJ provides a peaceful alternative and one that many countries now use. Between 1946 and 2017 the ICJ has heard 168 cases between nations. It has also provided non-binding advice to many countries.

Not all countries have accepted the ICJ's jurisdiction, and the ICJ can only hear those cases where all states in dispute agree that the ICJ should make a judgement. For example, with regard to French nuclear tests at Mururoa Atoll, Australia and New Zealand argued before the ICJ in 1974 and again in October 1995 that France had a case to answer under international law as it was a signatory to the Nuclear Test Ban Treaty. France invoked (put into effect) its rights under the concept of national sovereignty and refused to participate in either of the cases. However, the ICJ has been effective in peacefully resolving many disputes.

Devolutions (transfers) of power

In many cases, the granting of a high degree of local autonomy to an ethnic, religious or cultural minority has prevented or resolved a serious conflict. The case of the Swiss federation is the best example of a multi-ethnic state that has known a long period of peace and great prosperity, due largely to a high degree of autonomy that each of its cantons (subdivisions) and communities possess. In Great Britain, Scotland and Wales have been granted greater autonomy and now have their own parliaments.

Such federal and quasi-federal solutions have gained popularity in Western Europe as the power of the central institutions of the newly established European Union have grown. Many minorities now feel they can have local autonomy within a supra-state as the power of the old nation–states has gradually declined relative to the power of the European Union. A similar method has been used in Canada where the indigenous peoples (referred to as First Nations peoples) and the people of the French-speaking province of Quebec have gained increased autonomy. This has helped to reduce considerable ethnic tensions.

SPOTLIGHT

Republic of Benin vs Republic of Niger (the Frontier Dispute Case)

The Frontier Dispute Case is a recent case heard in the ICJ. It demonstrates how the court can provide an effective way to peacefully resolve disputes between nation–states. The border between the two countries concerned, Benin and Niger, has long been in dispute. (See Figure 11.7.10.)

Benin argued that the border lay on the left bank of the Niger River, meaning that the islands in the river belonged to Benin. Niger, however, argued that the border lay on the right bank and the islands belonged to them. In 2002 both countries agreed to allow the matter to be decided by the ICJ.

After hearing evidence for some time, the court found that neither country could prove ownership of the islands and that the best evidence of the border was the navigable channel that runs along the river. Thus, the islands to the left of the channel would belong to Benin and those to the right were owned by Niger.

Both nation–states accepted the ICJ's decision and the matter was resolved peacefully. There was no need to resort to conflict as happens in many similar border disputes around the world.

11.7.10 Benin and Niger

Community-based initiatives

Local tensions and conflicts often have to be resolved locally through community initiatives. The establishment and activities of citizens' research organisations, reconciliation movements, community awareness groups and self-help organisations are often instrumental in overcoming conflicts within and between communities. Many permanent organisations exist for these purposes. Such groups include religious organisations, service clubs and youth groups.

Community-based initiatives are often highly effective because they draw people into issues, give them a voice and an opportunity to express a view. In many cases geopolitical issues are on such a scale and so far removed from the everyday experience of people that individuals are disempowered. However, when these issues are raised and dealt with at a community level the individual has a far greater voice. Peaceful protests have the potential to greatly influence political decisions. Many of the examples of geopolitical change referred to in this chapter came about because of community actions. The fall of communism across Eastern Europe, for example, came about due to peaceful protest.

11.7.11 A picnic at the US–Mexico border

Activities

Understanding the text

1. Define the term realpolitik.
2. Explain why realpolitik is often not successful.
3. Describe the concept of global government.
4. Describe what a treaty is.
5. Outline the ways that treaties and international agreements can help resolve geopolitical tensions.
6. Explain what a partition is.
7. Describe the role of intergovernmental and non-governmental organisations in resolving disputes.
8. Outline the purpose of war crimes tribunals.
9. Differentiate between war crimes tribunals and the International Criminal Court.
10. Explain the purpose of the International Court of Justice.
11. Outline how community-based initiatives can help resolve geopolitical issues.

Working geographically

12. Write an extended response either in favour or against Carl von Clausewitz's proposition that 'war is a continuation of politics by other means'.
13. As a class, discuss the extent to which global governance is a realistic means of creating peace. Consider the factors that promote and inhibit global governance. Record your ideas.
14. Using specific examples, describe why partition is often an unsuccessful way to resolve geopolitical tensions.
15. Access the website of the International Court of Justice. Write a brief report on a current case that is before the court.

Figure 11.7.11 shows a striking image of a picnic organised by French artist JR on 10 October 2017. The picnic is taking place at the border between the US and Mexico, with diners on both sides. JR printed a large tablecloth showing the eyes of an 'illegal migrant' from Mexico to the US. JR wanted to highlight the plight of so called 'dreamers'—people whose parents brought them to the US as children and have lived there all their lives. President Donald Trump announced in 2017 that these people would be deported out of the US despite past decisions by the US to allow them to stay.

Plebiscites and elections

Disputes and conflicts at all levels of geopolitics are often resolvable, at least temporarily, by the holding of an election. Many interventions of the United Nations have been with the express purpose of organising and holding fair elections for new governments. Examples are Namibia in 1990, Cambodia in 1993 and East Timor (now called Timor-Leste) in 1999.

Many democracies not only decide their government by election but also resolve major contentious issues by general plebiscites or referenda of the population. Steps towards or away from federation, for example, are usually decided in this way. Sometimes plebiscites do not resolve the actual issue, especially if the discontented group is still unsatisfied because the vote went against them. For example, the desire by a proportion of the population of Canada's Quebec province for independence has been defeated in two plebiscites, yet the secessionists have not accepted the verdict and are continuing their agitation.

Exam-style questions

Extended responses

- Analyse the changing role and nature of the nation–state.
- Evaluate the extent to which international governance and nongovernmental organisations pose a threat to national sovereignty.
- Analyse the extent to which transnational corporations pose a threat to national sovereignty.
- Analyse the causes of political tensions and conflicts.
- Explain the relationship between political tensions and conflict and the migration and mobility of people.
- Outline the various paths towards the resolution of political tensions and conflicts.

Glossary

autonomy the right or power to govern oneself

colonialism a government policy of imperial conquest (see imperialism) or the founding of colonies to gain new territories for occupation so as to exploit the resources and people of that territory

community a group of people with a strong shared interest about which they communicate regularly—communities vary in size; examples include a club, a neighbourhood, a town, a political movement or a group of scholars scattered across the globe

country a sovereign state in the world system of states, having an internationally recognised border

dictatorship a form of government in which democratic politics and decision-making are suppressed and replaced with a self-appointed, usually military, autocratic ruler who governs by personal decree rather than by constitutional means

empire a region over which imperial power is exercised

ethnic of or relating to sizable groups of people with a common, distinctive racial, national, religious, linguistic or cultural heritage

federation a political unification of formerly separate states or colonies in which the former states retain some sovereignty and surrender some sovereignty to the new federal government; there is thus a constitutional division of powers between the two levels of government; that is, state and federal

fundamentalism the reduction of a religion or theory to its simplest, most basic form and the elevation of that simplest form to be the absolute truth about the world and human behaviour

geopolitics the processes of interaction of politics and geography and the study of politics in its geographical context; geopolitics attempts to explain the impact that political tension and conflict have on geography, economy, society, culture and population, globally and on other levels

ideology a set of ideas about how economy, society, culture and institutions are and/or function and should be organised

imperialism the conquest and political and military domination of a new territory by a foreign empire

individualism a philosophy that advocates the power of individuals to make effective choices and act on those choices, and a theory of social organisation as the outcome of individual choice and rationality

nation a group of people with a common and distinctive racial, national, religious, linguistic or cultural heritage

plebiscite a general vote or referendum of the population in order to decide on a particular issue

political philosophies and theories general ideas about how politics should work; about the proper structure and role of political constitutions, institutions and governments; about electoral systems; and about how politics does and should relate to societies, economies and cultures

political power the power to govern states and their peoples and thus control the destinies of states and peoples

popular sovereignty a political doctrine that has no underlying belief system other than to appeal to voters

racism a theory and attitude that leads to the ill-treatment of individuals because they are thought to embody a supposedly inferior category of person entirely determined by race

revolution the complete overthrow of the existing sociopolitical system and replacement with a new system

sovereignty autonomous, self-obtained and self-constituted power to control and govern a state

state a territory that has a well-defined boundary and is autonomously and effectively governed by a sovereign government; also known as a country or nation–state

superpower a country that has the power and capacity to influence events on a global scale

terrorism the use of, or threat to use, violence against innocent people to achieve political goals

totalitarian the political system in which absolute power is vested in a single party or dictator

CHAPTER

12 Geographies of development

Geographers have always been interested in the spatial patterns that occur in our world at a variety of scales, from the local to the global. The enormous variations in quality of life experienced by people in different parts of the world is of particular interest to geographers, as is the extent to which people in different parts of the world have unequal access to resources of all kinds. In attempting to understand and explain these differences, countries have often been classified as either 'developed' or 'developing', although these terms are not easy to define.

This chapter considers a range of ideas about the meaning of 'development', and examines the spatial variations in the living standards of people throughout the world. The ways that spatial variations in development can be measured is also examined. Most significantly, this chapter explores the underlying factors that give rise to global inequity and the different living standards experienced by people in the various parts of our world. The forces that contribute to different types and rates of development are complex and interrelated.

> **The future belongs to us, because we have taken charge of it. We have the commitment, we have the resourcefulness, and we have the strength of our people ...**
>
> **Ellen Johnson Sirleaf, former President of Liberia and the first female elected head of state in Africa**

12.0.1 A crowded slum market at Freetown, the capital and largest city of Sierra Leone

PINE

UNIT 12.1

Understanding development

Many people throughout the world do not enjoy the same lifestyle that most of us living in Australia enjoy. The worry for them is not how they will pay their mobile phone bill or upgrade their laptop or iPad, but how they can access the basic necessities of life, including clean water, adequate food and shelter. When discussing countries where large numbers of the population live in relative (comparative) poverty, the term 'development' is often used to describe a desirable condition or an improvement in conditions in those countries.

Defining development

There are many different views about the meaning of the term 'development'—over 700 definitions exist. Economic growth and industrialisation are commonly regarded as keys to successful development. However, other definitions of development feature the role of the local community in planning for and bringing about change. Others stress the importance of generating changes that can continue without harming other people, communities or the environment. This is often known as sustainable development.

12.1.1 The majority of people living in developed countries enjoy a high standard of living.

12.1.2 Shanty settlement, Freetown, Sierra Leone. Millions of people living in the world's poorest countries live in absolute poverty.

Sometimes development is used to describe a process of change; however, there is a wide range of opinions about what the outcomes of that process of development should be. For decades, modernisation, industrialisation and the attainment of high material standards of living were assumed to be the goals of development. It was believed that for poor countries to achieve these goals and become 'developed' it was necessary for them to follow the path of the wealthy countries. Today, many continue to assume that the path to development lies in the pursuit of economic growth and modernisation (see Figure 12.1.1). However, there are many who now believe that people living in the developed world, including Australia, would do well to focus less on consumption and instead emulate the lifestyles and values associated with traditional societies, such as strong family and community ties, sharing and cooperation, and living in harmony with the environment.

There is an assumption that industrialisation and modernisation are a more advanced state than ways of life based on subsistence agriculture or hunting and gathering. Some people are now questioning this assumption because it ignores the disadvantages of industrial growth, such as pollution, traffic congestion, social disharmony and stress.

Differing opinions

The meaning of development is context specific: it varies from place to place and depends on the interests, culture and values of those who define it. For this reason, opinion remains divided about what the outcomes of development should be. Common to all definitions, though, is the implication that the change process should be beneficial for those countries or people engaged in development.

No matter what people think development might be, there is general agreement that it concerns the eradication of poverty. If people are living in poverty (that is, are unable to attain the basic necessities of life) then their community or society could be regarded as underdeveloped (see Figure 12.1.2). Any discussion of the meaning of development can logically focus on the elimination of absolute poverty.

SPOTLIGHT

Defining development

The following extracts highlight the range of development definitions that exist.

> We believe that countries are responsible for their own development, driven by economic growth led by the private sector and by integration with the global economy.
>
> Source: AusAID

> Human development is about much more than the rise or fall of national incomes. It is about creating an environment in which people can develop their full potential and lead productive, creative lives in accord with their needs and interests. People are the real wealth of nations. Development is thus about expanding the choices people have to lead lives that they value.
> And it is thus about much more than economic growth, which is only a means—if a very important one—of enlarging people's choices.
>
> Fundamental to enlarging these choices is building human capabilities—the range of things that people can do or be in life. The most basic capabilities for human development are to lead long and healthy lives, to be knowledgeable, to have access to the resources needed for a decent standard of living and to be able to participate in the life of the community. Without these, many choices are simply not available, and many opportunities in life remain inaccessible.
>
> Source: UNDP

> Our view is that development is an ongoing, dynamic process by which individuals identify themselves as a community and are collectively empowered to use the necessary knowledge, values and organisational skills to sustainably share and enhance that community's resources and to bring about positive change for the benefit of all its members. Development is the realisation of rights, especially economic, cultural and social rights aimed at ending poverty, inequities, suffering and injustice.
>
> Source: Oxfam

> Sustainable development refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
>
> Source: Brundtland Commission, 1987

> [Development] assumes the conservation of natural assets for future growth and development.
>
> Source: OECD

> Development cannot be divorced from ecological and environmental concerns. Indeed, important components of human freedoms—and crucial ingredients of our quality of life—are thoroughly dependent on the integrity of the environment.
>
> Source: UNDP

Defining poverty

Poverty means different things to different people. The following extracts illustrate a range of perspectives.

> Poverty is the inability of having choices and opportunities, a violation of human dignity. It means lack of basic capacity to participate effectively in society. It means not having enough to feed and clothe a family, not having a school or clinic to go to, not having the land on which to grow one's food or a job to earn one's living, not having access to credit. It means insecurity, powerlessness and exclusion of individuals, households and communities. It means susceptibility to violence, and it often implies living in marginal or fragile environments, without access to clean water or sanitation.
>
> Source: United Nations

> Poverty is hunger. Poverty is lack of shelter. Poverty is being sick and not being able to see a doctor. Poverty is not having access to school and not knowing how to read. Poverty is not having a job, is fear for the future, living one day at a time. Poverty is losing a child to illness brought about by unclean water. Poverty is powerlessness, lack of representation and freedom.
>
> Source: The World Bank

> Poverty is about more than inadequate income. It is also about lack of fundamental freedom of action, choice and opportunity. It is about vulnerability to abuse and corruption.
>
> Source: The World Bank

> Poverty is associated with the undermining of a range of key human attributes, including health. The poor are exposed to greater personal and environmental health risks, are less well nourished, have less information and are less able to access health care; they thus have a higher risk of illness and disability. Conversely, illness can reduce household savings, lower learning ability, reduce productivity, and lead to a diminished quality of life, thereby perpetuating or even increasing poverty.
>
> Poverty is often defined in absolute terms of low income – less than US$2 a day, for example. But in reality, the consequences of poverty exist on a relative scale. The poorest of the poor, around the world, have the worst health. Within countries, the evidence shows that in general the lower an individual's socioeconomic position the worse their health. There is a social gradient in health that runs from top to bottom of the socioeconomic spectrum. This is a global phenomenon, seen in low, middle and high income countries.
>
> Source: World Health Organization

Absolute and relative (comparative) poverty

Absolute poverty

Absolute poverty refers to not having access to the minimum necessities or essentials needed to sustain an acceptable standard of living. It is often based on what a household should be able to count on in order to meet its basic needs. The determination of the absolute poverty line is often based on estimates of the cost of basic food needs (that is, the cost of the nutritional basket considered minimal for the healthy survival of a typical family), to which a provision is added for non-food needs (see Figure 12.1.3).

Relative poverty

Relative (comparative) poverty is defined in terms of a person's standard of living compared with the overall distribution of income or consumption in a country. For example, the poverty line could be set at 50 per cent of the country's mean income or consumption. In other words, a person may be living in relative poverty if their income is below the median level in a community or society. In developed countries with advanced social infrastructure, comparative (rather than absolute) poverty is the main form of disadvantage experienced by people. It means that they lack the material means to fully participate in accepted daily life.

The Sustainable Development Goals

The Sustainable Development Goals (SDGs), officially known as *Transforming our world: the 2030 Agenda for Sustainable Development*, is a set of 17 global goals with 169 specific targets and 304 indicators by which progress is to be assessed.

Initiated by the United Nations and negotiated with its 193 member states, the goals are a successor to the Millennium Development Goals, which had set the world's developmental priorities in the period 2000–2015.

DID YOU KNOW?

- The richest 20% of the world's population hold 75% of the world's income. The poorest 40% hold 5% of world income, while the very poorest 20% hold just 1.5%.
- For almost 25 years the average annual income of the poorest 10% of the world's people has risen by less than US$3 each year.

12.1.3 A person living in absolute poverty lacks the basic necessities of life.

The 17 sustainable development goals	
Goal 1	No poverty: End poverty in all its forms everywhere.
Goal 2	Zero hunger: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
Goal 3	Good health and wellbeing: Ensure healthy lives and promote wellbeing for all at all ages.
Goal 4	Quality education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Goal 5	Gender equality: Achieve gender equality and empower all women and girls.
Goal 6	Clean water and sanitation: Ensure availability and sustainable management of water and sanitation for all.
Goal 7	Affordable and clean energy: Ensure access to affordable, reliable, sustainable and modern energy for all.
Goal 8	Decent work and economic growth: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
Goal 9	Industry, innovation and infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.
Goal 10	Reduce inequality: Reduce inequality within and among countries.
Goal 11	Sustainable cities and communities: Make cities and human settlements inclusive, safe, resilient and sustainable.
Goal 12	Responsible consumption and production: Ensure sustainable consumption and production patterns.
Goal 13	Climate action: Take urgent action to combat climate change and its impacts.
Goal 14	Life below water: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
Goal 15	Life on land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
Goal 16	Peace, justice and strong institutions: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
Goal 17	Partnerships for the goals: Strengthen the means or implementation and revitalise the global partnership for sustainable development.

12.1.4 The 17 sustainable development goals

Activities

Understanding the text

1 Explain why it is difficult to define the term development.

2 Identify the essential elements of any definition of development.

3 Explain why the meaning of development is said to be context specific.

Working geographically

4 List all the characteristics of poverty mentioned in those definitions.

5 Working in groups, compare the definitions of development then discuss the following questions.

- **a** In each definition of development, what outcomes of development are anticipated?
- **b** Similarly, what different processes of development lead to those outcomes?
- **c** What do you think causes these different understandings about development?

6 Think about the topic of this chapter: geographies of development. What do you think the term development means when used in reference to countries? To assist you to think about the issues involved, answer the following questions.

- **a** If the term development is applied to countries, what does it mean? Try to write your own definition of what development of a country means.
- **b** If the term development implies positive change, or advancement to a better condition, what changes do you think are positive for the people of the world's poorer countries?
- **c** Of the changes you have suggested, would any be of benefit to all countries, including richer countries (such as Australia)?

7 Definitions of development usually fall into two broad categories: those that emphasise economic growth and those that emphasise social wellbeing. Write an example of each.

8 Distinguish between absolute and comparative (relative) poverty.

9 Study Figure 12.1.4, the 17 sustainable development goals.

- **a** What difficulties do you think may prevent some of the world's economically poorer countries from achieving the SDGs?
- **b** Undertake research to see whether you can find examples of the gains that have been made towards meeting the SDGs.

UNIT 12.2

Development and spatial variations

Before describing the spatial variations of development, the definition of development needs to be explained. However, the term 'development' has always been difficult to define and finding a collective term that describes the world's poorer countries has proved problematic.

Describing developing countries

'First', 'Second' and 'Third' worlds

The term 'Third World' first emerged in the 1950s in France. This term was originally used to describe the newly independent former colonial states, which were often politically unaligned with either the Soviet Union or the United States and its allies during the Cold War. Over time the term was used to describe economically poor countries.

The term 'First World' was used to designate the Western, capitalist, usually democratic countries, and the 'Second World' was the descriptor given to the then socialist countries, primarily located in Eastern Europe. The poorest countries, which had been singled out by the United Nations (UN) as 'least developed' and deserving of special assistance, also became commonly known as the 'Fourth World'. Increasingly, though, the 'Fourth World' is used to refer to poor or marginalised groups of people, often indigenous or 'first nation' people, within wealthy countries.

This set of terms is dated. Processes of democratisation among former socialist countries mean that 'Second World' as a political term now has little meaning. As well, the distinction between 'rich' and 'poor' countries became less obvious with rapid economic growth, primarily in East Asia. Along with the formation of new political alignments among poor countries, these changes largely invalidated the original political intentions of the terminology 'First', 'Second' and 'Third' worlds. Despite this, the term 'Third World' is still often used and widely understood to refer to the world's economically poorer countries.

DID YOU KNOW?

The Cold War was the struggle for power between the Soviet Union and the United States that lasted from the end of World War II until the collapse of the Soviet Union in 1991. The war was considered 'cold' because the aggression was ideological, economic and diplomatic rather than a direct military conflict.

'Developed' and 'Underdeveloped'

The terms 'developed' and 'underdeveloped' (or 'undeveloped') have also been used widely as collective terms to describe the rich and poor countries. These commonly used terms have been condemned by peoples of the world's economically poorer countries as being Eurocentric. It is maintained that these terms imply that material items or their monetary value alone determine states of development. For people whose cultural, spiritual and social systems are valued, social characteristics such as harmony, cooperation, sharing and peace may be more important to a community than material possessions.

'Industrialised' and 'Modernised'

The terms 'industrialised' and 'modernised' have also attracted criticism for their inference that poor countries have little industrial activity. These terms imply that being more 'traditional' equates to being 'backward' and that the dominance of non-Western traditions is not consistent with 'development'.

'Developing' countries

The label 'developing countries' has been widely adopted in an attempt to lessen the offensiveness of other terminology. Yet this term still suggests that low levels of economic development are necessarily problematic, and ignores the possibility that communities in some countries may exist happily and healthily in a local economy based on subsistence farming. In other words, lack of material wealth may not necessarily be a cause for concern in all communities. It is also problematic in the range of countries the term is applied to. It includes not only the world's poorest countries but also those that have developed rapidly in recent decades and whose people now enjoy a high standard of living.

Distinguishing developing and developed

For an increasing number of geographers (and economists) it is becoming increasingly difficult to divide the countries of the world into the developing and developed worlds because the process of economic and cultural integration (globalisation) has created a big category in the middle. Today it is becoming more meaningful to distinguish between the 1 billion rich, the 4 billion living in countries that are developing rapidly and the 1 billion in countries that are desperately poor and falling behind.

For purposes of clarity, the terms 'developed', 'developing' and 'least developed' will be used.

DID YOU KNOW?

- The wealthiest 1% of the world's population controls 46% of global wealth. The remaining 99% of people share the remaining 54%.
- The world's eight richest individuals (all men), control as much wealth as the poorest half of the global population.

Developed

'Developed countries' are those that are highly developed in terms of their economy and their technological infrastructure relative to other countries. The criteria used to determine a country's status includes its Gross Domestic Product (GDP) or its GNP, its per capita income, level of industrialisation and general standard of living. The 'developed' status of countries varies from one institution to another. The International Monetary Fund (IMF) identifies 39 'advanced economies'. The OECD identifies 35 'developed countries'. The World Bank identifies 78 'high-income countries'. All have relatively high ranking in terms of the Human Development Index (HDI).

Developing

'Developing countries' are defined as those that have a less developed industrial base and a low HDI relative to other countries.

Least developed

'Least developed countries' (LDCs) are low-income countries that are facing severe structural impediments to sustainable development (see Figure 12.2.1). They are highly vulnerable to economic and environmental shocks and have low levels of human assets. In 2017, there were 47 countries on the UN's list of LDCs. This list is reviewed every three years by the UN's Committee for Development.

12.2.1 Yemeni people wait to receive bags of food aid in the northern district of Abs. Yemen is one of the world's least developed countries, a situation made worse by an ongoing brutal civil war.

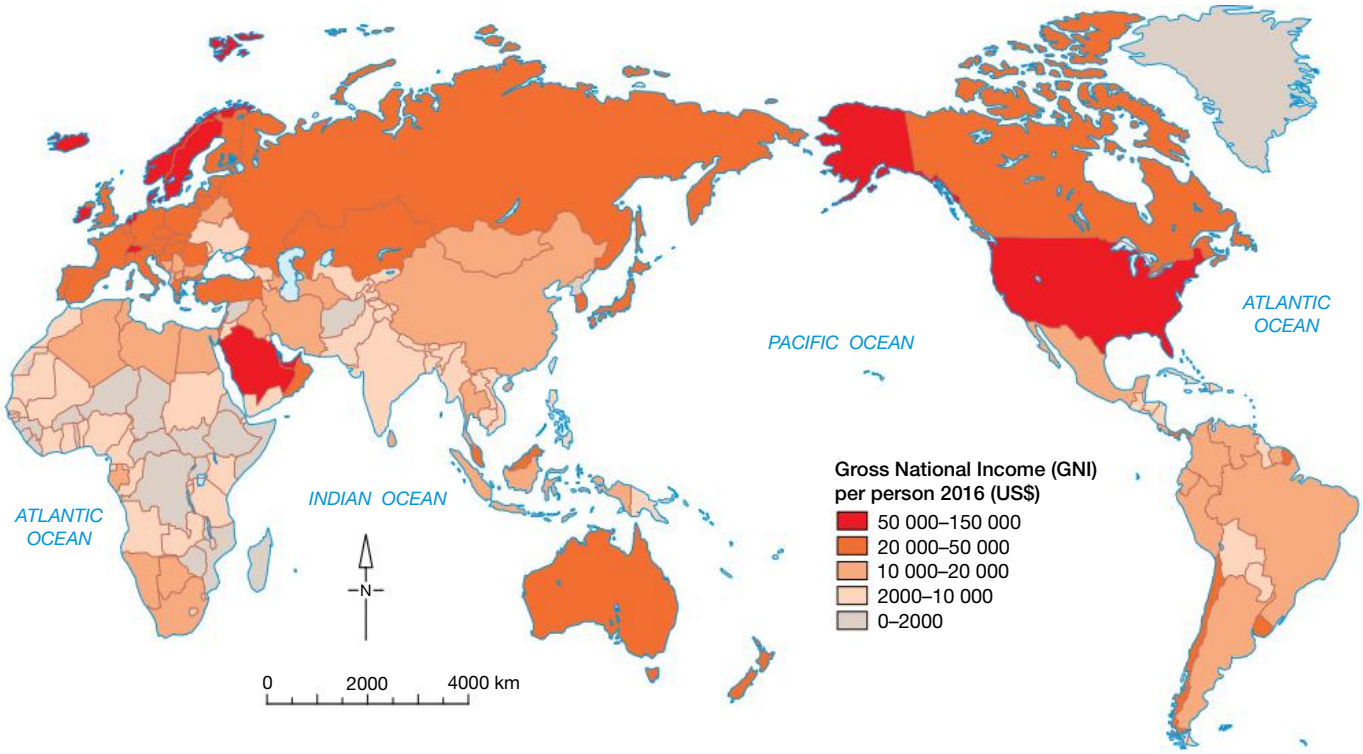
Measuring development

Spatial patterns in the levels of development evident throughout the world—and the reasons for these variations—is of interest. Development is a relative term: determining the extent to which a country may be developed is only possible when comparing that country to others. To enable such comparisons at a global scale, a range of methods have been used to try to measure the relative development of countries.

Quantitative indicators

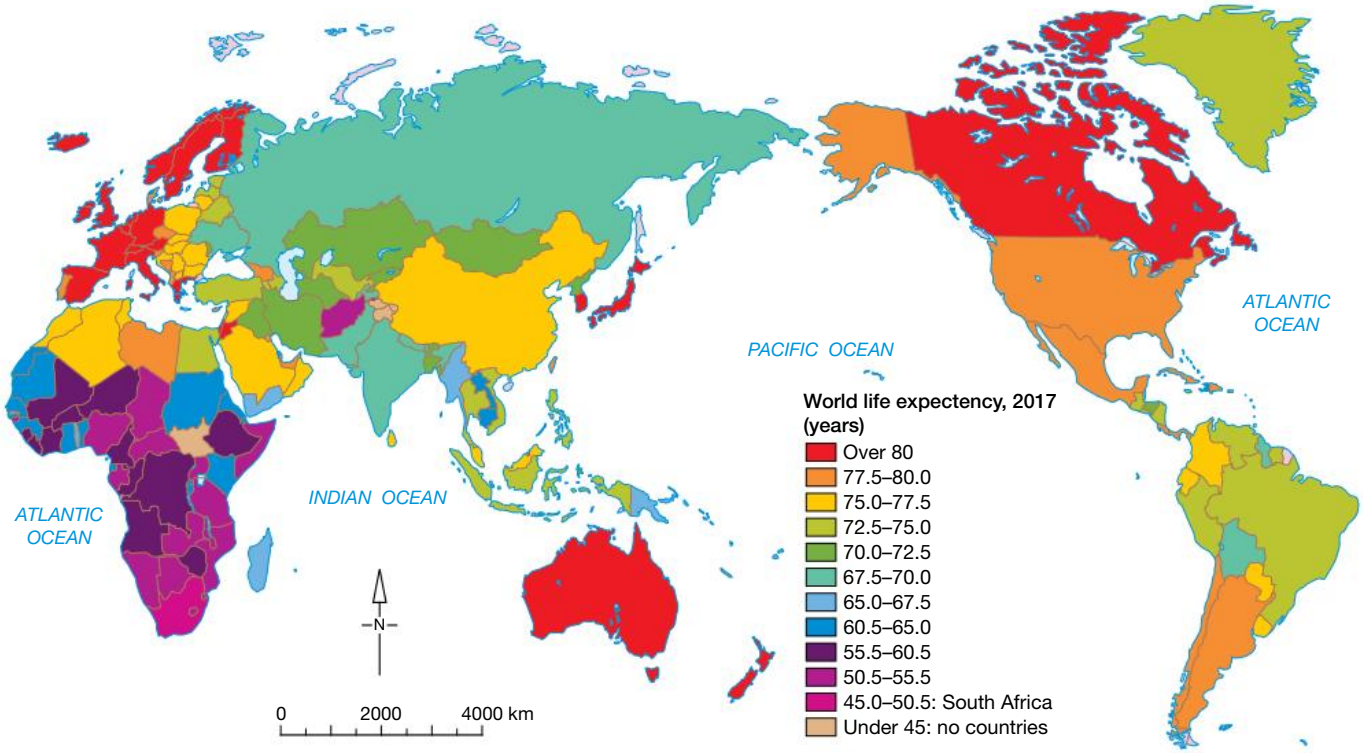
Historically, the most commonly employed means of comparison has been quantitative indicators of development. A quantitative indicator is a numerical measure of something that can be counted, or quantified. A variety of quantitative indicators have been used to measure development, with gross national income (GNI) per capita being the most commonly used measure of a country's state of development. These data are then used as a basis for comparison between countries.

Figure 12.2.2 shows a map of the countries of the world categorised according to their level of income—their GNI per capita. Other quantitative indicators commonly used to compare countries and regions include energy consumption, literacy rates or school completion rates, life expectancy (see Figure 12.2.3), infant mortality rates and the availability of services, such as clean water, sanitation, and internet access (see Figure 12.2.4).



12.2.2 GNI per capita (income per person), 2016

Source: Population Reference Bureau

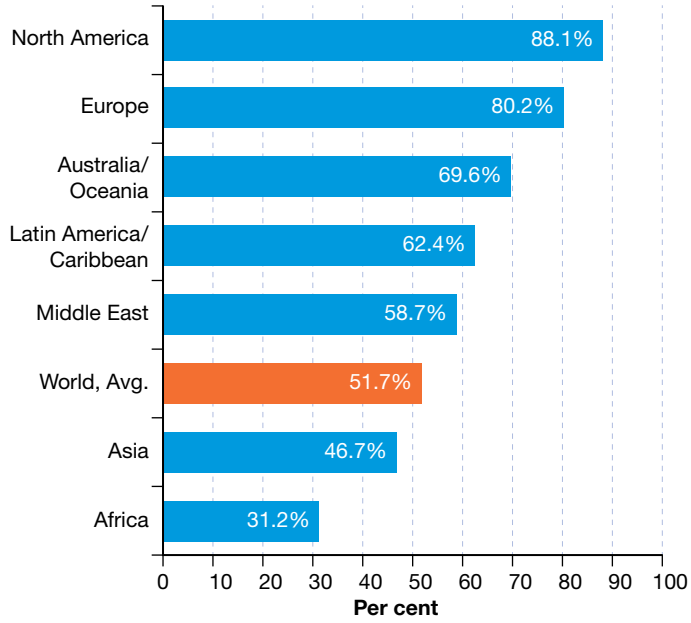


12.2.3 Life expectancy, 2017

Limitations of using quantitative indicators

Measures of economic growth, such as GNI, are frequently used to compare the levels of development among countries. However, there are a number of disadvantages in doing so.

In many of the world's poorer countries a large percentage of the population is engaged in subsistence activities, such as subsistence agriculture, simple home-based manufacturing or small-scale informal sector business activity. Often such subsistence activities do not attract monetary income or, in the case of businesses outside the formal sector, it is very difficult to assess income earned by those engaged in such activities. The total value of such production in dollar terms is therefore difficult to measure and is usually excluded from calculations of GNI. Therefore, production that may be the basis of survival for people living in developing countries is not valued and recorded.



Source: Internet World Stats website

12.2.4 Internet users by region (percentage of the population accessing the internet), 2017

Figures based on income per person reveal little about the purchasing power of that income. Even if the people of one country appear to have high incomes, the price of goods and services may also be high, so their income may not have great value in terms of what it is able to buy. Thus, the living standards of the population of such a country may not be better than those of people living in a country where incomes per person are much lower but where goods and services cost less.

Remoteness of communities, inefficient bureaucracies, poor transport and communication systems, and high levels of illiteracy can all cause problems in collecting survey-based data. This makes it very difficult to collect accurate financial and other quantitative data in many countries, which means that available figures may not be accurate. As well, there is no global consistency in years of census data collection or intercensal periods (periods between census counts). For this reason, census data collected in different countries cannot easily be compared.

Criticism of using economic indicators

A common criticism of the use of economic indicators of development is that they fail to measure the distribution of income or other resources within countries. For example, a small oil-producing country may have very high incomes per person, but most of the wealth is enjoyed by just a few beneficiaries of the oil-based wealth. Meanwhile, the majority of the population has a very low standard of living. Similarly, income statistics may indicate that a majority of people in a certain country do have a high standard of living, but disguise the fact that minority groups within the country may live in extreme poverty.

Clearly, it is difficult to define exactly which countries are home to the world's poor if we rely on economic, social, demographic or educational indicators alone. As well, using national boundaries as a basis for delineating the poor world ignores the question of inequality within countries.

Variations within countries

Although useful as a starting point for making comparisons between countries, quantitative indicators mask inequalities at a different scale. Geographers are not only concerned about the differences between countries, but also with spatial variations in the levels of development within countries. If quantitative indicators are used as a basis for answering the question 'Which are the developing countries?' the complexity and diversity within countries can be overlooked.

Activities

Understanding the text

1 Explain why it's difficult to develop appropriate descriptors to describe the relative level of development of nations.

2 Distinguish between 'developed', 'developing' and 'least developed' nations.

3 Define quantitative as a means for measuring development.

4 Identify the advantages and disadvantages of using quantitative measures of development.

5 Outline the limitations of using qualitative indicators of development.

6 Explain some of the problems inherent in attempting to decide on a precise boundary for the developing world and the developed world.

Working geographically

7 The terms underdeveloped or undeveloped have often been used to collectively describe the world's poorer countries. As a class, discuss whether you think these terms are appropriate. How do you think the residents of the poorer countries would feel about the use of these terms?

8 In describing the world's wealthier countries, the terms modernised or industrialised are often used, while the words traditional or non-industrial are employed as descriptors for the economically poorer countries. As a class, discuss whether you think this is appropriate terminology. Give reasons for your answers.

9 Study Figure 12.2.2 carefully. On the basis of this map, list five countries you would regard as developed and five countries you would regard as developing. Justify your selection.

10 Write a short statement explaining why measures of economic performance are sometimes preferred as a means of measuring development.

11 Write a short statement explaining the shortcomings of using only an economic measure, such as GNI per person, as a basis for ranking countries on a scale of development.

12 Study Figures 12.2.2 and 12.2.3, which show GNI per capita and life expectancy.

- **a** If you were to use the maps in Figures 12.2.2 and 12.2.3 as a basis for determining the boundaries of the poor world, is it clear where that boundary should be?
- **b** Quantitative measures can be used to rank countries according to their level of development. When different quantitative indicators are compared, some countries do not always fit neatly into the same category. Use an atlas map to name some of these countries.

13 Study Figure 12.2.4. Using data from the graph, describe the global pattern of internet access. What does this pattern suggest about levels of development?

Human Development Index

In attempting to find a better way to measure development, the UN Development Program (UNDP) has generated what it calls the Human Development Index (HDI) as a measure of development. A composite statistical measure, the HDI includes life expectancy at birth, educational attainment and income. Unlike GNI per person, the HDI is not solely focused on economic wealth. Instead, the measure incorporates the basic factors necessary for people to be able to participate in, and contribute meaningfully to, society. Figures 12.2.5 and 12.2.6 show the classification of countries based on HDI.

Figure 12.2.7 shows that levels of human development may be quite similar in individual countries, even when those countries have different levels of income. Similarly, improvements in the income levels of the poor do not necessarily result from high rates of economic growth. In other words, there are high levels of inequality in some countries, which means that the poor do not necessarily benefit from economic growth.

DID YOU KNOW?

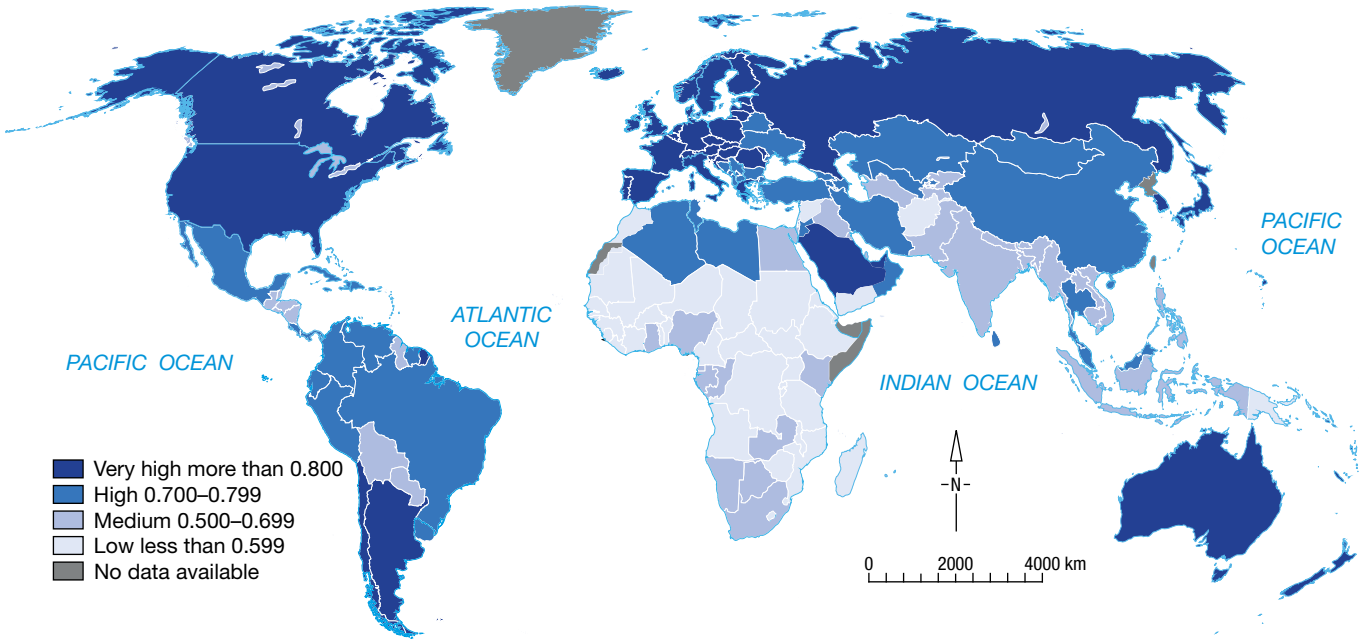
In 2017, Australia had the second highest HDI ranking (HDI 0.939). Only Norway had a higher ranking (HDI 0.949).

Qualitative indicators

A focus on quantitative indicators of development means that other important aspects of development may be undervalued. Values such as peace, harmony, cooperation and joy are important contributors to quality of life and could be considered positive attributes of a developed society. Yet, how can they be measured? Trying to gauge 'national harmony' or 'levels of joy in a country's population' is not as simple as counting dollars or determining death rates. Similarly, it is difficult to measure levels of human rights, individual freedoms and the status of indigenous people, all of which are generally regarded as important components of human development.

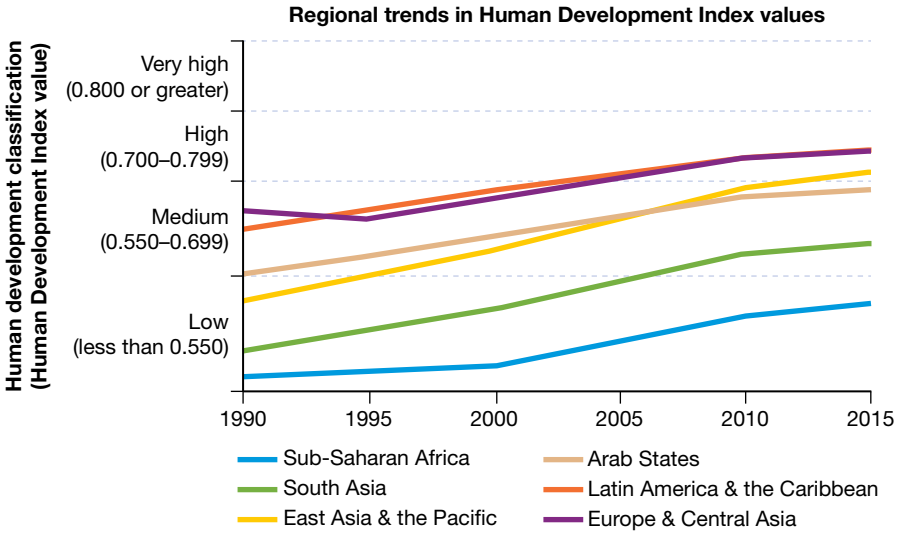
Factors such as traffic congestion, social disharmony and stress also affect quality of life, yet are rarely used as a basis for comparing the levels of development of countries. If qualitative indicators, such as social harmony and low stress levels, were used as a basis for comparison between countries or regions, the boundaries drawn between what are regarded as developed or less developed countries may well be very different from those based on quantitative indicators, such as per capita incomes.

There are difficulties involved in attempting to define the term 'development' and in attempting to demarcate or identify the poor world. Any acceptance of generalisations and assumptions may limit understanding of the complexity and diversity of the developing countries. Despite this, it is possible to recognise some general characteristics that give a measure of unity to much of the poor world.



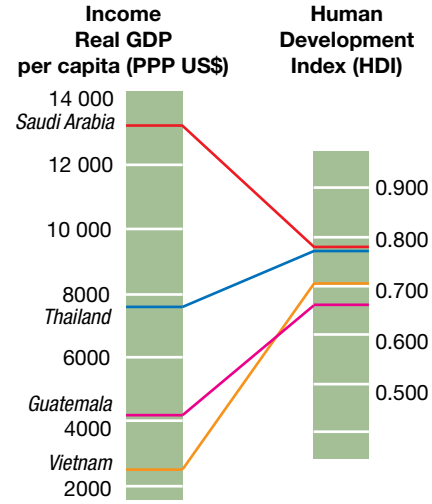
Source: *Human Development Report 2016*, United Nations Development Programm

12.2.5 Human Development Index by country (based on 2015 and 2016 data, published in 2017)



Source: *Human Development Report*, United Nations Development Programme

12.2.6 Regional trends in HDI values, 1990–2015. The human development trend is upwards in all regions.



12.2.7 Different income, similar HDI, 2017

The rise of the middle class

The world's middle class is growing rapidly. There were about 3.2 billion people in the global middle class at the end of 2016. Of the 140 million people joining the middle class annually, the overwhelming majority (an estimated 88 per cent) live in Asia. China and India alone claim more than 20 per cent of the global consumer middle class—with a combined total of 362 million people, more than in all of Western Europe.

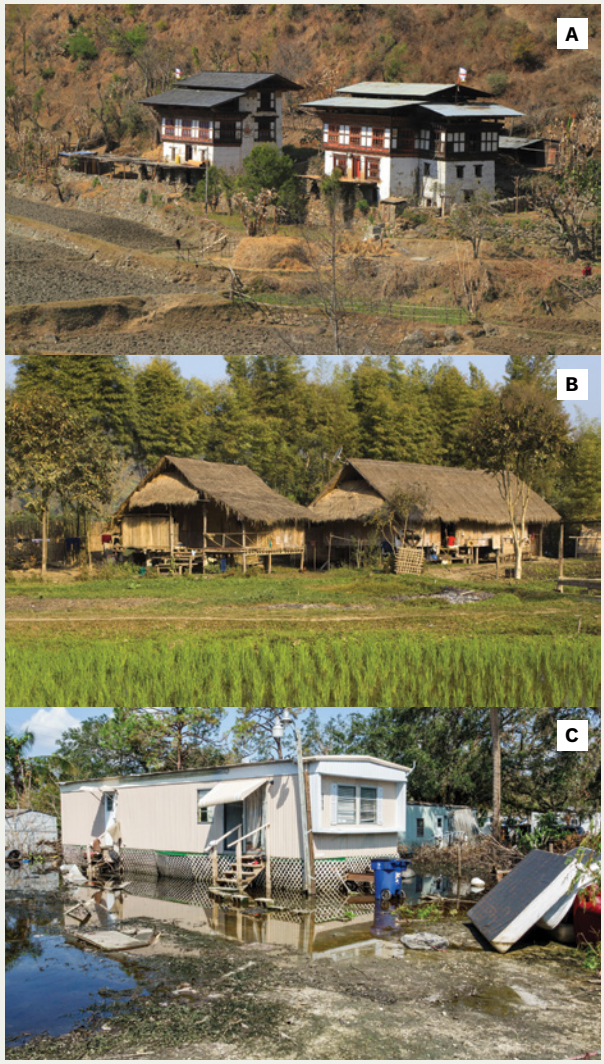
The changing distribution of middle-class spending toward new entrants is having an effect on markets. Households entering the middle class will seek to purchase consumer durables, as well as services including tourism, entertainment, health, education and transport. Middle-class consumption is estimated at US$35 trillion, or about US$12 000 per head, evenly divided between developed and developing countries.

SPOTLIGHT

Housing as a measure of development: photographic interpretation

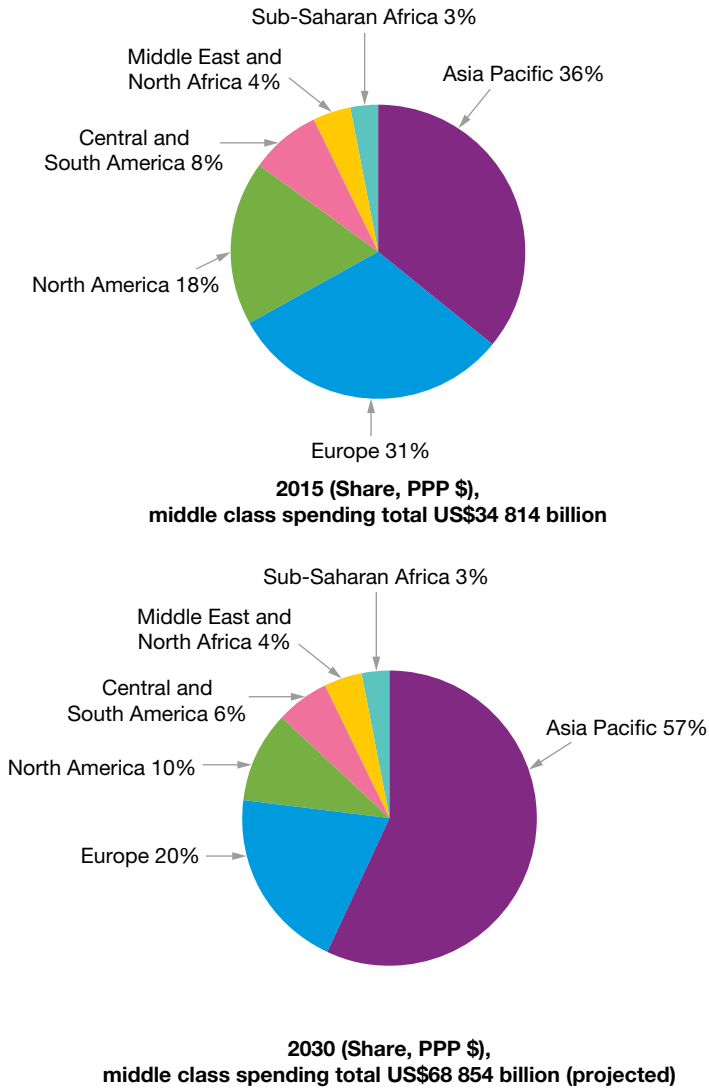
Figure 12.2.8A is the home of a rice farmer in Bhutan. Figure 12.2.8B is the home of a farming family in rural southern Thailand. Figure 12.2.8C shows a trailer park home in Florida, USA. More people in the USA are living in trailer parks due to the costs of living. These photographs make it obvious that it is difficult to generalise about wealthy and poor countries.

People living within the so-called 'developed world' sometimes have standards of living, literacy, health and life expectancy similar to people living in the poor world. Likewise, as the photo of the home in Bhutan illustrates, residents of what we think of as poorer countries often enjoy a high material standard of living.



12.2.8 **A** The home of a rice farmer in Bhutan, **B** the home of a farming family in rural southern Thailand, **C** a trailer park home in Florida, USA. The trailer park was destroyed by Hurricane Irma.

Despite the rapid growth of the middle class, 9 per cent of the world's population (700 million people) still live below the poverty line (US$1.90 per day). Figure 12.2.9 shows spending by global middle class (PPP share).



12.2.9 Spending by the global middle class, 2015 and 2030 (projected)

DID YOU KNOW?

Purchasing power parity (PPP) refers to data that equalise the purchasing power of different currencies in their home countries for a given basket of goods. It is often used to compare the standards of living between countries.

SPOTLIGHT

Australian facts

- Life expectancy for Indigenous Australians is estimated to be 69.1 years for males and 73.7 years for females. This compares with 79.7 years for all Australian males and 83.1 years for all females; a difference of approximately 10.6 years for males and 9.4 years for females.
- In 2016, the overall school attendance rate for Indigenous students nationally was 83.4 per cent, compared with 93.1 per cent for non-Indigenous students.
- Indigenous Australian students were still around half as likely as non-Indigenous Australian students to progress to the final year of schooling.
- Nationally the proportion of Indigenous 20- to 24-year-olds who had achieved Year 12 or equivalent increased from 45.4 per cent in 2008 to 61.5 per cent in 2014–15.
- Indigenous Australian students are under-represented in the higher education sector, accounting for only 1.5 per cent of the total higher education population in 2015.
- Indigenous Australians experience lower levels of labour force participation and employment and higher levels of unemployment than non-Indigenous Australians. In 2014–15, Indigenous Australian adults were 3.6 times more likely to be unemployed than non-Indigenous Australian adults: 20.8 per cent compared with 5.8 per cent.
- The disadvantage and alienation experienced by Indigenous Australians has resulted in them having a rate of imprisonment 11 times greater than that experienced by non-indigenous Australians.

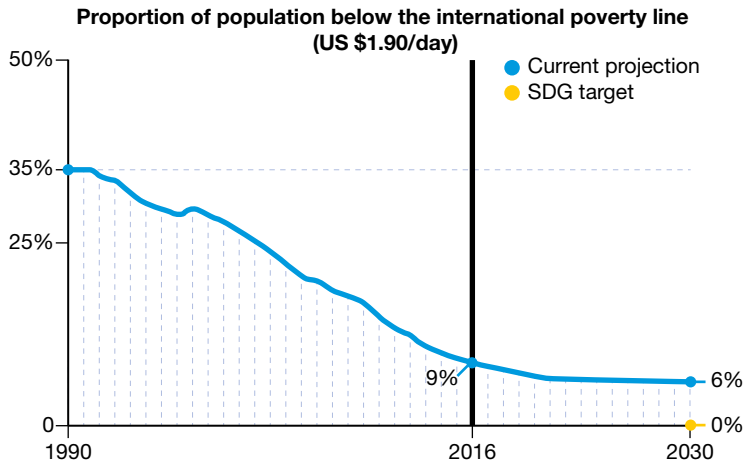
Source: Australian Bureau of Statistics

Progress is being made

It is easy to feel overwhelmed by the magnitude of the challenges faced by developing countries. However, progress is being made. On a range of indicators, the wellbeing of people living in developing countries is improving. This progress is not evenly distributed; much of this improvement has occurred in the emerging economies of East and Southern Asia. In the world's least developed countries progress has been slower.

Consider the following:

- Global life expectancy at birth rose by five years between 2000 and 2015 to 71.4 years, the fastest increase since the 1960s.
- The big improvements made in life expectancy have reversed the decline in the 1990s, when life expectancy fell in Africa because of the AIDS epidemic, and in Eastern Europe following the collapse of the Soviet Union. The biggest regional gain since then has been in Africa, where life expectancy has climbed by 9.4 years since 2000 to 60 years.
- Australia is part of this trend. Life expectancy at birth in Australia is now close to 83 years and among the highest in the world.
- The share of people living below the international poverty line of US$1.90 a day has been slashed from 35 per cent to 9 per cent (see Figure 12.2.10).



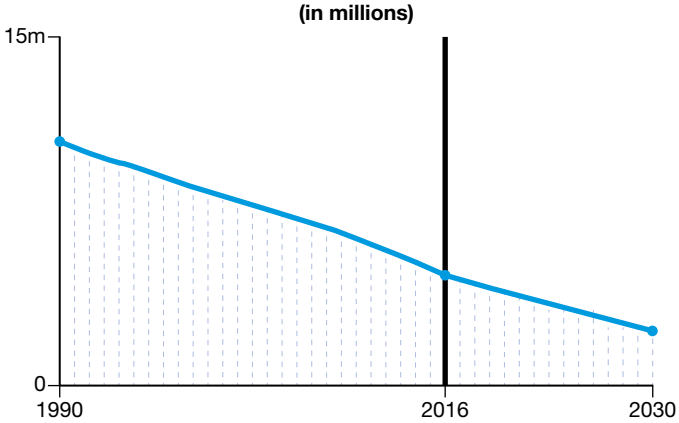
SDG Target: Eradicate extreme poverty for all people everywhere.
Source: Sustainable Development Goals, UNDP

12.2.10 Proportion of the population below the international poverty line (US$1.90 a day), 1990–2030. The graph highlights the dramatic decline in poverty since 1990. Much of the improvement has occurred in the emerging economies of China and India.

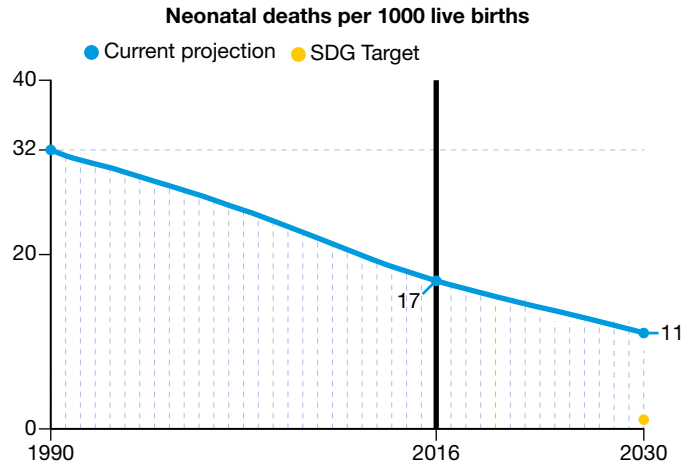
DID YOU KNOW?

In the USA in 2015, infant mortality for black infants was 11.6 per 1000 births, for white infants the rate was 4.8 per 1000 births.

- The number of deaths of children under the age of five years is declining (see Figure 12.2.11) as is the rate of neonatal deaths (see Figure 12.2.12).
- The rate at which women die in childbirth has fallen (see Figure 12.2.13).
- The prevalence of stunting due to malnutrition is in decline.
- More people are using improved and safe sanitation (see Figure 12.2.14).
- More children are learning to read and write (see Figure 12.2.15).

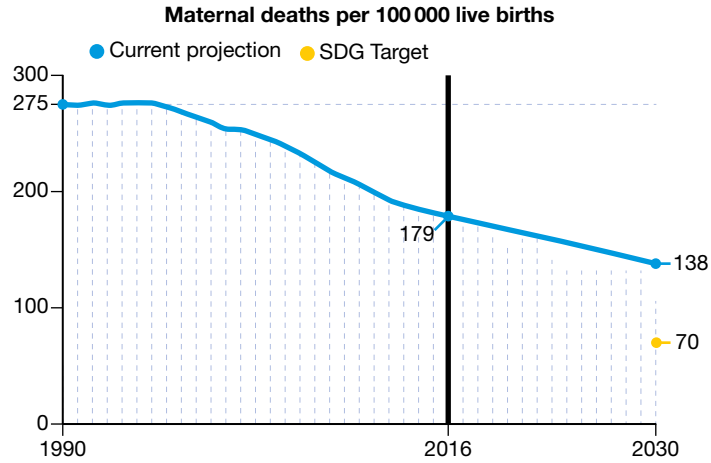


12.2.11 The number of deaths of children under age five, 1990–2030. More than 100 million children have been saved since 1990, largely due to better newborn care practices and vaccines.



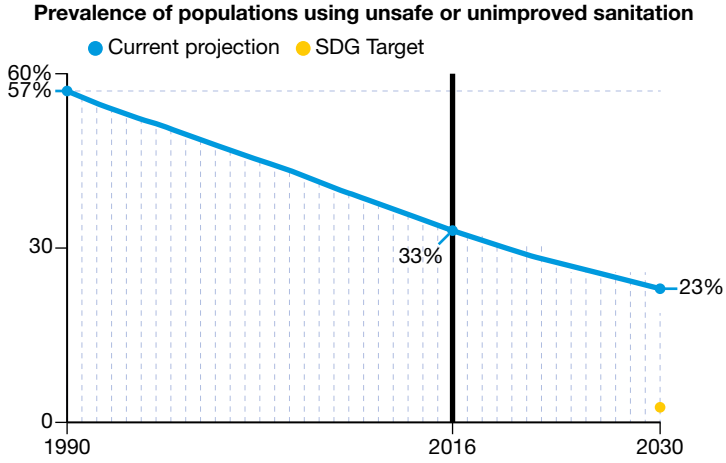
SDG Target: End preventable deaths of newborns and children under age five, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under five mortality to at least as low as 25 per 1000 live births.

12.2.12 Neonatal deaths per 1000 live births, 1990–2030. Almost half of all child deaths happen within the first 28 days of life.



SDG Target: Reduce the global maternal mortality ratio to less than 70 per 100 000 live births.

12.2.13 Maternal deaths per 100 000 live births, 1990–2030. In recent years there has been a shift in the number of women giving birth in health facilities rather than at home.



SDG Target: Achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

12.2.14 Prevalence of populations using unsafe or unimproved sanitation

12.2.15 More children are attending school around the world.

SPOTLIGHT

Useful development-related websites

Listed below are internet sites that are useful sources of information about development issues:

- New Internationalist
- Australian Aid
- Australian Council for International Development (ACFID)
- World Bank
- World Resources Institute
- UN Development Program.

The first site contains copies of most of the *New Internationalist* magazines. The AusAID and ACFID sites provide details about Australia's official and nongovernmental aid, as well as press releases and information about current issues in different developing countries. The rest of the sites are good sources of development data.

Activities

Understanding the text

1 Explain what human development means. How does this definition differ from other definitions of development?

2 Distinguish between a country's economic development and human development.

3 Explain what the Human Development Index (HDI) is. What indicators of development does it include?

4 Explain why the HDI is a more useful measure of development than other indicators.

Working geographically

5 Study Figures 12.2.5 and 12.2.6.
   - **a** Identify the regions of the world with the highest and lowest HDI.
   - **b** Describe the regional trends in HDI values, 1990–2015.

6 Study Figure 12.2.7. Write a brief report describing the relationship between incomes and levels of human development illustrated by the graph.

7 Study Figures 12.2.8.
   - **a** Which home do you think is from the poorest country? Give reasons for your answer.
   - **b** Which home belongs to people with the highest standard of living? Why do you think this?

8 Study Figure 12.2.9. Write a report outlining the growth of the world's middle class. How is the spending pattern of the world's middle class expected to change between 2015 and 2030?

9 Using data from Figures 12.2.10 to 12.2.14, write a report outlining the progress being made and the challenges faced by those living in developing countries.

10 Watch the first 20 minutes of the film, *The Gods Must Be Crazy*. Then answer the following questions.
   - **a** What are the benefits of being part of civilisation?
   - **b** What attributes of the hunter–gatherer society do you regard as civilised?
   - **c** The intrusion of one object from civilisation—a Coca-Cola bottle—had profound impacts on the community in the Kalahari. What were they?
   - **d** How do you think we can best measure which societies are developed and which are not?

11 The World Bank described poverty as 'an inability to attain a minimal standard of living'. What do you think a 'minimal standard of living' should be? Is it possible to define a minimal standard of living that is appropriate for all people in all societies?

CASE STUDY

Timor-Leste

Timor-Leste, formerly known as East Timor, is a South-East Asian country located in the Lesser Sunda Islands at the eastern end of the Indonesian archipelago, seen in Figure 12.2.16. Timor-Leste includes the eastern half of the island of Timor and the Oecussi district on the north-west portion of the island of Timor.

History

Timor-Leste was colonised by the Portuguese in the sixteenth century. It was declared independent in 1975 by the Revolutionary Front for an Independent Timor-Leste (known as Fretilin). Within days it was invaded and occupied by the Indonesian military and declared a province of Indonesia. This action initiated a decades-long conflict between separatist forces (principally Fretilin) and the Indonesians. The Indonesians relinquished control following a United Nations–sponsored act of self-determination in 1999. Timor-Leste became an independent country in May 2002.

Economy

Timor-Leste ranks 138 out of 181 nations in terms of GNI per capita. Its HDI is 0.605 (ranking it 133 out of 188 nations included in the ranking). This gives it a 'medium' classification.

Timor-Leste's economy depends on the exports of a few commodities such as petroleum, coffee, marble and sandalwood. Eighty per cent of the population is engaged in agriculture with coffee the principal non-subsistence crop grown.

In 2017, Australia and Timor-Leste resolved a long-running dispute over the maritime boundaries in the Timor Sea. At stake was sovereignty over oil and gas deposits worth an estimated $40 billion.

12.2.16 Timor-Leste

See Figure 12.2.17 for a profile of Timor-Leste overall.

Profile of Timor-Leste

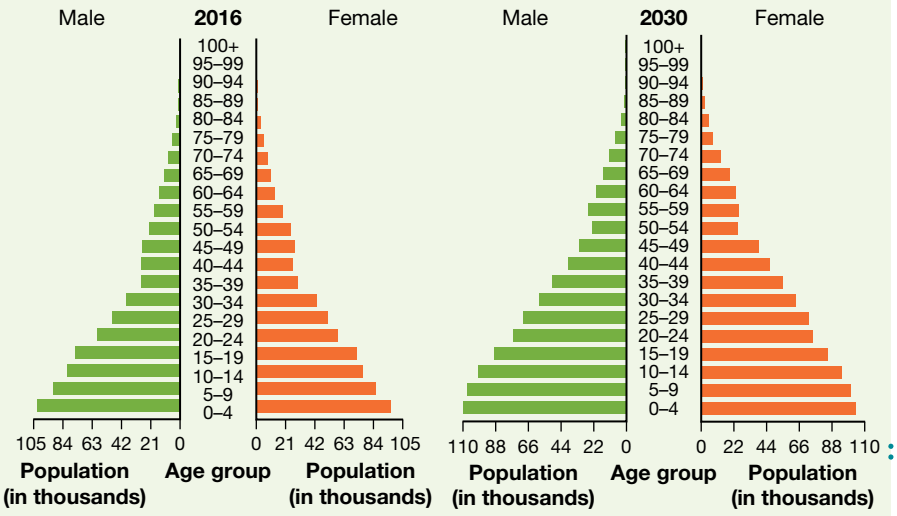
Capital:	Area:	Density:	Forest:	Arable land:	Climate:
Dili	**14 874 km²**	**78 persons per km²**	**53.7% (2005)**	**8.2%**	**tropical, hot, humid, distinct rainy and dry seasons**

Language	Tetum and Portuguese (official), Indonesian, English†	**Education**	■ Adult literacy rate: 58.3% ■ Gross enrolment ratio (GER): 136% (2014)*
Religion	■ Roman Catholic 96.9% ■ Muslim 1% ■ Protestant 1%	**Housing**	■ Access to sanitation facilities: 39% (2012) ■ Access to drinking water from an improved source: 70% (2012)
Population	Total: 1.3 million (mid-2017) ■ Birth rate: 38 births per 1000 population ■ Annual growth: 3.4% (2005–2015 estimate) ■ Urban: 33% (2017) ■ Rural: 66% (2017) ■ Population per km² of arable land: 839 ■ Projected population: 2.4 million in 2050 ■ Population structure (see Figure 12.2.18) ■ Population under the age of 15 years: 44% ■ Ethnic minorities: Eastern Tetum 45%, Mambai (Damata) 11%, Galolo 7%, Timorese (Vaikino) 7%, others (30%)	**Economic activity**	GDP (PPP): US$4567 billion (2017) GDP per capita: US$3804.8 (2017) GNI per capita (PPP): US$4340 GDP by sector: ■ Agriculture: 7.5% ■ Industry: 68% ■ Services: 24.4% External debt: US$311.5 million National currency: US$ Labour force by sector: ■ Agriculture: 64% ■ Industry: 10% ■ Services: 26% Unemployment: 11%
Health (2017 estimate)	■ Life expectancy (male/female): 67/70 ■ Infant mortality: 39 per 1000 live births ■ Birth rate: 38 births per 1000 population ■ Death rate: 10 deaths per 1000 population ■ Fertility rate: 5.6 ■ Maternal mortality: 215 per 100 000 live births ■ Population below the poverty line: 37%	**Exports**	Major exports: coffee, sandalwood, marble, wood, some petroleum and natural gas, livestock and fish products, spices, coconuts, cacao ■ Petroleum, oils and crude: 31% ■ Petroleum gases: 26% ■ Coffee: 22% ■ Others: 21%

†There are about 16 indigenous languages. Of these, Tetum, Galole, Mambae and Kemak are spoken by significant numbers of people.

* Gross enrolment ratio, primary. Total is the total enrolment in primary education, regardless of age, expressed as a percentage of the population of official primary education age. GER can exceed 100% due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition.

12.2.17 Timor-Leste profile



12.2.18 Population pyramids for Timor-Leste, 2016 and 2030 (projected)

Activities

Working geographically

1 Conduct research into the history of Timor-Leste. What historical factors do you think may account for some of its present-day problems?

2 Study Figures 12.2.17 and 12.2.18.

- **a** Estimate the population of Timor-Leste under the age of 15 years in 2017 and 2030.
- **b** Calculate the proportion of Timor-Leste's population under the age of 15 years in 2017 and 2030.
- **c** Explain why Timor-Leste's population will continue to grow for the foreseeable future.

UNIT 12.3

Development issues

Although tremendous diversity exists within and between all countries, some issues confront developing countries more commonly than the wealthier, developed countries. To some extent, these issues can be regarded as defining characteristics of the world's poorer countries.

Characteristics of developing countries

Many of the distinctive characteristics of poor countries correspond to the quantitative indicators that are frequently used to measure development. Although these features are regarded as common to developing countries, they don't always share all of these characteristics. For example, although Thailand and Vietnam are commonly regarded as developing countries and the average income per person is relatively low compared to that enjoyed by people in the developed world, they have high levels of adult literacy: 96.4 per cent and 94.5 per cent, respectively. When discussing poverty and development, spatial and temporal variations (that is, variations over time and space) will always exist; there are exceptions to any generalisation.

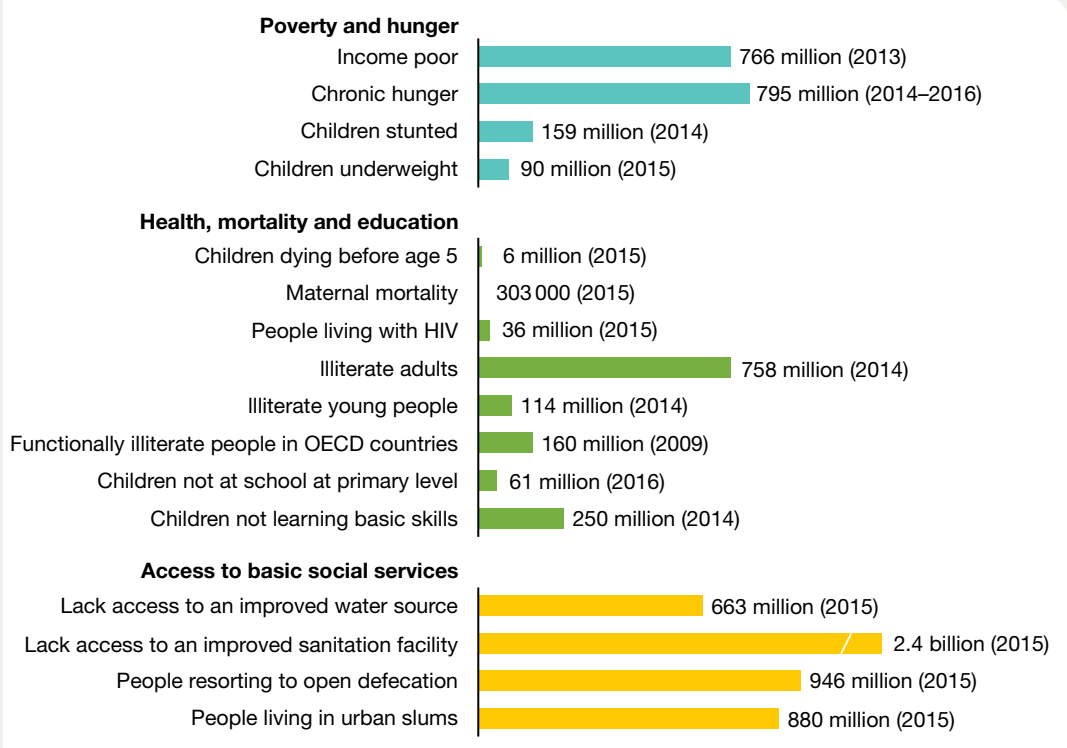
Poor health and low access to health services

The availability of quality health services is generally low in developing countries. For example, Niger and Ethiopia have just three physicians per 100 000 people. Australia, on the other hand, has 250 physicians per 100 000 people, while the equivalent measure in Belgium is 450.

SPOTLIGHT

Human deprivation lingers

Despite often-impressive progress in indicators of human wellbeing, millions of people continue to suffer from a range of deprivations. In 2017, nearly 800 million people—one in nine of the world's people—went to bed hungry or undernourished. Levels of deprivation are summarised in Figure 12.3.1.



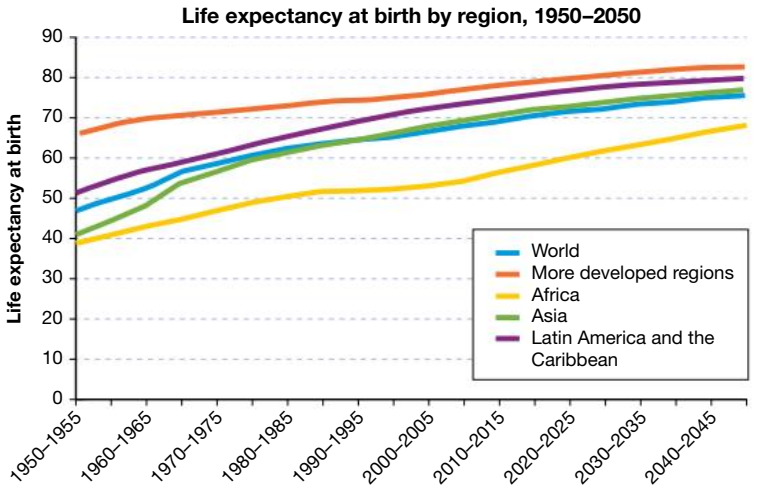
12.3.1 Despite significant advances across of a range of indicators human deprivation lingers.

Low life expectancy at birth

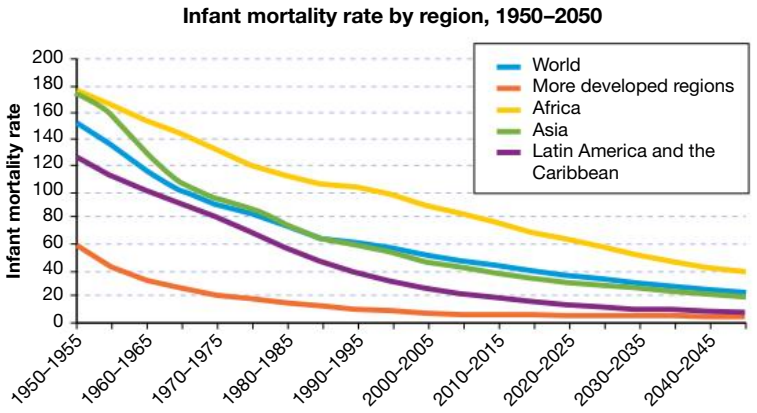
The lack of accessible medical services in many of the world's poorest countries means that people are less likely to survive the diseases of poverty. They are also more susceptible to preventable diseases because immunisation is not as widely available as it is in the developed world. Furthermore, a greater proportion of women and infants are likely to become very ill or die as a result of lack of medical care at childbirth. These problems are compounded by factors that contribute to poor health and disease, including poor nutrition, unclean water, poor sanitation and inadequate supplies of food. The average life expectancy in the least developed countries was 64.5 years in 2017, compared with 79 years in developed countries. Figure 12.3.2 illustrates the regional differences in life expectancy. While Africa still lags, the gap is getting smaller.

High infant mortality rates

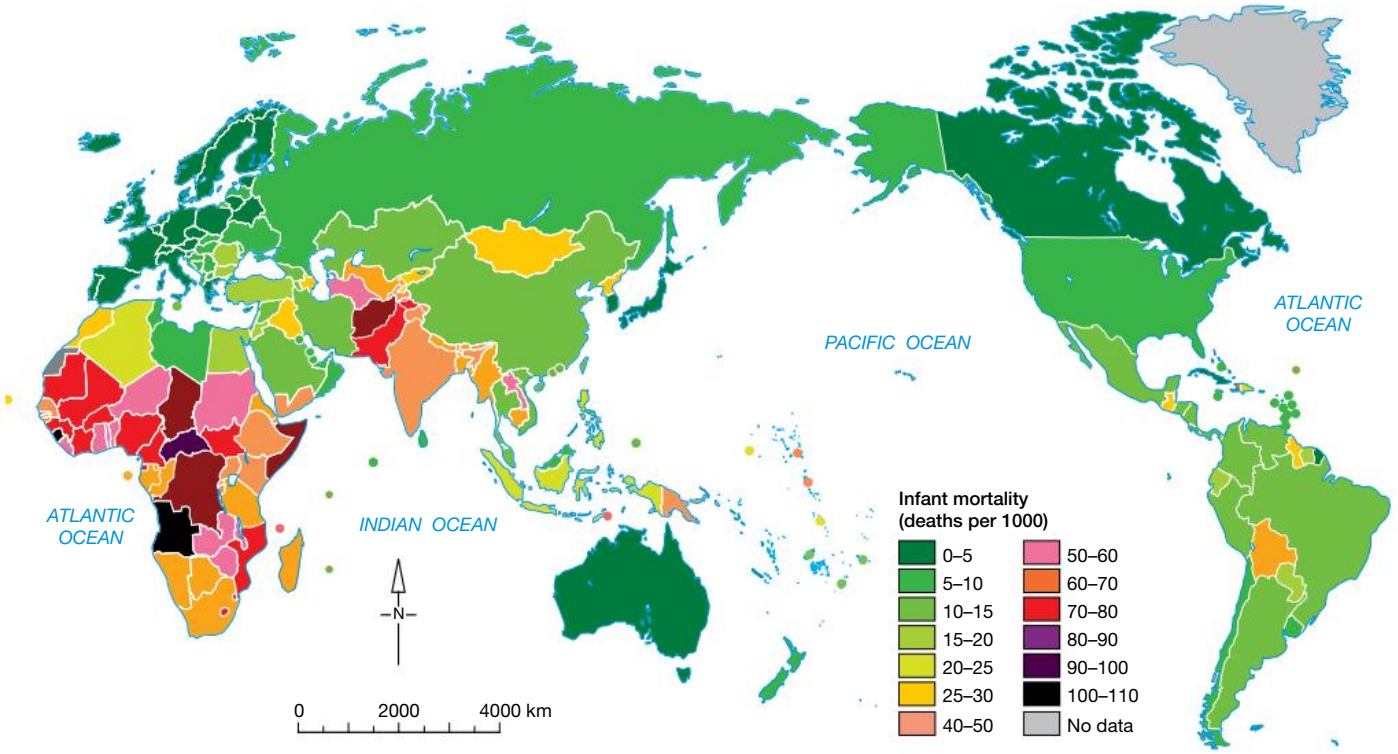
Although infant mortality rates have decreased in the developing world, they are still high: 35 deaths per 1000 live births in 2017, and 52 per 1000 in the least developed countries, compared with 5 deaths per 1000 in the high-income countries. (See Figures 12.3.3 and 12.3.4.) The under-five mortality rate is particularly high in some of the poorest countries: as high as 156.9 per 1000 live births in Angola (2015), 138.8 in Somalia, 138.7 in Chad, 130.1 in the Central African Republic, 120.4 in Sierra Leone, 114.7 in Mali and 108.8 in Nigeria.



12.3.2 Life expectancy is improving in most regions of the world.



12.3.3 Regional trends in infant mortality, actual and projected, 1950–2050

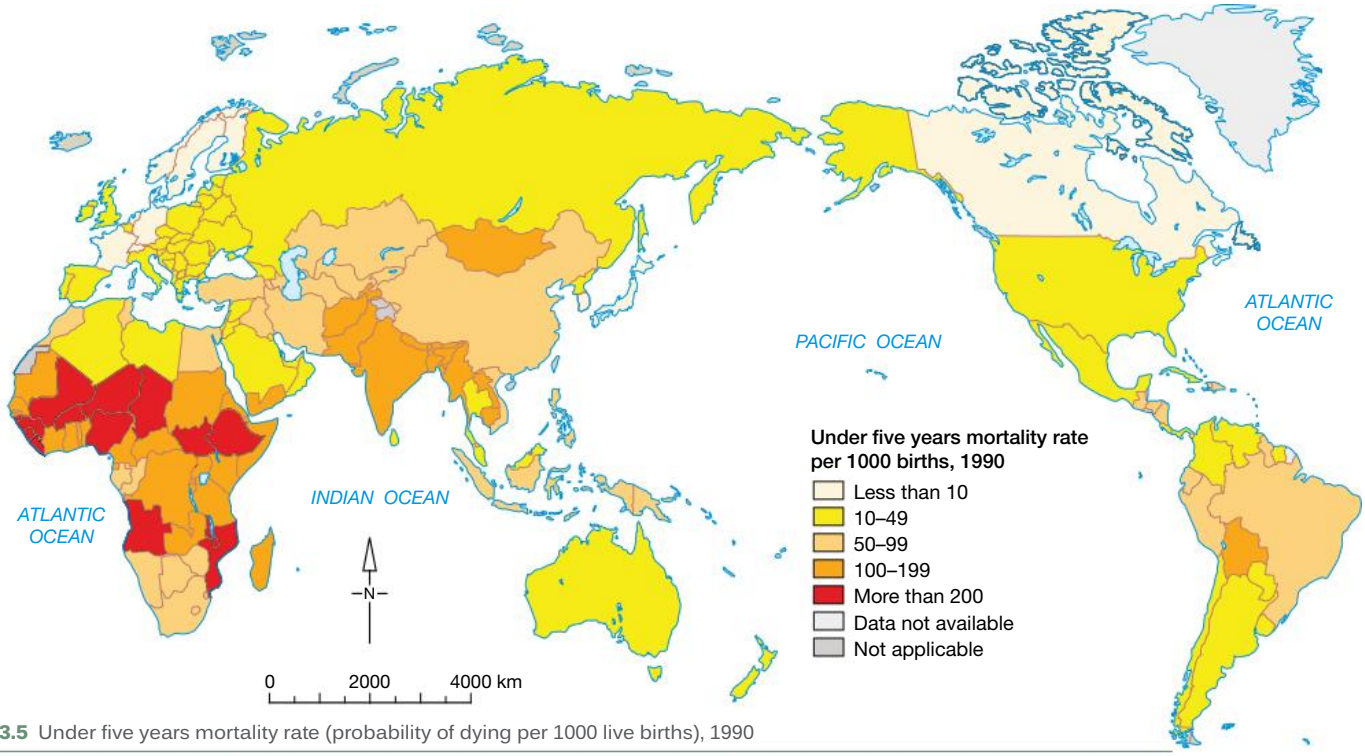


12.3.4 Infant mortality, 2015

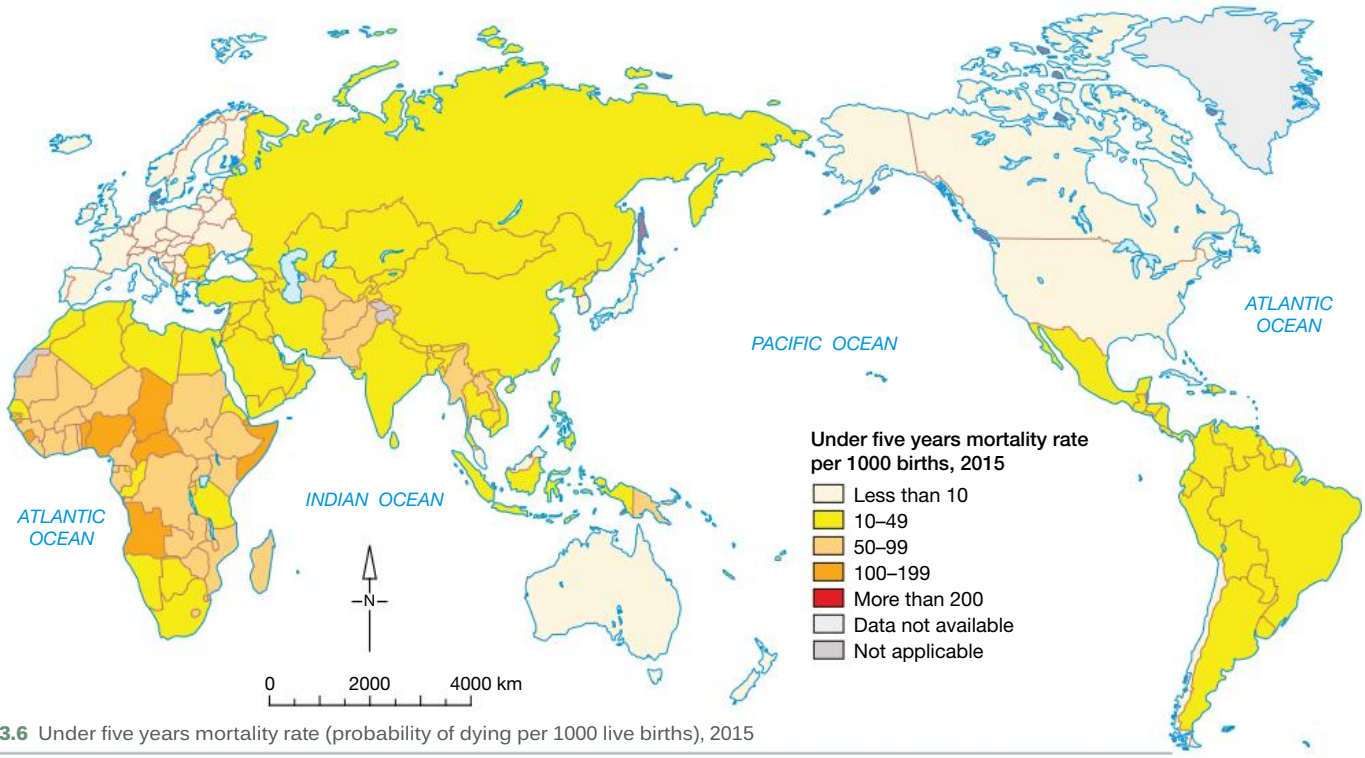
While these figures are a big improvement on those recorded in 1990 (see Figures 12.3.5 and 12.3.6), they are still well in excess of the global average of 42.5 and Australia's rate of just 3.8 deaths per 1000 live births.

Low per capita income

In general, developing countries tend to have low levels of per capita income when compared to wealthier countries. In 2015, the per capita GNI (US$) of those living in the countries of the developed world was $39 963, approximately four times that of those living in developing countries: $10 214. Those living in the least developed countries had an average per capita income of just $2424.



12.3.5 Under five years mortality rate (probability of dying per 1000 live births), 1990



12.3.6 Under five years mortality rate (probability of dying per 1000 live births), 2015

Poverty and indebtedness

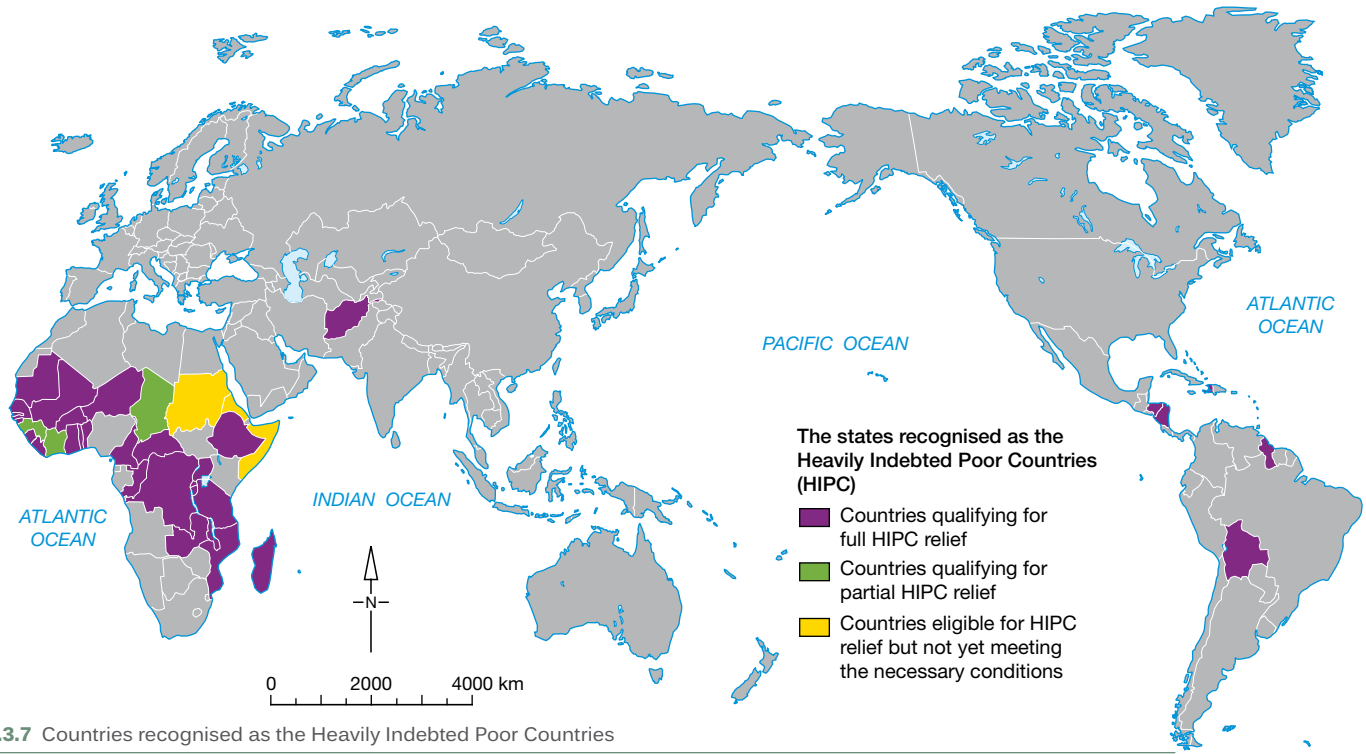
The World Bank estimates that 9 per cent the world's population lived on less than US$1.90 a day in 2015, compared to 12.4 per cent in 2012. That's down from 35 per cent in 1990. While nearly 1.1 billion people have moved out of extreme poverty since 1990, 760 million continue to people live on less than US$1.90 a day (down from 1.85 billion in 1990).

While poverty rates have declined in all regions, progress has been uneven. The reduction in extreme poverty has been mainly driven by East Asia and the Pacific (notably China and Indonesia), and South Asia (notably India). Half of the very poor live in sub-Saharan Africa. The number of poor in the region still exceeds 380 million people, more than all the other regions combined. The vast majority of the global poor live in rural areas and are poorly educated, mostly employed in the agricultural sector, and over half are under 18 years of age.

Debt relief

Developing countries have tended to be heavily indebted. Debt drains public budgets and drains the resources needed to support essential service provision and improve levels of human development. Initiatives to 'forgive' debt in the last decade have reduced the debt burden of many countries. These initiatives include the Heavily Indebted Poor Country (HIPC) program implemented by the World Bank and the International Monetary Fund (IMF). The aim of the debt relief program is to promote growth and reduce poverty in the world's poorest, most heavily indebted countries. The Heavily Indebted Poor Country (HIPC) initiative targeted 39 countries (33 of which were located in sub-Saharan Africa). (See Figure 12.3.7.) Of these, 36 countries have received full or partial debt relief. The cost of the initiative has now exceeded US$76 billion dollars.

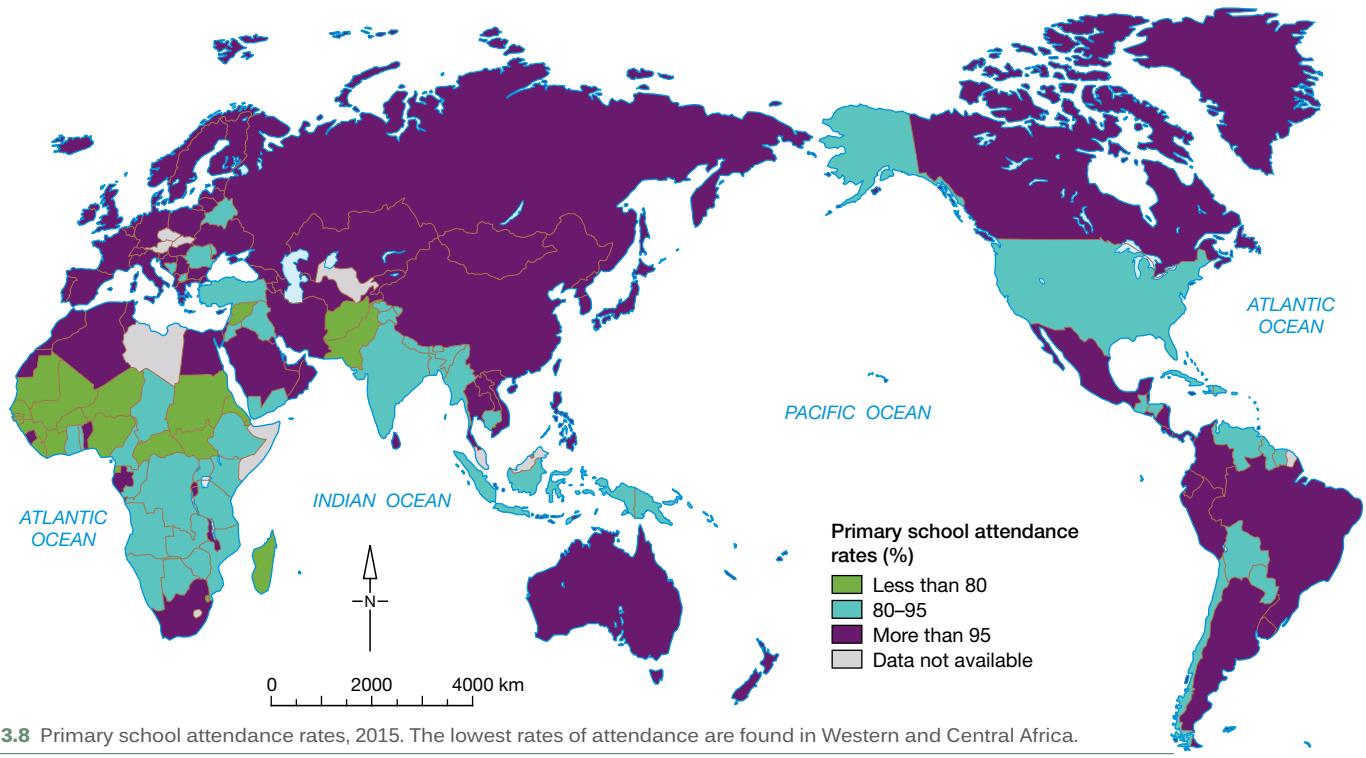
Debt relief is one part of a much larger effort, which includes aid flows, to address the development needs of low-income countries and make sure that debt sustainability is maintained over time. For debt reduction to have a tangible impact on poverty, the additional money needs to be spent on programs that benefit the poor.



12.3.7 Countries recognised as the Heavily Indebted Poor Countries

High levels of illiteracy

Among the most frequently used indicators of development are adult literacy rates, school attendance (see Figure 12.3.8) and retention rates. The adult literacy rate is generally taken to be at 99 per cent in developed countries, compared with 70.2 per cent in South and West Asia, and 64.0 per cent in sub-Saharan Africa. Over 75 per cent of the world's 758 million illiterate adults live in South Asia, West Asia and sub-Saharan Africa. Women make up two-thirds of illiterate adults globally. Just over 61 million primary school aged children were not in school in 2016, with the majority of these from West Asia and sub-Saharan Africa.



12.3.8 Primary school attendance rates, 2015. The lowest rates of attendance are found in Western and Central Africa.

Activities

Understanding the text

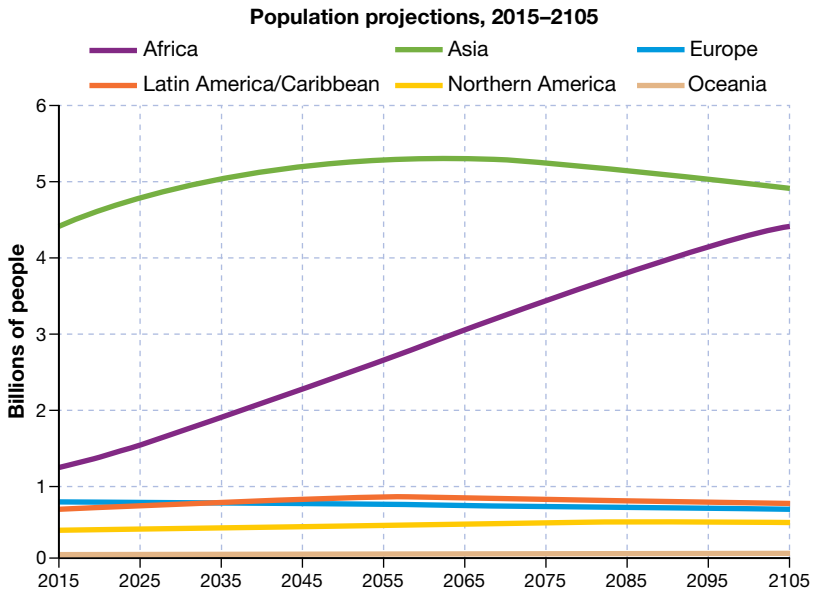
1. List the issues that typically confront developing countries.
2. Outline the consequences of poor health and low access to health services, especially as it related to the wellbeing of children and mothers.
3. State the progress achieved in the alleviation of poverty between 1990 and 2015. Outline the spatial pattern of these advances.
4. Outline the impacts of debt and the initiatives used to alleviate the debt burden on the world's poorest countries.
5. Outline the extent to which literacy and school attendance vary in different regions of the world.

Working geographically

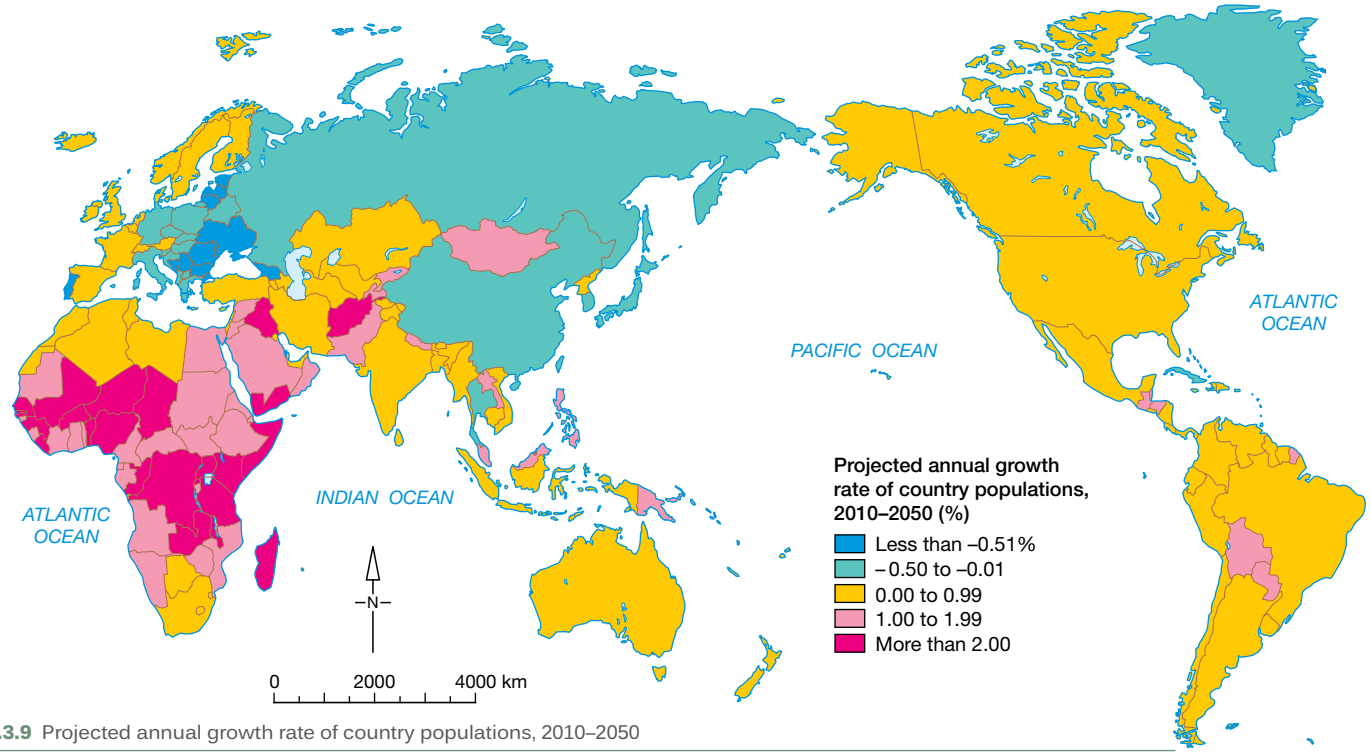
6. Study Figure 12.3.1. Write a report outlining the extent of human deprivation that continues to exist in the world's least developed countries.
7. Study Figure 12.3.2. Using data from the graph, describe the actual and projected trends in life expectancy in different regions of the world, 1950–2050.
8. Study Figure 12.3.3. Outline the trends in infant mortality, actual and projected, 1950–2050. Speculate on the implications of these trends for population growth in the future.
9. Study Figure 12.3.4. With the aid of an atlas, outline the global pattern of infant mortality. Where are infant mortality rates highest?
10. Study Figures 12.3.5 and 12.3.6. Describe and account for the improvements in the under-five mortality achieved between 1990 and 2015.
11. Study Figure 12.3.7. Describe the spatial distribution of countries qualifying for full and partial debt relief.
12. Study Figure 12.3.8. Write a paragraph describing the global pattern of school attendance.

High rates of population growth

Developing countries generally have higher birth rates than is the case in the wealthier countries. The annual population growth rate for developed countries averaged 0.5 per cent for the period 2010–15, compared with 1.4 per cent for developing countries and 2.4 per cent for the least developed countries (see Figure 12.3.9). Six countries have a growth rate greater than 4 per cent. These include Niger and South Sudan. The growing population in the world's poorer countries places added strain on already limited national resources, and creates additional demand for employment, schooling, infrastructure, health and other services. While growth rates are moderating, they are projected to remain relatively high in Africa, Southern Asia and parts of South-East Asia, as shown in Figure 12.3.10. While Asia's population is projected to start declining mid-century, Africa's population is expected to grow strongly.



12.3.10 Population projections, by region, 2015–2105



12.3.9 Projected annual growth rate of country populations, 2010–2050

Low levels of technology

In developing countries there are comparatively low levels of technology and applied science in agriculture and industry. Labour-intensive methods of production (see Figure 12.3.11) still tend to dominate in both agriculture and industry in the world's poorer countries.

12.3.11 A woman weaves a traditional East-Timorese hand-woven textile. In developing countries, many industrial processes still employ labour-intensive methods of production.

12.3.12 A subsistence farmer uses donkeys to plough his field in Makueni County, Kenya, East Africa.

12.3.13 The UN World Food Program delivers food aid in Malawi in 2015. Famine is just one of the many causes of nutritional deficiencies.

12.3.14 Many of those living in the world's least developed countries still don't have access to adequate public infrastructure.

Emphasis on primary production

A high percentage of the labour force is engaged in primary production: often subsistence production. Processes of urbanisation have been increasing in developing countries; however, in general a far greater percentage of the labour force is still engaged in agricultural activities in these countries than is the case in developed countries. The percentage of the population engaged in agriculture was 1.4 per cent in the United States in 2015, about 1.6 per cent in the United Kingdom and 7 per cent in Europe. This contrasts with 38 per cent of the population in East Asia, 46 per cent in South Asia and 62 per cent in sub-Saharan Africa. (See Figure 12.3.12.) Corresponding with this, the manufacturing and industrial sectors engage far less of the labour force in economically poorer countries.

Dietary deficiencies

Dietary deficiencies result from an inadequate food intake. The food may be of poor quality and/or an insufficient quantity of food is consumed. The World Food Program reports that about 795 million people worldwide suffered from chronic hunger in 2014–2016 (down more than 100 million over the last decade). The vast majority of undernourished people live in developing countries, where 1 in 8 were chronically hungry in 2012–2014. Women and children are particularly vulnerable to nutritional deficiencies due to biological and social inequalities. Globally, under-nutrition accounts for more than one-third of child deaths; 159 million children suffer from stunting; 90 million are underweight and six million children die before the age of 5.

The sub-Saharan region, shown in Figure 12.3.13, has by far the highest prevalence of chronic hunger of any region. One in four people are chronically hungry. Climate change increases food insecurity and the breakdown of food systems. This disproportionately affects poorer populations.

Low levels of infrastructure

Low national incomes are often reflected in low levels of public infrastructure provision, especially the utilities we normally take for granted (electricity, water and sanitation). (See Figure 12.3.14.) In 2016, an estimated 1.2 billion people—16 per cent of the global population—lacked access to electricity. In Africa only 45 per cent of the population has access, and in sub-Saharan African the figure falls to just 35 per cent. In India, 19 per cent of the population still does not have access to electricity.

Globally, 663 million people lack access to improved water sources; 2.4 billion people lack access to improved sanitation facilities; 946 million (13 per cent of the world population) are forced to defecate in the open; and 880 million live in urban slums.

Considerable progress has been made (more than 2.1 billion people gained access to improved sanitation facilities between 1990 and 2015); however, urban-rural disparities persist—70 per cent of the gains in access to improved sanitation were in urban areas. Seventy per cent of people that do not have access to improved sanitation live in rural areas.

Low levels of energy consumption

Developing countries consume far less of the world's global energy supplies than the wealthy countries. In countries classified as developing, 19 per cent of people still don't have access to electricity. In the least developed countries, 66 per cent don't have access.

These areas also have very large differences in energy consumption per capita. People living in high-income countries such as Canada, the USA and Australia use on average 4853.1 kilograms of oil equivalent a year. Those living in the world's least developed countries consume just 339.8 kilograms of oil equivalent a year.

SPOTLIGHT

Global Nutritional Targets for 2025

The UN's World Health Organization has endorsed global targets for improving maternal, infant and young child nutrition and is committed to monitoring progress. The targets play an important role in identifying priority areas for action and promoting global change.

World Health Organization global targets

Priority area	Target
Stunting	40% reduction in the number of children under five who are stunted
Anaemia	50% reduction of anaemia in women of reproductive age
Low birth weight	30% reduction in low birth rate
Childhood overweight	No increase in child overweight
Breastfeeding	Increase rate of exclusive breastfeeding in the first six months up to at least 50%
Wasting	Reduce and maintain childhood wasting to less than 5%

Activities

Understanding the text

1 State the difference in population growth rates being experienced in the developed, developing and least developed countries of the world. What are the implications of high population growth rates in the least developed countries?
2 Describe the nature of the workforce and the technology used in developing countries.
3 Outline the extent of dietary deficiency and its associated impacts.
4 Summarise the extent to which developing countries are disadvantaged in terms of infrastructure.
5 State the gap in per capita energy consumption between the developed and least developed worlds.

Working geographically

6 Study Figure 12.3.9. With the aid of an atlas identify those parts of the world projected to have the greatest population growth rates in the period 2010–2050. Which countries are projected to have a negative growth rate?
7 Study Figure 12.3.10. Using data from the graph, outline the population projections for both Asia and Africa.
8 Write an explanation outlining the relationship between poverty, undernourishment and disease and their impact on human potential.
9 Conduct a class debate. Topic: 'High consumers should live more simply so that others may simply live.'

GEOSKILLS

Environmental footprint

It has been calculated that if the entire world's population consumed food, fuel and other natural resources at the same rate as the people of the rich countries, three planet earths would be needed to support everyone.

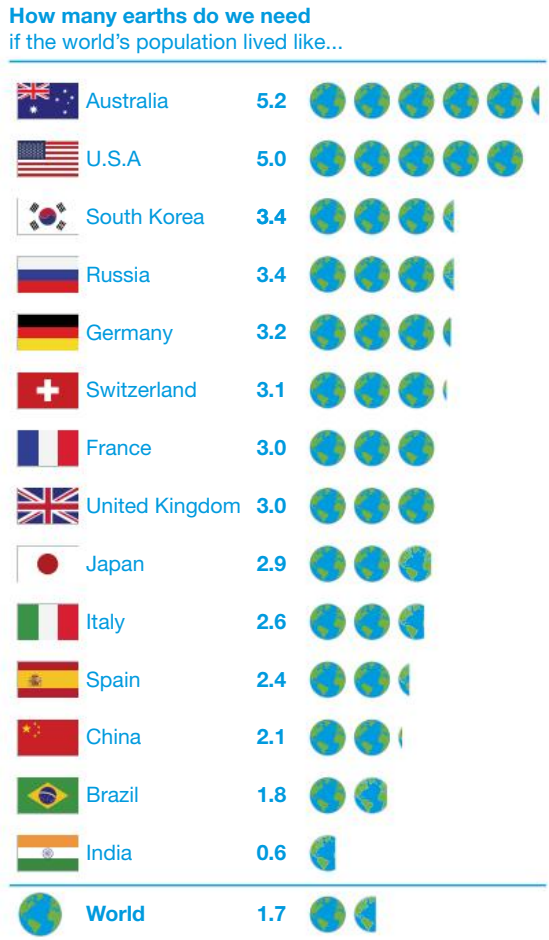
Even though the US population is only a quarter the size of India's, its environmental footprint is over twice as big. In 2015, the USA released 5170 million metric tonnes of carbon into the atmosphere compared with India's 2454 million tonnes.

Energy consumption

There has been a dramatic surge in energy use in many developed countries. Compared with just 10–20 years ago Americans are driving larger and less efficient cars and buying bigger homes and more appliances. As a result, the USA's annual consumption of petroleum products now equals 7.21 billion barrels of oil, an average of about 19.69 million barrels a day. This is more oil than is used daily in India and Pakistan, which together contain more than four times as many people as the United States. On average, one American consumes as much energy as two Japanese, six Mexicans, 13 Chinese, 31 Indians, 128 Bangladeshis, 307 Tanzanians and 370 Ethiopians.

Yet energy consumption is rising fastest in the developing world, where petroleum use alone has more than quadrupled since 1970. China is already the world's number one coal consumer and the third largest oil user, India comes in at number four and Brazil is the sixth largest oil consumer. Current trends in global energy use simply cannot be sustained: if the average Chinese consumer used as much oil as the average American uses, China would require 90 million barrels per day. This is 9.4 million more than the entire world produced each day in 2016 (80.62 million barrels).

Figure 12.3.15 shows the number of earths needed to sustain humanity if everyone had the same standard of living experienced by those living in selected countries in 2017.



12.3.15 How many earths do we need? The number of earths needed to sustain humanity if everyone had the same standard of living experienced by those living in selected countries, 2017.

Calculating your environmental footprint

For more information about humanity's environmental footprint access the website of the Worldwatch Institute and the Global Footprint Network, and see also Figure 12.3.16.

A number of websites help you calculate your environmental footprint. Try one of these:

- Global Footprint Network
- Environment Protection Authority Victoria
- World Wildlife Fund for Nature.

12.3.16 A cartoonist's perspective on the concept of environmental footprint

Activities

Understanding the text

1 Explain the concept of environmental footprint.

Working geographically

2 Study Figure 12.3.15. State the number of earths needed to sustain humanity if everyone had the same standard of living as Australians.

3 Select one of the environmental footprint calculators listed. Calculate your environmental impact.

UNIT 12.4

Factors affecting the rate of development

Geographers attempt to understand the differences they observe between countries and within countries, and to describe and account for changes that occur over time. This section will explore some of the factors that have contributed to the creation of these different patterns of wealthier and poorer countries.

When discussing what may cause the differential rates of development between countries, consider the following:

- **Scale:** At the local level (for example, among indigenous minority groups, such as Aboriginal Australians) factors contributing to poverty may not be the same as those responsible for poverty at the national level, or on the macro scale.
- **Whether internal or external:** Factors internal or external to a community or country may be the cause of poverty and create the characteristics common to poor countries.
- **Complexity:** Complex interrelationships usually exist between factors that contribute to poverty and lack of development.

Early geographical studies of the developing world tended to be descriptive, focusing primarily on the uniqueness of foreign places and their peoples. References to internal factors were used to explain the persistence of poverty. These factors include a poor natural resource base and climatic conditions. Some believed that the poor were the chief cause of their own problems. Today, it is widely acknowledged that a complex relationship between frequently interrelated factors contributes to the ongoing problems of poverty. These factors are both internal and external to the developing countries and are outlined below.

Internal factors influencing development

The resource base

Differing levels of wealth can be partially attributed to the resource base available to communities or countries. Some countries are able to derive considerable wealth from the exploitation of natural resources. These nation-states include oil-producing countries, such as Saudi Arabia, Qatar and the United Arab Emirates. However, there may be only limited potential for other countries to generate income from the exploitation of natural resources.

When a country's biophysical environment (that is climate, soils and landform) is suitable for a range of agricultural activities, the country has the potential to become self-sufficient in production of food resources. Any surplus can be exported to generate capital for investment in other areas. Lack of a suitable environment for production of food resources means a country may be forced to rely on costly imports to meet the needs of its people.

If other compensatory factors come into play, the lack of a strong natural resource base need not be an impediment to development. Japan, for example, has few natural resources but was able to achieve a high level of development based on the importation of raw materials and the export of manufactured goods.

Political instability

Political instability hampers economic and social development, and may be the cause of poverty. History has left many countries with fragile and artificial national boundaries. Many of the world's former colonies are now among the world's poorest countries. The national boundaries and notions of national sovereignty, which they inherited after the demise of colonialism, often fit uneasily with local traditions and customs.

Frequently, formerly distinct groups of people, often from different ethnic backgrounds, were forced together within national boundaries. This led to conflict and instability within the newly formed countries. Internal political instability, as seen in Mogadishu, Somalia in Figure 12.4.1, can carry a heavy cost burden. Instead of funds being devoted to development-related projects or social infrastructure, which may improve levels of human development, they are often diverted to finance the activities of the military and police forces. As a result, infrastructure is often damaged, crops destroyed, people displaced and the economy disrupted.

12.4.1 In late 2017 at least 500 people were killed or seriously injured in Mogadishu, the capital of Somalia, when a truck packed with several hundred kilograms of military-grade and homemade explosives exploded. Al-Shabaab, an Islamist group, claimed responsibility. The group describes itself as waging jihad against 'enemies of Islam', and is engaged in combat against Somalia's government.

Timor-Leste, Rwanda, Nigeria, Burundi, South Sudan and Darfur, Sri Lanka and Myanmar, among others, provide examples of the effects of political upheaval. Although present-day political instability is often internal to a country, it must be remembered that often the seeds of instability were sown in the form of artificial national boundaries, which are a product of history.

Population growth

A sharp decline in mortality rates since the middle of the twentieth century (a result of improvements in nutrition, and access to health care and immunisation) contributed to a spike in population growth rates throughout the developing world. The decrease in mortality also meant that more women reached childbearing age. As a consequence, there was a surge in the number of young people in the population, who then had their own children. Only in relatively recent times has a decline in fertility rates resulted in a moderation of population growth rates.

A country's ability to provide medical and educational facilities, infrastructure and adequate food supplies is immediately affected by any rise in the number of births. There are added demands for infrastructure as a result of increased population. Some countries have tried to introduce national population policies that encourage couples to limit family size.

The issue of population growth and control is controversial. Many argue that population growth is largely to blame for the world's environmental and development problems. Others argue that poverty, indebtedness, inequities in access to land, and global inequalities are the real causes of environmental degradation and poverty. Women's groups argue that the population issue can be addressed by improving the status and economic wellbeing of women. This can be achieved by providing access to education, employment and family planning services. People of the developing countries also argue that overconsumption by the industrial countries has to be addressed, rather than just focusing on controlling population growth.

Environmental degradation

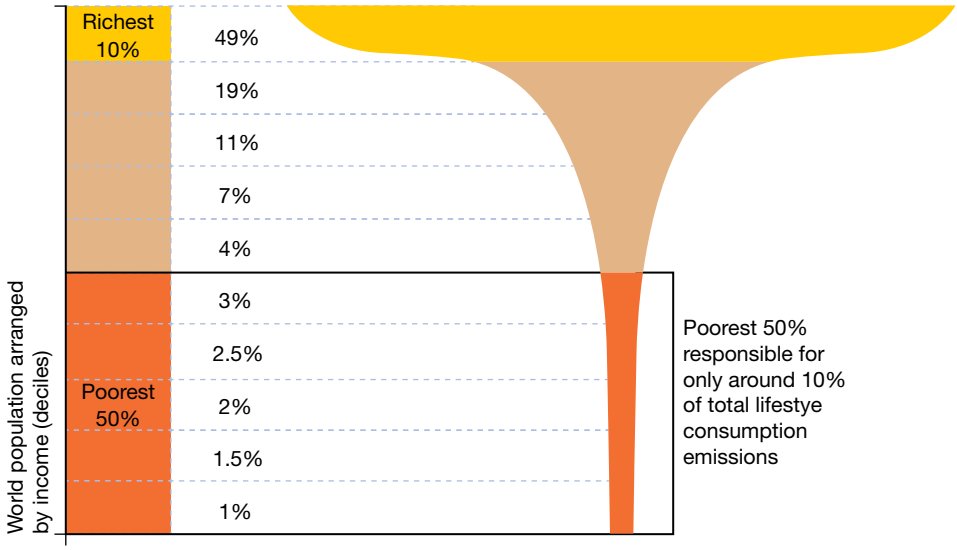
Environmental degradation in developing countries is both a symptom of poverty and a factor contributing to ongoing poverty. At the local level, people are often engaged in practices that can cause environmental degradation. This is frequently the result of the struggle of individuals to survive, shown in Figure 12.4.2. Population growth and increased use of land for commercial agriculture can force the extension of subsistence agricultural activities into marginal areas. This results in land being cleared for agricultural purposes or to access timber for firewood or housing. Furthermore, land overuse results in the reduction of soil fertility. At the national level, the necessity to repay foreign debt means that governments of many developing countries have encouraged the further development of cash cropping, mining and forestry, frequently at the expense of the environment.

12.4.2 Continued environmental degradation in all regions is unfairly shifting burdens onto future generations, and contradicts the principle of intergenerational equity.

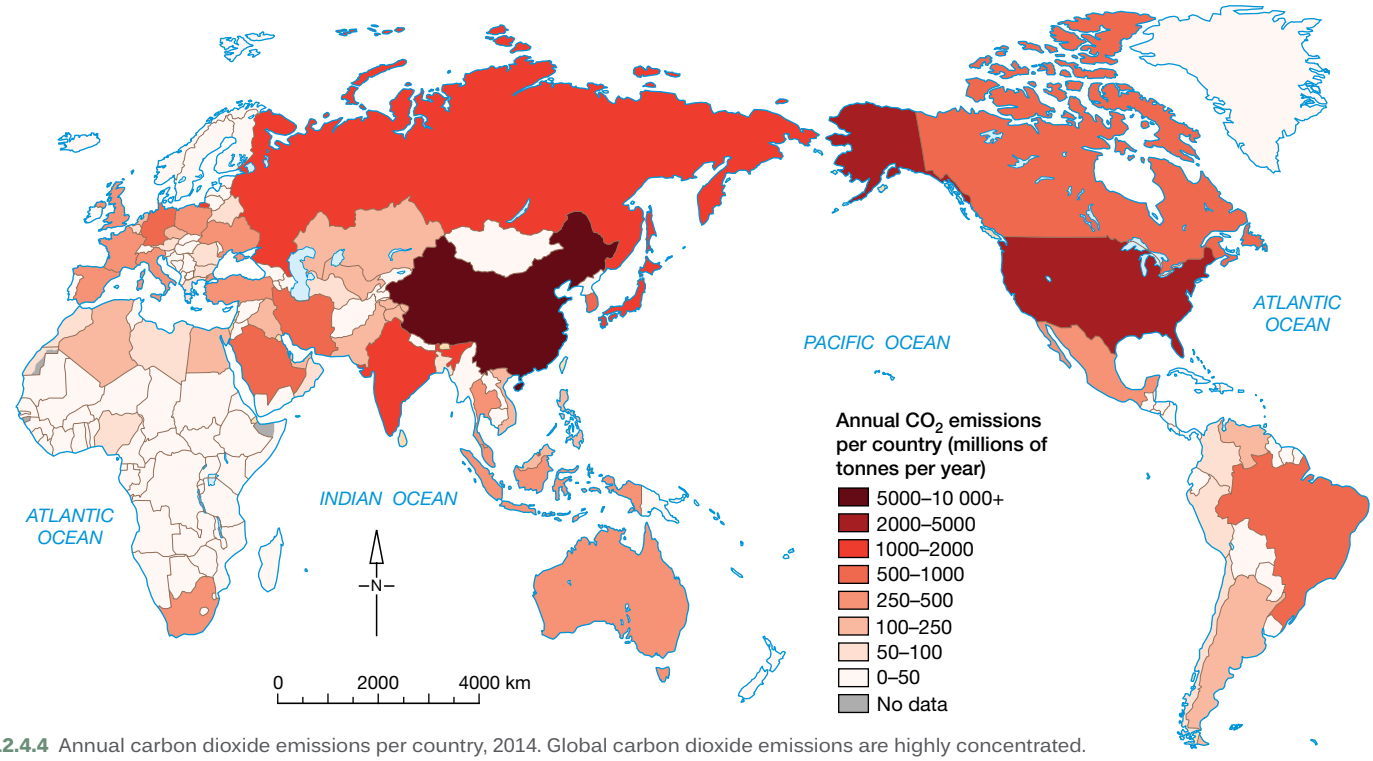
In some areas, such as the Sahel region of Africa, overuse of land and destruction of ground cover, principally a result of rapidly increasing populations, has led to rapid desertification. Because the boundaries of the desert are gradually being extended, arable land is subject to increasing pressure through overuse. Subsistence farmers simply do not have the resources to reverse these processes or reduce their use of the land.

The land is further degraded and becomes less fertile, and the poor become still poorer.

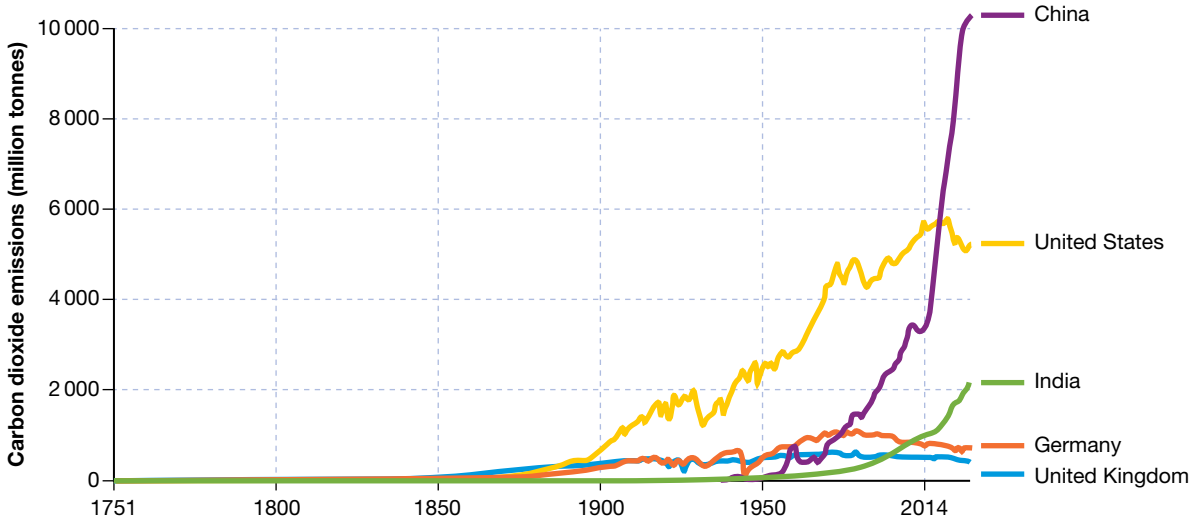
There is growing concern about the impacts of climate change on the world's most vulnerable people. As Figures 12.4.3 to 12.4.6 demonstrate, the people of the world's poorer countries have contributed least to global climate change; yet these are the people who are most at risk from its impacts.



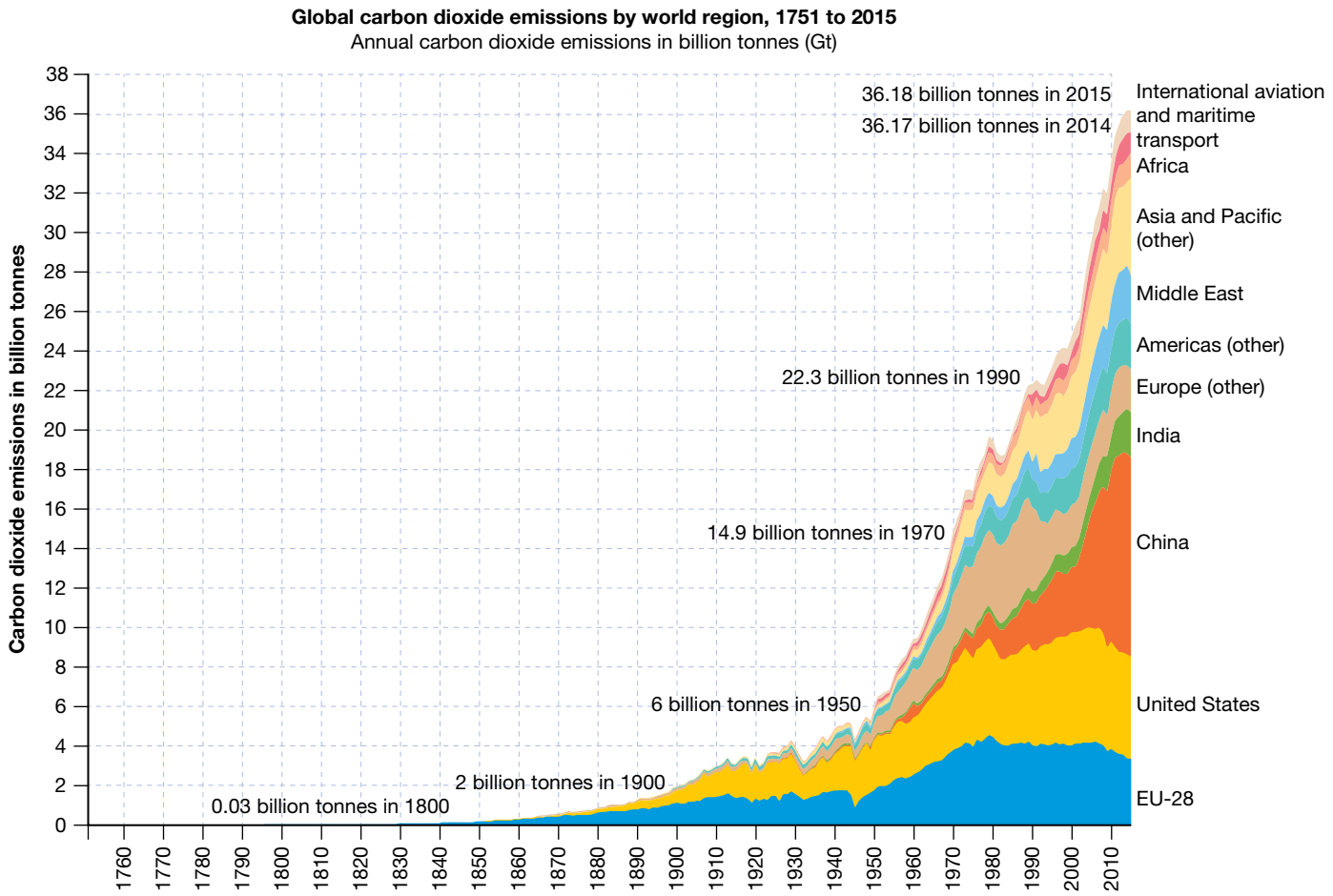
12.4.3 Percentage of carbon dioxide emissions by world population. The world's wealthiest 10 per cent account for 40 per cent of all carbon dioxide emissions. The poorest 50 per cent of the world's population account for just 10 per cent of all lifestyle-related carbon dioxide emissions.



12.4.4 Annual carbon dioxide emissions per country, 2014. Global carbon dioxide emissions are highly concentrated.



12.4.5 Annual carbon dioxide emissions by major emitters. China and the USA are the world's biggest carbon dioxide emitters.



12.4.6 Global carbon dioxide emissions by region, 1751–2015

Problems may be compounded

The symptoms of low levels of development often contribute to the ongoing problems of developing countries. It is argued that poor health reduces the productivity of people in certain areas. Similarly, low levels of national income mean some governments do not have the capacity to invest in health care services and education facilities, or in efforts to mitigate the increasing effects of climate change.

The priorities of individual governments may also determine the nature of development within a country. A government may choose to spend the limited available capital on meeting the basic needs of the poor majority. Another government may direct it towards priorities such as the protection of the interests of wealthy elites or military expenditure. So, good governance in terms of giving priority to spending on human development through improving access to education and health services can significantly affect levels of human development.

Local culture and traditions are sometimes regarded as obstacles to development. In India, people of the Hindu religion are born into particular social classes known as castes. An individual's caste frequently determines their occupation and status in life. The persistence of such rigid social systems can hinder development for some social groups or communities.

Corruption is also cited as an internal cause of poverty and continued underdevelopment. Corruption exists everywhere; however, in some poor countries people are more vulnerable to the influence of corrupt individuals, elites and bureaucracies. This is because in these countries there are higher levels of illiteracy and less understanding of rights. In addition, people's lives are more likely to be dominated by a daily struggle to survive.

Activities

Understanding the text

1 Identify the factors geographers need to take into account when studying the differential rates of development between countries.

2 Outline the importance of natural resources to the process of development.

3 Explain how the biophysical environment contributes to the wellbeing of people.

4 Outline the causes of the political instability.

5 Outline the ways in which political instability can hinder development.

6 Identify the reasons why rapid population growth is being experienced in the developing world.

7 Outline the ways in which rapidly growing populations hinder development.

8 Explain why the issue of population control is controversial.

9 Explain why it is important to improve the status and rights of women.

10 Explain why people living in developing countries are sometimes forced to degrade the environment.

11 Outline the impact that rapid population growth and the expansion of commercial agriculture are having on the environment in the Sahel.

12 Explain why the high-consumption lifestyle of the developed world is said to be unsustainable.

13 Explain the ways in which environmental degradation within developing countries may be caused by factors external to developing countries, rather than by factors internal to poor countries.

Working geographically

14 Identify the type of natural resources that can bring wealth to a country. List some countries that have been able to exploit natural resources to achieve increased national income. Does exploiting natural resources to generate national income have any negative consequences?

15 Working in groups, identify at least five countries whose economic and social development are constrained by the limitation of available natural resources.

16 Undertake library and internet research. Find the population growth rates for five developing countries and five wealthy countries. Does a clear pattern emerge? How can you account for this?

17 Study Figure 12.4.3 and conduct a class debate. Topic: 'Those who have contributed most to climate change should take responsibility for it.'

18 Study Figure 12.4.4. With the aid of an atlas identify the biggest emitters of carbon dioxide. Where are the lowest carbon dioxide emitters found?

19 Study Figure 2.4.5. Using data from the graph, describe the trends in carbon dioxide emissions for China, India, the USA, Germany and the UK.

20 Study Figure 12.4.6. What does this graph tell us about the world's total carbon dioxide emissions and the changing regional distribution of these emissions?

External factors impacting on development

The legacy of history

Many of the world's poorest countries were once European colonies. In the years immediately after World War II, most colonial powers gave up, or were forced to give up, their colonial territories. However, the legacy of colonialism remained and has influenced the development paths of many of the former wealthier and industrialised colonies. The extent to which their colonial past hinders development varies, but this is generally seen to be a contributing factor.

Many of the colonies were used as markets for finished products and other surpluses produced in the industrialised countries. At the same time, the colonial countries supplied raw materials and foodstuffs needed by the colonial power. Restrictions were often placed on the ability of the colony to produce goods that were already produced by the colonial power, or to trade freely with countries other than the colonial power. Such arrangements were designed to benefit the colonial power rather than the colony, and placed severe restrictions on the colony's economic activities. Many of these established trade relationships continued long after the demise of colonialism, continuing to dominate international trading relationships. The uneven distribution of wealth between countries is perpetuated by relationships established in the colonial era. Many former colonial countries still suffer from continued economic dependence on the more developed regions of the world.

While pre-colonial, colonial and post-colonial experiences may have contributed significantly to the problems of some poor countries, some developing countries, such as Thailand, remained independent and were never colonised. In today's interdependent world, a complex mix of factors must be examined in relation to each country in order to understand its comparative wealth. It is too simplistic to argue that colonialism alone is the chief cause of the problems of the poor world. While the impacts of colonialism are still apparent in many parts of Africa, they are less so in the newly emerging economies of East and Southern Asia (for example, India, Malaysia, Singapore and Indonesia). These countries are now well integrated into the global economy as a result of the process of globalisation.

Debt burdens

During the 1970s, oil prices increased dramatically. Huge amounts of money were generated through the sale of oil and then deposited in the world's commercial banks. At the same time, the developed world suffered an economic recession, which was generated in part by the increasing cost of oil. The recession in the developed countries meant that demand for credit from the commercial banks declined. Seeking to earn income on the reserves they held, the commercial banks began to look for new markets. They saw a potential market in the poor countries.

Borrowing money

In an attempt to follow the road to industrialisation and increased national income, the poor countries were keen to borrow funds to build infrastructure and to assist their countries to industrialise and modernise. At the time, the loans available were attractive; surpluses meant that they were being offered at low interest rates. As a result of these factors, commercial lending and loans offered through official aid programs to developing countries grew dramatically.

Recession and rising interest rates

Rising interest rates in the 1980s meant that repayments on the debts began to cost more and more. At the same time, the export earnings of developing countries declined. This was because the recession experienced at that time in developed countries meant that poor countries were receiving lower prices for their exports. The recession in the developed world also meant that foreign investment in poor countries declined. Western countries also became protectionist to try to support their own producers. These factors reduced the potential for developing countries to increase their incomes. So, developing countries were forced into a situation where their income was declining but at the same time they had increasing debts to service (in ongoing interest and repayments to the lender).

Under pressure to meet debt repayments, many developing countries attempted to increase export earnings by allowing the exploitation of natural resources, such as native forests and mineral deposits. They also concentrated their agricultural activities on the production of cash crops for sale to the wealthy countries. Many poor countries were financially strangled for decades by the burden of debt repayments.

Reducing the debt burden

There have been attempts in recent years to find solutions to the high levels of debt.

'Debt for nature swaps' are an innovative attempt to solve the problem of debt while ensuring the conservation of natural resources. The first 'swap' occurred in July 1987, when an organisation called Conservation International bought out US$650 000 of Bolivian debt for US$100 000. The money saved was to be used for the management of several biological reserves. Since then, other 'debt for nature swaps' have been successfully implemented in a number of other countries, including Ecuador and the Philippines.

Recognition of the burden that debt payments impose has led to concerted campaigns by nongovernmental organisations (NGOs), advocacy groups, academics and the general public for debt forgiveness. Campaigning about this issue began in the 1980s. Some wealthy countries have elected to cancel the debts owed to them by smaller countries.

In 1995, Denmark cancelled the debts of five very poor countries: Angola, Ghana, Nicaragua, Zimbabwe and Bolivia. In 2000, the global Jubilee Campaign called for cancellation of the total debt of the most impoverished countries. Sponsored by NGOs and churches, Jubilee 2000 aimed to link the biblical concept of debt forgiveness with the year 2000. The global Make Poverty History movement was launched in 2005 and has continued to campaign for global debt relief.

The Heavily Indebted Poor Countries (HIPC) initiative was set up in 1996 by the World Bank and the International Monetary Fund (IMF) to reduce the debts of poor countries. Under this initiative, if they meet certain conditions, heavily indebted poor countries are eligible for debt relief. Their debt will be reduced to a level deemed to be 'sustainable' by the World Bank and the IMF. The HIPC initiative targeted 39 countries (33 of which were located in sub-Saharan Africa, see Figure 12.4.7). Of these, 36 countries have received full or partial debt relief. The cost of the initiative has now exceeded US$76 billion dollars.

12.4.7 A cartoonist's view on the issue of debt relief

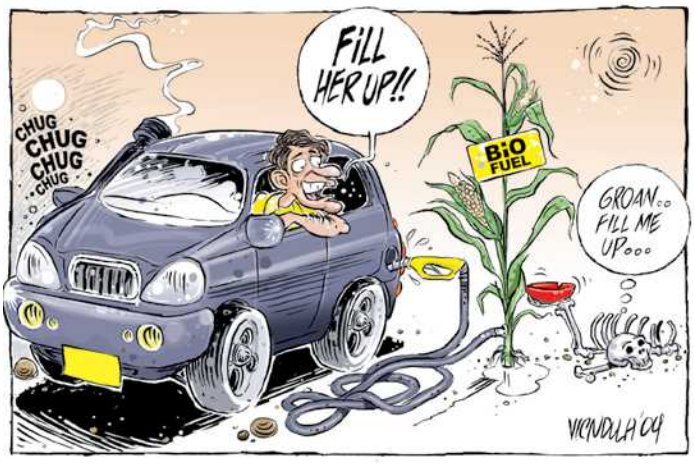
Trade imbalances

The world's least developed countries and some developing countries are net importers of manufactured goods, while developed countries and the emerging economies of South and East Asia are mostly net exporters of manufactured goods. Manufactured goods have added production costs, and are more costly than the raw material exports that most developing countries are able to sell. Many poor countries are still dependent on the industrialised, wealthy countries for high-cost, technology intensive, imported goods. Meanwhile, they rely heavily on agricultural products for export earnings. Developing countries have increased their share of global output, but developing countries are usually at a disadvantage in world trade: the value of their imports often exceeds the income earned from their exports. Consequently, they are likely to incur a debt rather than earn surplus income through trade.

Many poor countries have encouraged the conversion of farmland from subsistence production to production of cash crops (such as tea, coffee and flowers) in order to earn export income (see Figure 12.4.8). This can have devastating effects on poor local farmers, who forgo more dependable subsistence farming systems in favour of cash cropping, see Figure 12.4.9. In doing so, they become dependent on export income, which in turn depends on continued and consistent demand for cash crops. As well, countries become highly dependent on unreliable sources of export earnings.

Natural conditions (such as drought, floods and insect plagues) are likely to influence the supply of cash crops and raw materials, and the incomes received from their sale. Prices of raw material products are prone to decrease in times of oversupply. For these reasons, the export income of developing countries can fluctuate greatly.

12.4.8 Commercial, greenhouse-based rose production in Tanzania. Increasingly, farmland has been converted from subsistence production of food for local consumption to the production of cash crops for export.



12.4.9 Food or biofuels?

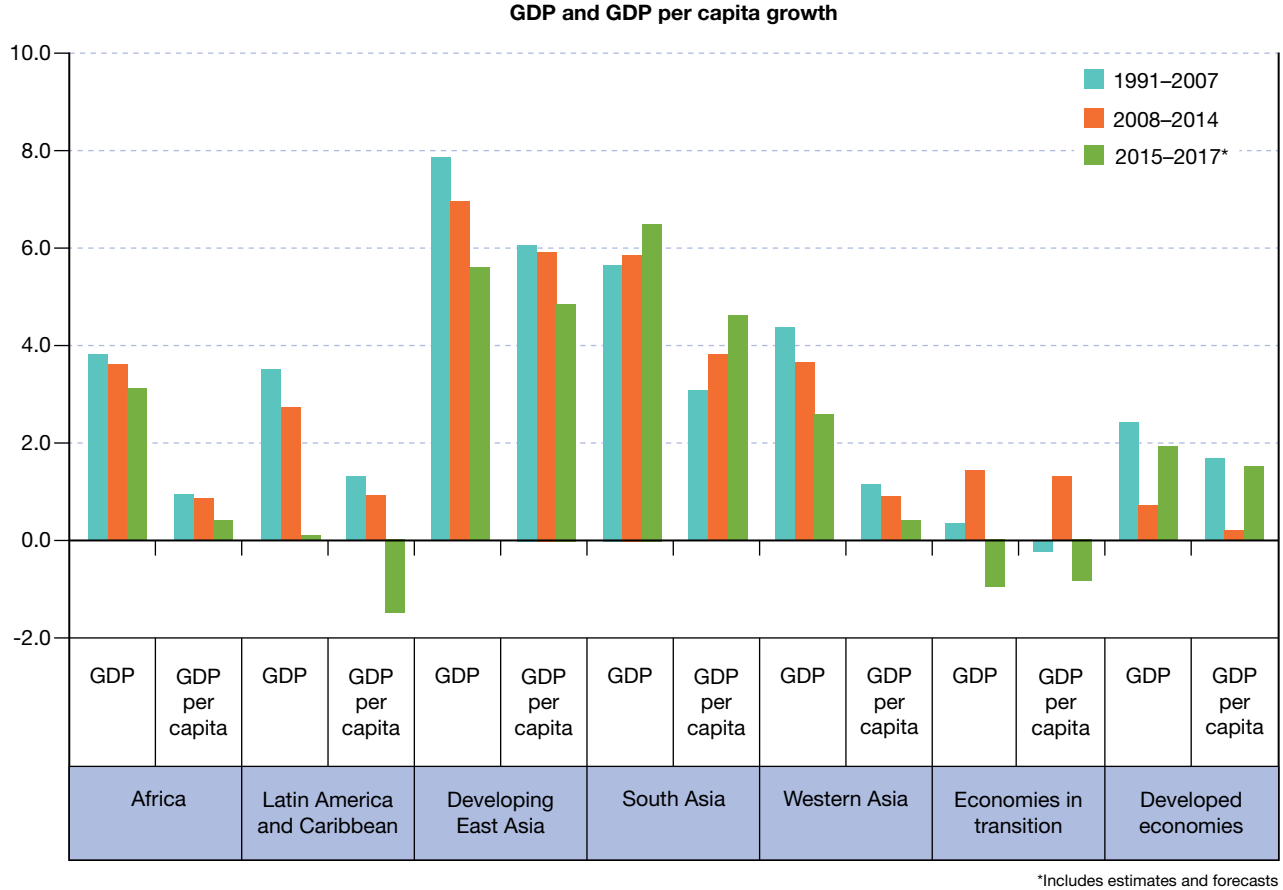
SPOTLIGHT

Changing patterns of economic growth

Figure 12.4.10 highlights the rapid economic growth experienced by countries in East and South Asia since the beginning of the 1990s. For almost three decades, annual growth rates (as measured by both GDP and GDP per capita) have increased in the range of 5 to 8 per cent in East Asia and 5 to 6 per cent in South Asia. Growth rates have been much more modest in Latin America and the Caribbean. In Africa and Western Asia, GDP increases in the range of 3 to 4 per cent have been achieved but because of rapid population increases, the GDP per capita figures have been much more modest. The economic growth in South and East Asia has been driven by the large-scale relocation of labour-intensive manufacturing from developed countries and, more recently, the growing demand for goods and services generated by the emergence of a rapidly growing middle class in these countries. Growth rates in the economies in transition (those centrally planned economies transitioning to a free market economy: for example, Russia, Poland, Hungary and Bulgaria) and the developed world have been much more modest.

In the 2010s, the economic growth rates experienced in the least developed countries reached 4.8 per cent in 2016 and 5.5 per cent in 2017, well below potential and well below the Sustainable Development Goal target of at least 7 per cent GDP growth per annum. There is a growing risk that many of the world's least developed countries, especially those that largely rely on commodity exports, may be unable to sustain much needed public spending on education, health and climate change adaptation, and that progress in poverty reduction may stall. Poverty reduction also risks setbacks from the economic consequences of climate change.

Economic growth in Africa is losing momentum, as it is affected by global, regional and internal issues. While many countries have embarked on a gradual process of economic diversification, with investment increasingly directed towards the manufacturing sector, the continent remains highly commodity-dependent.



12.4.10 GDP and GDP per capita growth, world regions: 1991–2007, 2008–2014 and 2015–2017

Transnational corporations

Transnational corporations (TNCs) are large organisations with operations in several countries. Usually they have a parent company based in a developed country; TNCs frequently operate subsidiary companies in developing countries. In the 1970s, many developing countries actively welcomed TNCs, believing they would bring employment, use raw materials and stimulate economic growth. For TNCs, developing countries are an attractive base because of their abundant supply of relatively cheap labour, often accompanied by less stringent industrial relations laws regarding wages, hours of employment and working conditions. They also appeal because of the lower cost of inputs (such as land and services) and often because of the availability of cheap raw materials. The profit generated belongs to the parent company based in a developed country, and this means that TNCs frequently remove more capital from a poor country than they generate there. At the same time they ensure that consumers in wealthy countries (or the rich elite and growing middle class in poor countries) are able to purchase an abundance of consumer items manufactured cheaply in poor countries. These items are often beyond the financial reach of those employed to manufacture them.

Militarisation

After independence and without developed security and defence forces, the newly independent countries were faced with concerns about their security. In response to these concerns, many developing countries accepted military and economic aid. Expenditure on armaments by developing countries has contributed to their debt burden and used resources that could have been devoted to meeting the basic needs of their peoples.

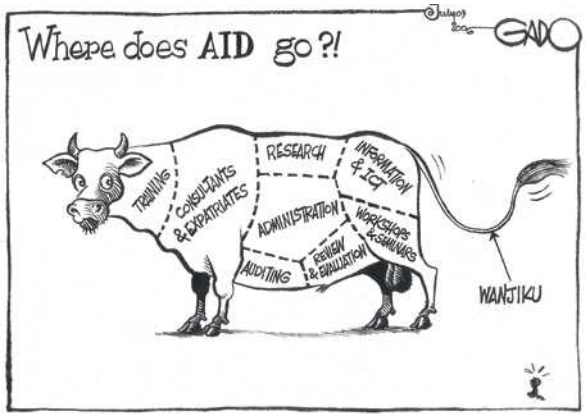
Dependency on development assistance

Overseas aid is also known as 'development assistance' or 'development cooperation'. It is generally considered to be the provision of assistance on concessional terms for promoting development. Many poor countries are heavily dependent on development assistance supplied by wealthy countries.

Aid is a by-product of decolonisation. Before World War II, colonial governments gave grants or budgetary subsidies to colonies. It was only in the early 1950s that aid distribution began in its present form. Aid was promoted as the means to stimulate economic growth in the poor world.

There are three major types of aid donation:

- **Bilateral aid:** This is development assistance provided by governments of wealthy countries to governments of developing countries. Australia's financial support of Papua New Guinea ($546.3 million in 2017–18) is an example of such aid.
- **Multilateral aid:** Multilateral aid is given by multilateral institutions, such as the World Bank, the IMF and the Asian Development Bank. This aid is frequently provided in the form of loans.
- **Nongovernmental aid:** This includes donations distributed by nongovernmental, non-profit organisations (NGOs), which receive most of their income from voluntary donations from the general public. Some well-known Australian NGOs are Oxfam Australia, World Vision and Austcare.



12.4.11 A cartoonist's perspective on the beneficiaries of development assistance.

Debate about distributing aid

There is debate about how aid should be distributed and whether or not aid has had any impact in addressing the 'big issues', such as the imbalance in trade relationships, which perpetuate poverty. It can also be argued that most forms of aid are designed to meet donor rather than recipient interests (see Figure 12.4.11), and that it merely offers a crutch, causing dependency of poor countries on outside assistance.

Aid is also often used to achieve the donor's geopolitical objectives: to strengthen alliances and exert influence.

SPOTLIGHT

World military expenditure

World military expenditure was estimated at US$1686 billion in 2016, equivalent to 2.2 per cent of global gross domestic product or US$227 per person. With a total of US$611 billion, the United States remained the largest military spender in 2016. The total cost of the US wars in Iraq and Afghanistan/Pakistan to the US taxpayer exceeded US$4.8 trillion by late 2017. Much of the money was borrowed. By the middle of this century the interest paid will raise the cost of the wars to more than US$8 trillion.

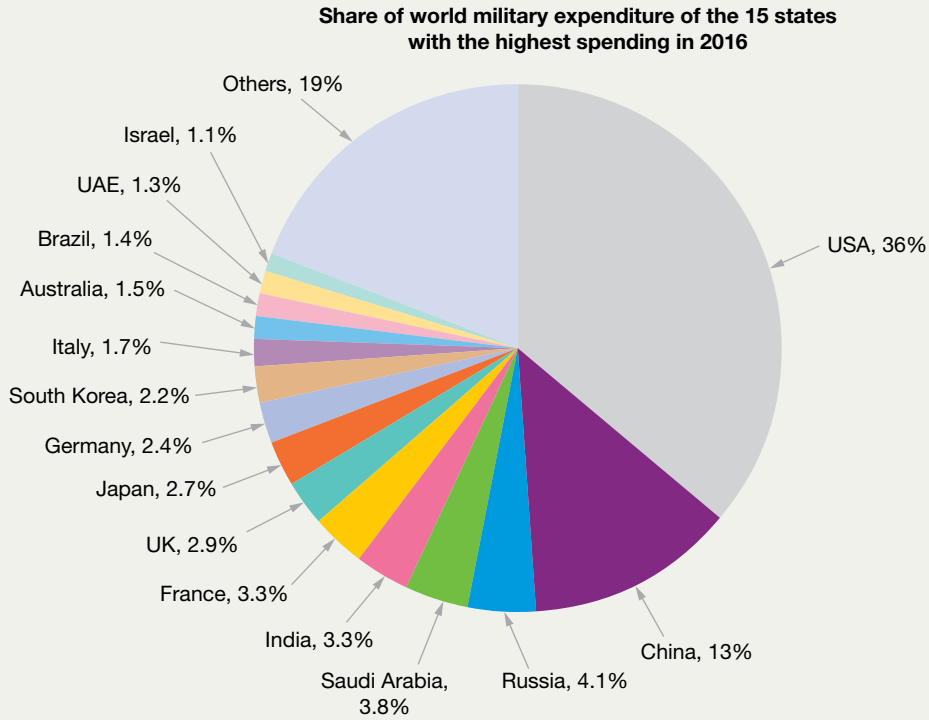
Figure 12.4.12 shows the share of world military expenditure of the 15 states with the highest spending in 2016. Figure 12.4.13 illustrates the trend in the international transfers in major weapons 1950–2016. Figure 12.4.14 shows the major exporters and importers of weapons in 2012–2016.

Major exporters and importers of weapons, 2012–2016

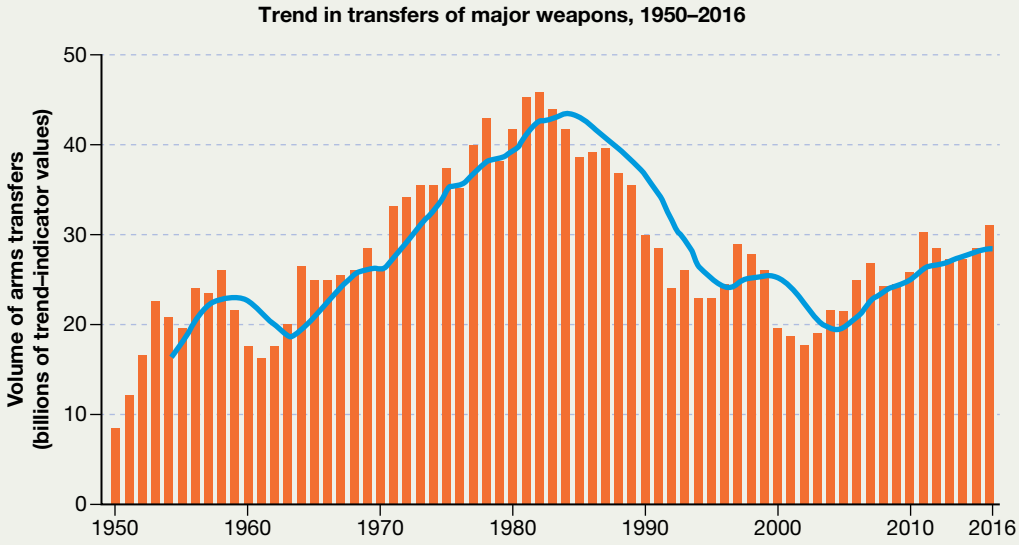
Exporter		Global share (%)
1	USA	33.0
2	Russia	23.0
3	China	6.2
4	France	6.0
5	Germany	5.6
6	UK	4.6
7	Spain	2.8
8	Italy	2.7
9	Ukraine	2.6
10	Israel	2.3
Importer		**Global share (%)**
1	India	13.0
2	Saudi Arabia	8.2
3	UAE	4.6
4	China	4.5
5	Algeria	3.7
6	Turkey	3.3
7	Australia	3.3
8	Iraq	3.2
9	Pakistan	3.2
10	Vietnam	3.0

Source: Stockholm International Peace Research Institute

12.4.14 The major exporters and importers of weapons in 2012–2016



12.4.12 The share of world military expenditure of the 15 states with the highest spending in 2016



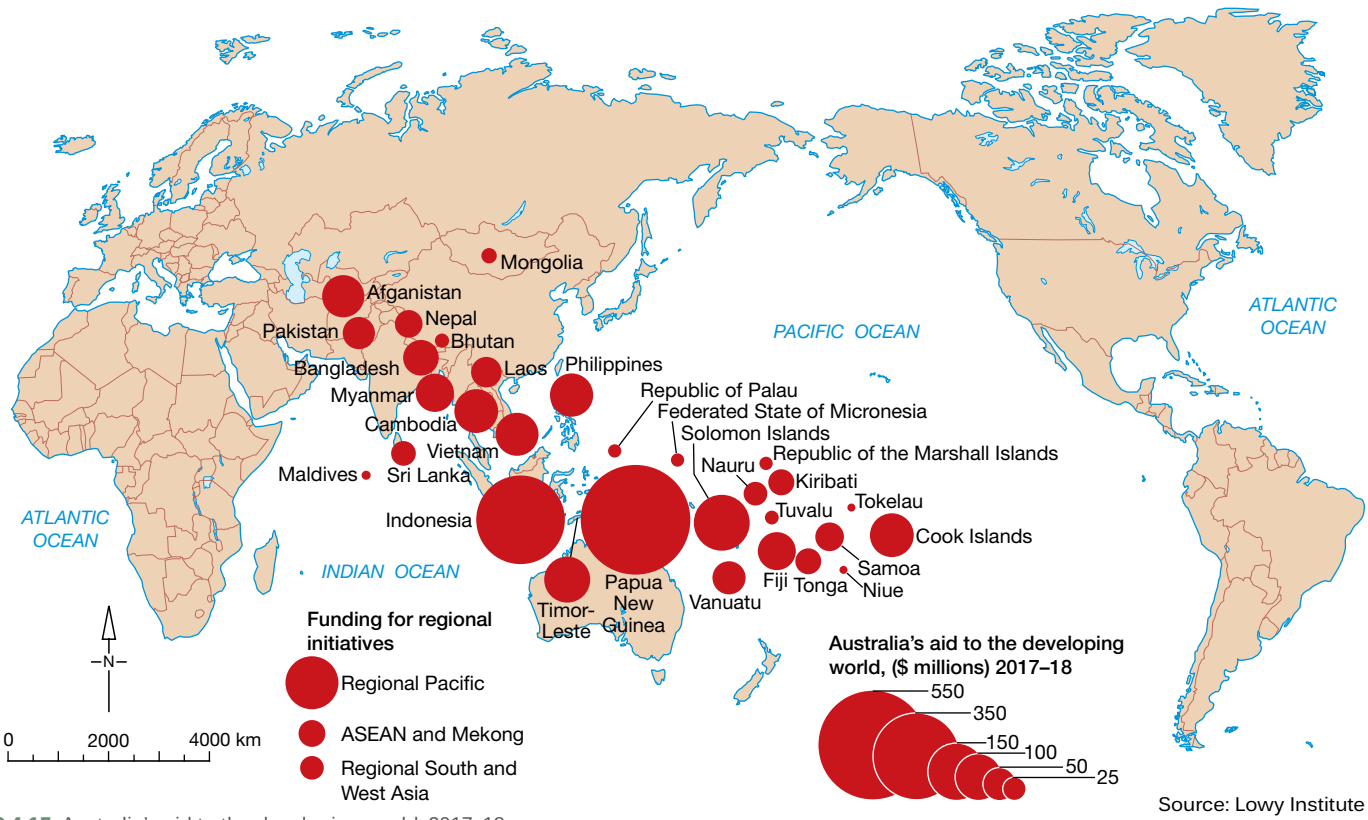
Source: Stockholm International Peace Research Institute

12.4.13 Trend in the international transfers of major weapons, 1950–2016

Support of highly visible projects, such as grand infrastructure developments, has frequently been a feature of foreign aid programs. Such projects have often been undertaken without careful consideration of the impacts on the social fabric and the environment of the recipient country. It is also frequently alleged that foreign aid props up corrupt officials and governments whose priorities are not directed towards addressing the problems of poverty in their countries. Inappropriate aid is aid that does not contribute to a country's capacity to enhance the wellbeing of its people; for example, lavish public buildings. However, there has been a historical shift towards support of poverty-focused projects that directly involve poor people in the design of projects intended to assist them to improve their own lives.

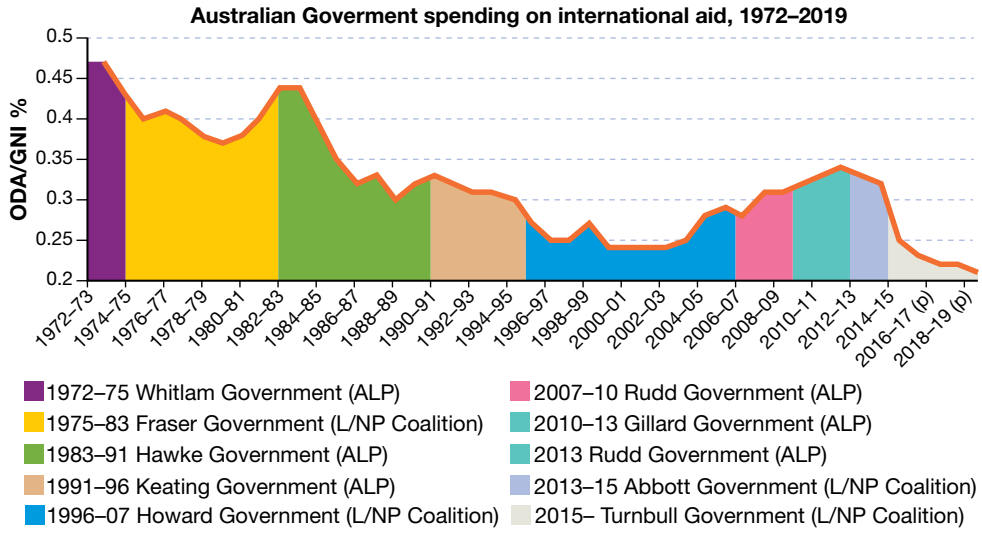
Australia's aid program

The recipients of Australia's bilateral aid are shown in Figure 12.4.15. These countries are spread across the Asia-Pacific region; South, East and West Asia; and Africa and the Middle East. In 2017–18 Australia allocated $183.4 million to non-government organisations and $919.3 million in multinational programs. Within its multinational aid program, Australia will spend over $200 million on climate change in 2017–18, with significant investments across country, regional and global initiatives.



12.4.15 Australia's aid to the developing world, 2017–18

Australia's aid program has been reduced significantly since the early 1970s, as shown in Figure 12.4.16. This decline shows no sign of being reversed.



12.4.16 Trends in Australia's aid to other countries

Activities

Understanding the text

1. Outline the ways in which the priorities of individual governments can affect the nature and rate of development.
2. Identify the characteristics of poor countries that could be considered as obstacles to development.
3. Outline the ways in which the legacy of history can affect the nature and rate of development.
4. Explain how the debt crisis faced by many developing countries came about.
5. Explain why many developing countries found it increasingly difficult to service their accumulated debt.
6. Outline the ways developing countries have sought to increase exports to meet debt repayments.
7. Explain why developing countries are disadvantaged in world trade.
8. Outline the impacts of an expansion in export-orientated cash cropping in developing countries.
9. a Outline the benefits that developing countries expect to gain from working with TNCs.
   b Why are TNCs attracted to countries in the developing world?
   c How have the activities of TNCs disadvantaged developing countries?
10. Explain why developing countries seek to expand their defence forces.
11. Explain how militarism has contributed to the problems faced by developing countries.
12. State why aid is said to be a by-product of decolonisation.
13. Distinguish between bilateral aid and multilateral aid.
14. Define nongovernmental aid.
15. List the main points raised in debates about how aid should be distributed.
16. Explain what is meant by inappropriate aid.

Working geographically

17. Study Figure 12.4.7. Write a paragraph outlining the point the cartoonist is making in the illustration.
18. Study Figure 12.4.10. Using data from the graph, describe the global pattern of GDP and GDP per capita growth in the period 1991–2017.
19. Study Figures 12.4.12, 12.4.13 and 12.4.14.
    a Identify the five largest military spending countries.
    b Outline the trend in major weapon transfers since 1950. Account for the increase since the early 2000s.
    c Identify the largest exporters of weapons and the major importers, 2012–2016. How many developing countries rank as significant importers of weapons?
20. Study Figure 12.4.15. Identify the largest recipients of Australian aid in each region.
21. Study Figure 12.4.16. Describe the long-term trend in Australia's aid to other countries. Which governments have been more supportive of Australia's aid program?
22. Undertake library and internet research into the impacts of colonialism in one country.
23. Write an extended response. Topic: 'The nature and rate of development experienced by a country is a product of the interaction between a range of factors, both internal and external to the country. Discuss.'

CASE STUDY

China's aid program

The 'Silk Road' was the name given to the ancient trade route that ran between China and Europe during the days of the Roman Empire. Today, the name has been given a new meaning. In 2013 Chinese President, Xi Jinping, announced a massive infrastructure program designed to create a new double trade corridor between China and its neighbours to the west: most notably Central Asia, the Middle East and Europe, as seen in Figure 12.4.17.

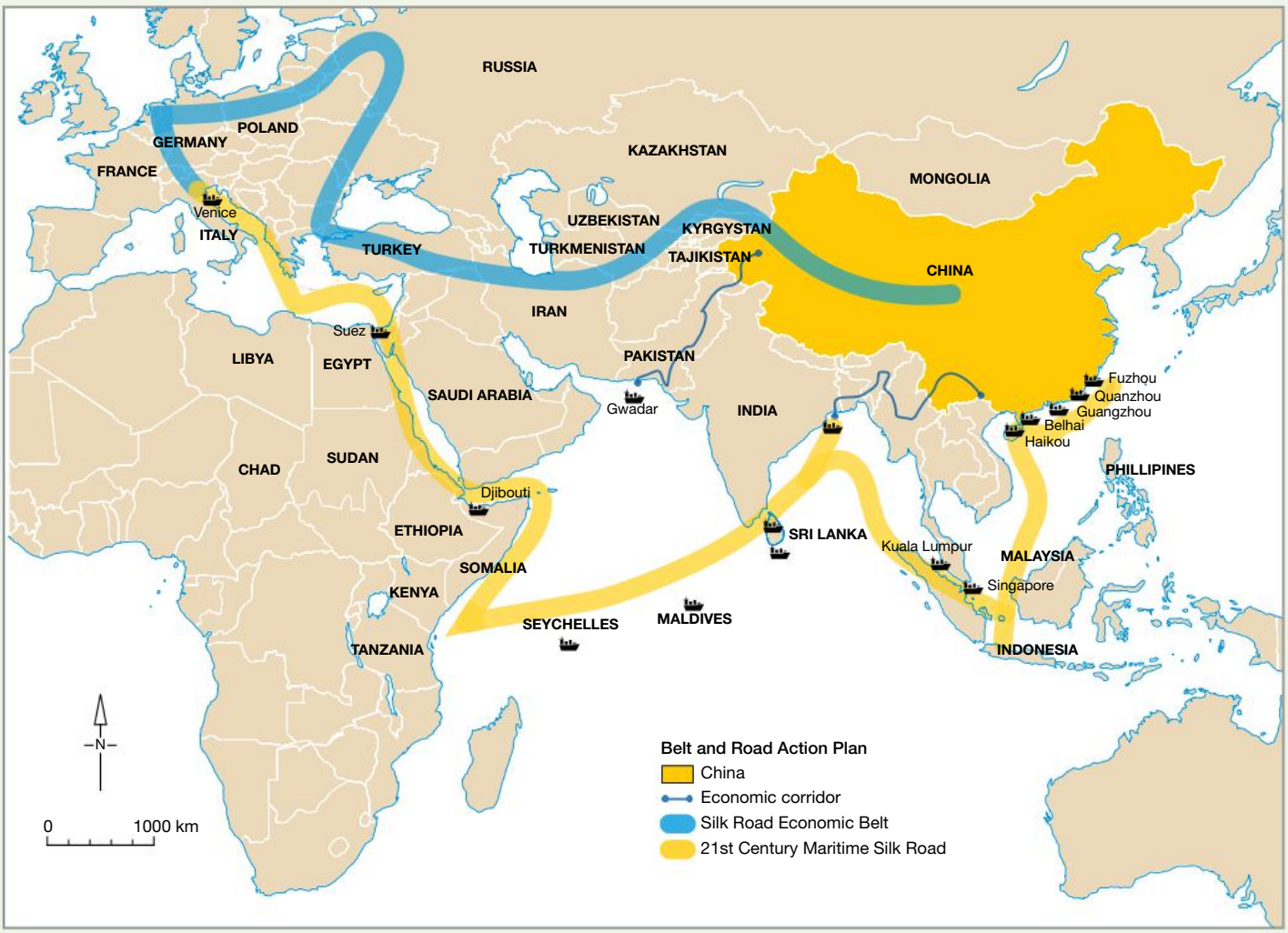
China's Silk Road and Belt initiatives

According to the 'Belt and Road Action Plan' (2015) the initiative will include massive infrastructure investments in land routes (the 'Belt') and maritime routes (the 'Road') with the geopolitical and economic aim of advancing China's interests in the region through the promotion of trade. China claims that the US$900 billion assistance initiative will usher in a new era of globalisation, a new 'golden age' of commerce that will benefit all those involved.

Beijing plans to eventually lend as much as US$8 trillion for infrastructure developments in 68 countries. Together these countries account for as much as 65 per cent of the global population and a third of global GDP.

The economic benefits of the initiative are significant. One benefit is that the Trans-Eurasian trade infrastructure will provide an economic boost to poorer countries to the south of China, as well as boost global trade. Domestic regions are also expected to benefit: especially the less-developed border regions in the west of the country, such as Xinjiang.

Chinese manufacturing stands to gain from the infrastructure build. The country's vast industrial overcapacity—mainly in the steel and heavy equipment sectors—will not only benefit from the development of new infrastructure, it also stands to gain lucrative markets along the Silk Road and Belt, and this could allow Chinese manufacturing to expand production of high-end industrial goods.



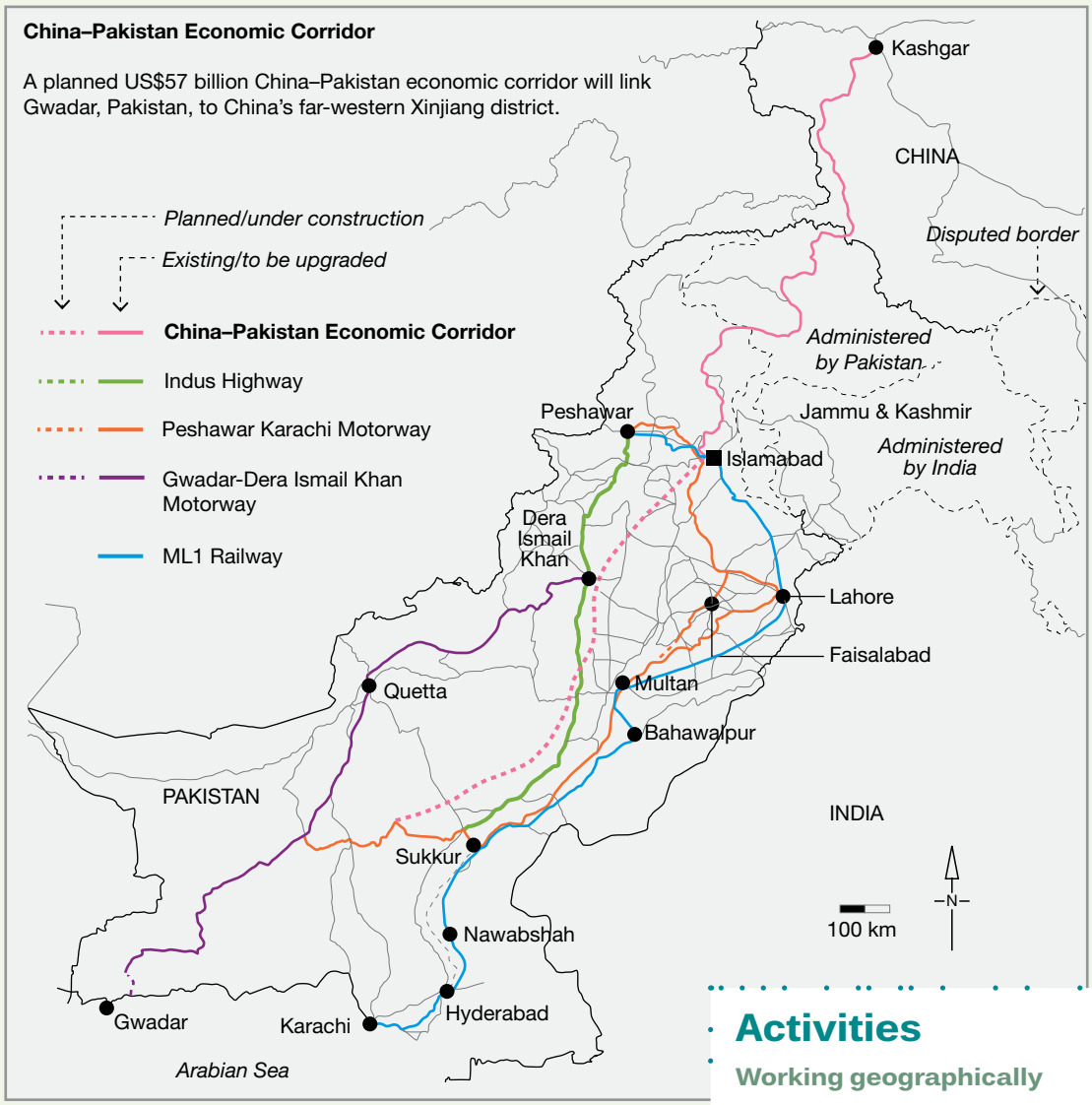
12.4.17 One belt, one road: China is expanding its geopolitical influence via a massive infrastructure program involving 68 developing countries.

The 68 countries involved in the initiative could see investments of up to US$500 billion over the next five years, with most of that directed to India, Russia, Indonesia, Iran, Egypt, the Philippines and Pakistan. Chinese companies are already involved in several energy related projects, including oil and gas pipelines between China and Russia, Kazakhstan and Myanmar. Roads and infrastructure projects are under construction in Ethiopia, Kenya, Laos and Thailand.

Pakistan is one of the New Silk Road's ardent supporters as the country that stands at one end of the proposed China–Pakistan Economic Corridor, shown in Figure 12.4.18. The country stands to benefit from US$46 billion worth of new roads, bridges, wind farms and other infrastructure projects.

Critics of China's plans

Some countries are suspicious of China's motives. Some see it as a means of promoting China's influence globally. Others concede that it is simply reflecting the changing focus of world power: China's emergence as geopolitical heavyweight, stepping into the breach left by the United States on matters of free trade and climate change. India, given its long-standing political tensions with Pakistan, is not a supporter of the Chinese initiative. Neither is the USA, who sees it as a vehicle for expanding Chinese geopolitical influence throughout the region. China concluded years ago that it would not embrace the USA's approach to its superpower status. The US achieved its geopolitical influence status via the security blanket it provides for its allies. China sees such an option as too expensive. Instead it offers connective and economic development.



12.4.18 The China–Pakistan Economic Corridor

Activities

Working geographically

1 Using the text and Figures 12.4.18 and 12.4.19, write a report outlining the nature and scope of China's Silk Road and Silk Belt initiative. Speculate on China's motivations in such a vast and expensive undertaking.

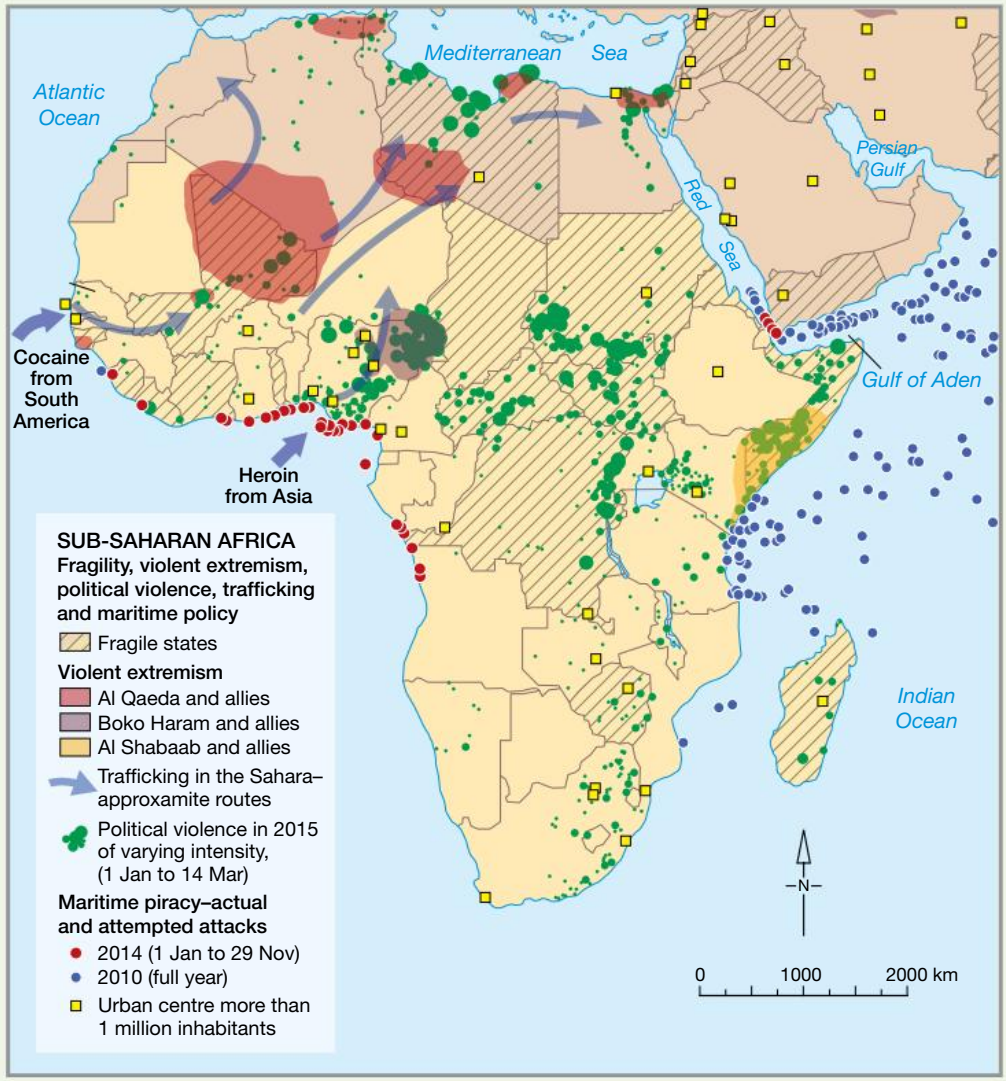
CASE STUDY

Africa: conflict and aid

Conflict in Africa

Conflicts in Africa tend to be highly localised and have their origins in the geopolitics of the colonial era. In the nineteenth century, Africa was divided between the European colonial powers with little consideration of the continent's cultural and ethnic divisions. At independence the boundaries of the newly created states simply mirrored those of the colonial years. The result of this process was the creation of a series of multi-ethnic states, with minorities sometimes dominated by ethnic majorities with their own economic and social interests to protect.

In recent years, fifteen African countries have experienced armed conflict. Geographically Africa's conflicts are tightly clustered along an arc stretching from northern Mali through southern Algeria and Libya into Egypt, extending into the Sinai Peninsula, as shown in Figure 12.4.19. The Boko Haram conflict in north-eastern Nigeria is another epicentre and located relatively close to conflict hot spots in the Central African Republic, eastern Democratic Republic of the Congo, Burundi, South Sudan and Darfur. On Africa's eastern coast, the three-decade long Somali civil war is still going strong.



12.4.19 Political conflict in Africa

Nigeria and Boko Haram

The conflict between Boko Haram and the Nigerian government is the deadliest conflict Africa is currently experiencing and has now spread into neighbouring countries. Boko Haram is an Islamic extremist terrorist group based in north-eastern Nigeria, but active in Chad, Niger and northern Cameroon. Since the current insurgency commenced in 2009, Boko Haram has killed tens of thousands and displaced 2.3 million people from their homes. In 2015, the Global Terrorism Index ranked Boko Haram as the world's deadliest terror group. (See Figure 12.4.20.)

12.4.20 Holding a rocket-propelled grenade, a Nigerian soldier patrols the outskirts of the town of Damasak in North-East Nigeria in April 2017 as thousands of Nigerians, who were freed in 2016 by the Nigerian army from Boko Haram insurgents, return to their homes.

The most notorious of the Boko Haram outrages was the kidnapping of more than 200 schoolgirls from the northern Nigerian town of Chibok in 2014. The girls were finally released in May 2017 in exchange for members of the militant group held by authorities. The kidnapping sparked international outrage and protests.

Mali–Algeria–Libya region

The other international terrorist hot spot in Africa is the Mali–Algeria–Libya area, with many groups—including Al Qaeda in the Islamic Maghreb—being active across some of the most ill-defined borders in the world. These conflicts are interrelated. Mali (a former French colony) descended into conflict in 2012 when Tuareg rebels took control of the northern part of the country. The conflict was further complicated by a military coup and fighting between the Tuareg and Islamist extremists. In response to the gains made by the Islamists, the French military intervened. The French forces recaptured the north and a semblance of order was restored. A corrupt political elite continues to cling to power.

East African emergency

In 2017, drought conditions increased food insecurity in Ethiopia, Kenya and Somalia, and conflict contributed to increases in food insecurity in South Sudan and displacement in Uganda.

In the worst affected regions of Ethiopia, Kenya and Somalia, the late onset of rains meant that famine quickly became a reality. Approximately 6.2 million people (half the region's population) needed urgent assistance. In South Sudan, a food crisis caused by conflict and political instability has had a devastating impact on peoples' livelihoods and nutrition.

In South Sudan, conflict between government and opposition forces broke out in late 2013 and has continued periodically since. As a result of the conflict, people have been forced to flee affected areas. As communities fracture and go searching for food and water, millions of children have been forced to abandon their studies. By mid-2017 almost 900 000 South Sudanese refugees had fled across the border into Uganda, which became home to more than a million refugees. A total of 7.5 million people—60 per cent of South Sudan's population—needed humanitarian assistance.

In South Sudan's conflict areas, food assistance has become people's main source of food. But it is rarely enough to meet all their needs, and acute malnutrition became a major public health emergency. At the peak of the crisis, one million children were acutely malnourished and 270 000 children were suffering from severe malnutrition.

NEED AND ASSISTANCE

While the underlying cause of food security was different in each country, one thing was common across the region. Without a massive and well-coordinated response by aid agencies, the situations would have deteriorated rapidly.

Across East Africa an estimated 25 million people were in need of humanitarian assistance. Acute malnutrition affected 4.3 million children. Out-of-school children (who don't have access to a school or who do not enrol) numbered 8.8 million. Twenty-five million people lacked access to a clean source of water and sanitation.

WORLD VISION

World Vision's response to the crisis was to appeal for donations to support an increase in humanitarian assistance across the region. Its assistance program targeted 2.7 million people in Ethiopia, Kenya, Somalia, South Sudan and Uganda. The organisation's objective was to work closely with community-based groups and other agencies to meet the health (see Figure 12.4.21), nutrition, child protection, livelihood, shelter, education and water and sanitation needs of vulnerable children across the affected countries.

CARE AUTSTRALIA

CARE Australia had teams on the ground in some of the worst affected areas and provided critical medicines and healthcare to children suffering from malnutrition, diarrhoea and cholera; food aid and cash vouchers to parents so they could feed their children; seeds, so families could replant devastated crops; and clean drinking water. CARE has assisted 350 000 people in South Sudan, 460 000 people in Somalia, over 1.5 million people in Ethiopia and 160 000 people in Kenya.

12.4.21 Displaced Kenyans gather at a health centre

Activities

Working geographically

1. Using Figure 12.4.19, identify the major conflict 'hot spots' in Africa.
2. Use media resources, including the internet, to trace the course of a conflict over the use of one or more resources in a developing country.
3. Undertake library and/or internet research to find out what you can about one aid organisation working to alleviate the suffering of people in East Africa. Describe its major aims. Write a description of one aid project funded by this organisation.

UNIT 12.5

Equity issues and development

This unit examines some of the attempts being made to foster development in the world's poorer countries, and some of the impacts of those changes on people and places. The issues being addressed include problems of environmental degradation, rapid population growth, trade imbalances and debt burdens. This unit also focuses on equity issues associated with development, particularly those connected with ethnicity, gender, class, children and ownership of resources.

Economic development and change

The view that economic growth would provide the 'key' to the successful development of poor countries was widely held throughout the latter half of the twentieth century. Such a view is still held by many. It was generally believed that, for poor countries to overcome problems of poverty and lack of development, their economic, political and social structures needed to be transformed. They had to change from structures that were considered to be traditional or lacking a 'development' focus to those that were modern or 'developed'. Agricultural productivity seemed to offer limited prospects for the poorer countries to achieve prosperity. It seemed that industrialisation was the key to affluence for the poor countries, as it had been for the wealthier countries.

Industrialisation

Development theorists, governments and commentators from the industrialised countries, and local elites in the poorer countries all assumed that industrialisation was a desirable (if not the only) process for the world's poorer countries. They believed that injecting resources (such as capital, technology and expertise), in the form of aid, into the economically poorer countries would stimulate the transformation of poor countries into industrialised economies. While this approach worked for a centrally planned command economy, such as China, it has proved more problematic for the developing countries of Africa.

These assumptions largely denied the possibility of any different forms of development. They also ignored the possibility that the changes associated with industrialisation and modernisation along Western lines may not always be appropriate or the best form of development. There was no acknowledgement that traditional lifestyles can be sustainable, and lead to successful communities.

The trickle-down effect

Another underlying assumption of the push to encourage economic growth in poor countries is that the benefits of economic growth in the form of increased income would eventually trickle down to the most needy. This is known as the trickle-down effect. In fact, the income generated by economic growth is rarely distributed equitably. In practice, economic growth in many countries has brought little improvement in the living conditions of the majority of the poor.

The drive to achieve 'development' by pursuing the path to industrialisation and economic growth has failed to reduce the poverty of the masses of poor in many parts of the world. It has often resulted in unintended consequences for some groups of people and for the environment. See Figures 12.5.1 to 12.5.3.

12.5.1 A cartoonist's perspective on the issue of global inequality.

12.5.2 A cartoonist's perspective on the problems faced by the developing countries of Africa.

12.5.3 A cartoonist's perspective on the distribution of wealth as a result of economic growth.

Activities

Understanding the text

1 Outline the view that regards economic growth as the 'key' to successful development. According to this approach, what needs to be done to transform poor countries into industrialised economies?

2 Explain what an emphasis on industrialisation and modernisation fails to appreciate.

3 Explain the trickle-down theory. Describe its failings.

Working geographically

4 Study Figures 12.5.1 to 12.5.3. As a class discuss the issue and message being addressed by the cartoonist in each of the illustrations. Which do you think is the most powerful cartoon? Which is the most effective in conveying a point of view on an important development-related issue?

5 Collect cartoons related to development issues. Select one development issue and draw your own cartoon to explain it.

Modernisation, land ownership and landlessness

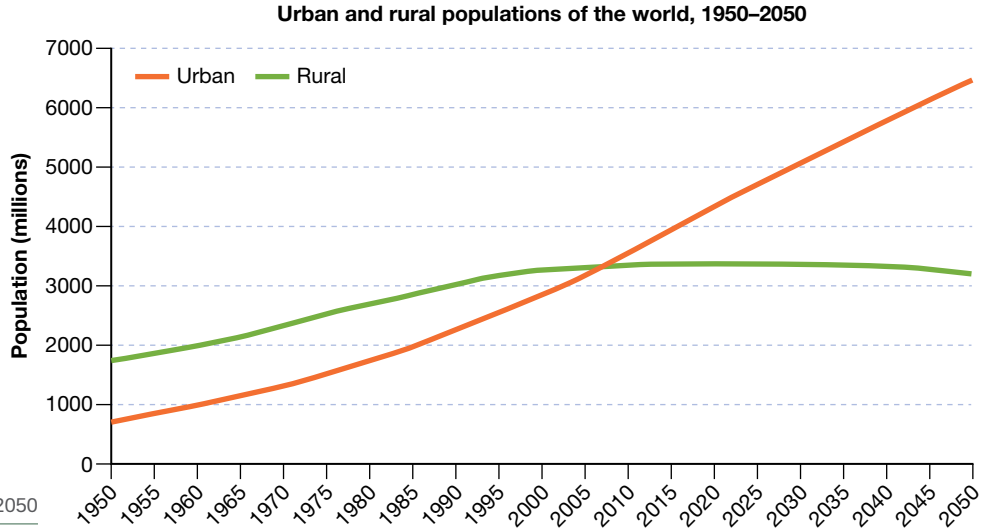
Some countries inherited systems of plantation agriculture, or cash cropping, that had been introduced in the colonial period. To increase national income, many developing countries encouraged cash cropping. Many governments introduced projects to generate growth by the modernisation of agricultural production systems. This involved the introduction of new crops or crop varieties; fertilisers and other inputs; new cultivation and management practices; credit; and, frequently, new technology. Often these were all introduced in collaboration with foreign aid donors or agribusinesses.

These changes rarely benefited poor farmers because the introduction of mechanisation brought greater benefits on large landholdings, and poor farmers often could not afford the capital inputs necessary to purchase fertilisers, pesticides, machinery and new seed varieties. The wealthier farmers benefited from cash cropping. Poorer farmers frequently borrowed the capital to purchase these inputs and concentrated on the production of cash crops. By doing this, poor rural farmers became increasingly dependent on income to purchase food, rather than being able to rely on subsistence production of basic foodstuffs. Income gained from cash crops was unreliable, dependent on crop yields and susceptible to fluctuations in world market prices. As a result of this unreliability, small farmers were often forced to sell their land in order to purchase basic necessities, such as food, or to repay debts. Without access to land, many either became labourers (often only seasonal agricultural labour was available) or joined the flood of migration to urban centres in search of work.

The commercialisation of agriculture contributed to excessive land clearing, overuse of land, soil erosion and contamination of soils through the use of chemical inputs. As well, agriculture based on monoculture is more susceptible to pest attack. This has resulted in massive expenditure on pesticides, often with little measurable impact on the percentage of crops lost from pest attack. In response to the negative impacts of the modernisation of agriculture, in recent years there has been growing recognition of the value of traditional farming practices.

Urbanisation and the urban poor

Urbanisation refers to the increasing proportion of national populations living in urban areas; that is, towns and cities. The world's urban population has been growing at four times the rate of the rural population (see Figure 12.5.4). Today, 54 per cent of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050. Projections show that urbanisation combined with the overall growth of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 per cent of the increase concentrated in Asia and Africa (see Figure 12.5.7). Rural–urban migration is significant in the world's poorer countries because of a mixture of what are known as 'push' and 'pull' factors.



12.5.4 Rural and urban populations, 1950–2050

SPOTLIGHT

Brazilian farmers take on agribusiness

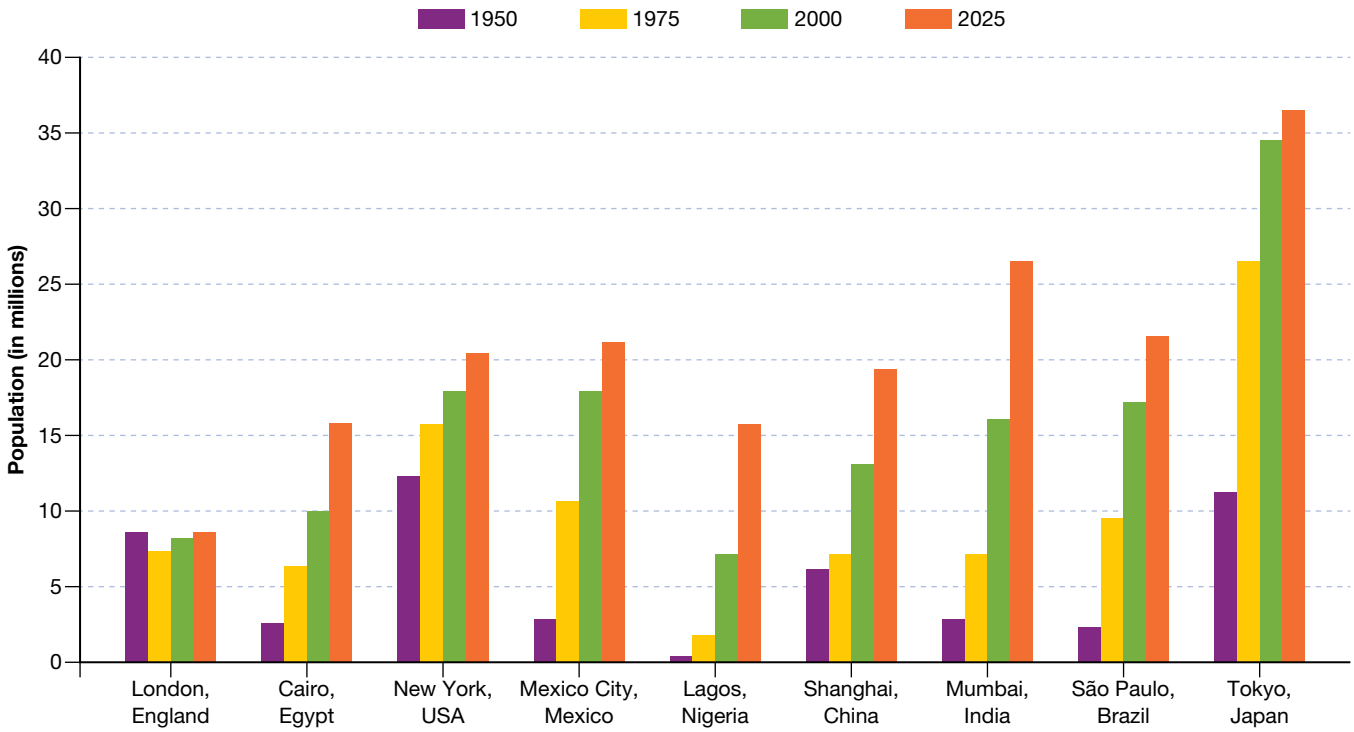
Brazil's Movement of Small Farmers, the Movimento dos Pequenos Agricultores (MPA), is mounting a campaign to challenge the expansion of vast monoculture plantations of eucalypts, sugar cane and soy (see Figure 12.5.5), and the TNCs that fund them. These industrial-scale farming land-use practices result in the destruction of vast areas of rainforest, displace entire populations, poison the land with chemicals and contribute nothing to local food supplies. The movement has so far mobilised 10 000 families across 14 Brazilian states.

At risk from the inroads of agribusiness are the small-scale family farms that produce almost 60 per cent of Brazil's food, such as the corn farm pictured in Figure 12.5.6. Through collective action the MPA seeks to resist the pressure from agribusiness companies for farmers to sell their land. Resisting the interests of agribusiness in rural Brazil, however, takes courage. Small farmers are often victims of violence and sometimes murder.

In advancing its campaign, the MPA promotes crop diversity, organic farming, local production and women's empowerment. It has also developed links with the Landless Workers' Movement (MST), indigenous communities and interested NGOs.

12.5.5 Large-scale commercial harvesting of soybeans in Brazil. The clearing of land for agriculture has displaced tens of thousands of small-scale subsistence farmers.

12.5.6 Corn production on a family-operated subsistence farm in Brazil. Such landholdings are under threat from large agribusiness corporations.



12.5.7 Major urban centres, 1950–2025 (projected)

Push and pull factors

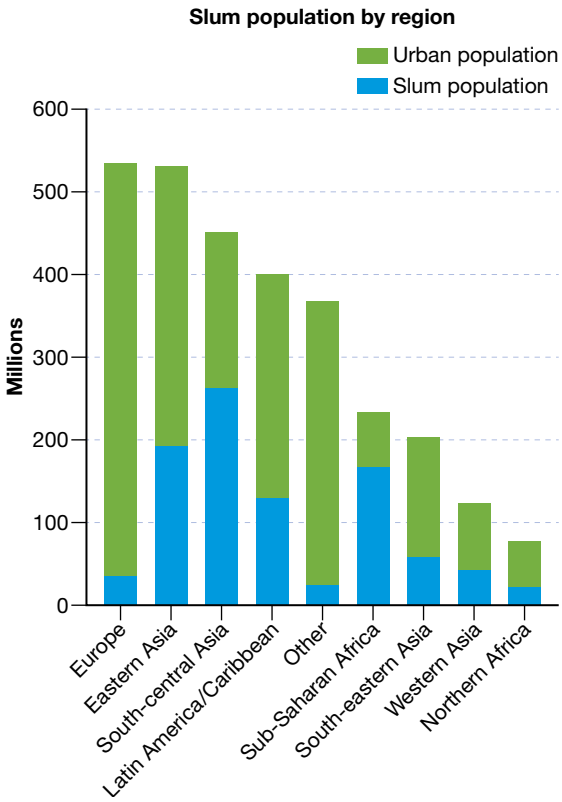
The push factors that encourage rural–urban migration include:

- loss of land, due to indebtedness, population increase and land degradation
- loss of job opportunities, because labour is displaced by mechanisation
- rural poverty
- famine
- crop failure
- natural or climatic disasters
- war and civil unrest.

Meanwhile, people are pulled to large urban centres in the hope of:

- finding employment—usually as unskilled labourers in developing industries
- achieving a higher material standard of living
- securing better access to educational opportunities and healthcare facilities
- enjoying entertainment facilities and the 'bright lights' (often known as the 'bright lights syndrome').

12.5.8 Buenos Aires informal settlement



12.5.9 Slum population by region, 2016

The push to modernise agriculture in many countries, and the introduction of commercial cash cropping, have displaced many subsistence farmers and rural labourers. This has added to the flow of migrants flocking to urban areas. At the same time, the promotion of industrialisation has led to a growing demand for unskilled labour in factories. This has contributed to the attraction of cities to the rural landless and unemployed. These population movements have resulted in the creation of a growing class of urban poor. The rapidity of urban growth has created problems for the urban poor.

If well managed, cities offer important opportunities for economic development and for expanding access to basic services, including healthcare and education, for large numbers of people. Providing public transportation, as well as housing, electricity, water and sanitation for a densely settled urban population, is typically cheaper and less environmentally damaging than providing a similar level of services to a dispersed rural population.

Cities out of balance

The biggest toll of urbanisation has been concentrated on the poorest residents of a city. In the absence of amenities such as adequate housing, flushing toilets, running water and regular garbage collection, shantytown dwellers spend their days maintaining cramped homes, walking long distances to a menial job, accepting contaminated water, and living in some of the planet's least secure and dirtiest neighbourhoods.

Often they must also tolerate sharp inequalities of wealth and influence. Residents of *villas de emergencia* (squatter settlements) in Buenos Aires (see Figure 12.5.8) are compelled out of desperation to inhabit the polluted banks of the Reconquista and Matanza Rivers, which are 'overrun with rats, mosquitoes, flies, and other insects'. Less than 2 kilometres away, some of the wealthiest residents of the city live in gated communities of lawns, swimming pools and security guards.

One effect of living in such unequal societies is that the poorest people must live in environments that concentrate hazards and multiply health problems. In Dhaka, Bangladesh, the wealthy can afford to buy land at prices inconceivable to most of the city's population. As a result, 40 per cent of the people are crammed onto just 5 per cent of the land area. Some of the most desperate of these settlers, victims of eviction or floods elsewhere, live on a ledge precariously situated between a toxic factory and a poisoned lake. Figure 12.5.9 shows the proportions of urban slum populations by region.

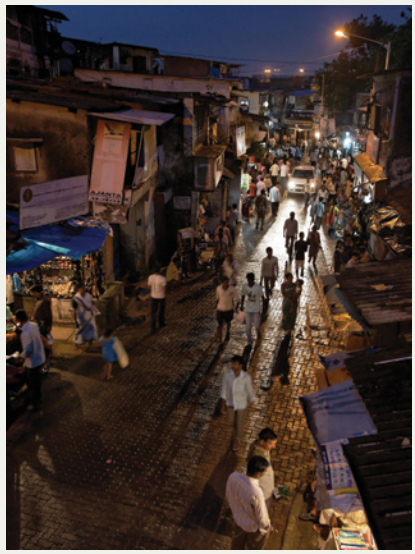
SPOTLIGHT

Life in Mumbai's Dharavi slum

There is a range of slums and informal settlements in India. They range from simple shacks, made of cardboard and corrugated iron sheets on Mumbai and Kolkata streets, to organised slums like Dharavi in Mumbai, which is Asia's biggest slum and can be seen in Figure 12.5.10. In Dharavi, residents pay rent to slumlords for a tiny amount of space; it is not uncommon for as many as 10 people to occupy one small room. The room might have a refrigerator, bottled gas stove and perhaps even an air conditioner for the blistering Indian summer. These are considered essentials, not luxuries, in India. Most homes have a television.

What they all have in common is a lack of privacy. Women often have to queue for hours for water, and queue again to use public toilets and to bathe. Most urban Indians, even the poorest, bathe every day if they can. It's seen as essential in a climate that is hot and humid for most of the year. Often the bathing is done at roadside water hydrants in full view of the passing traffic.

There have been a number of plans to redevelop the Dharavi slum. Any improvement will be welcomed by those living there.



12.5.10 The Dharavi slum of Mumbai

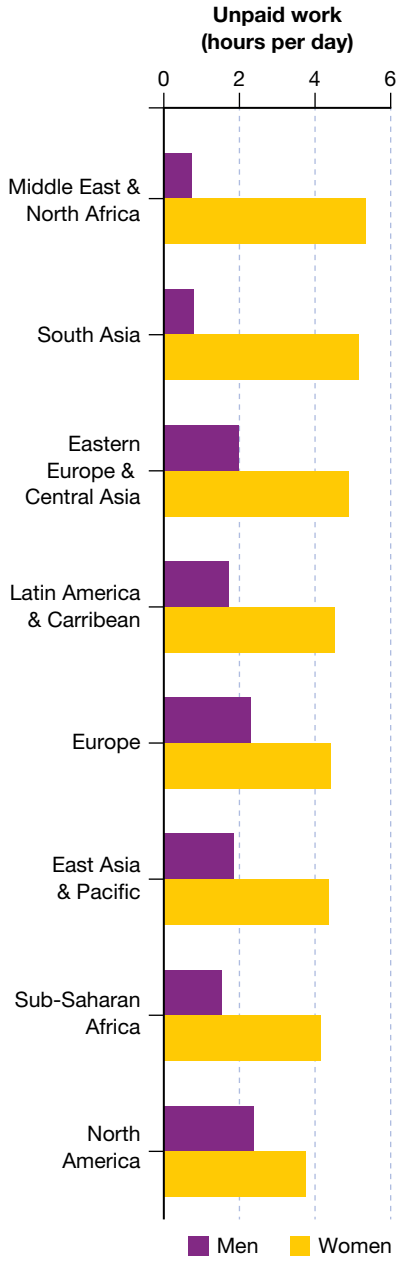
Gender issues and development

Generally, women around the world have a lower economic, political and social status. In developing countries, compared to men, women are generally poorer, have lower literacy rates and educational levels. In addition, the civil rights of women are often limited: women's rights to property, in divorce, in custody of children and in employment are second to men. Female children frequently receive less of their family's resources: less and poorer quality food, less education and less medical care.

Women in the poor world consistently work harder and longer than men and perform the bulk of household subsistence work. When poverty forces men to seek paid employment, women can be left doing the bulk of the ploughing and land-preparation tasks (see Figure 12.5.11).

Frequently, women bear the burden of environmental degradation, having to work harder to produce food on poorer soils, to walk further to collect uncontaminated water and to search further for firewood. Commonly, in areas influenced by the introduction of cash cropping and labour-saving technologies, women and their children have been displaced from subsistence agriculture. This often forces women to seek income in other ways—in domestic service, as factory labourers, doing piecework (work paid at a set rate per unit, such as each garment sewn), or in prostitution. Women's wages are consistently lower than those of men.

Women play an essential role in survival tasks (such as growing food, gathering fuel and finding water), household tasks (food preparation and child rearing) and income generation (handicraft production and trading of produce). Despite this, they generally have very limited access to, and control over, income, credit, land, education, training and information. In most societies throughout the world, women do not share equally in their country's resources and do not enjoy status equivalent to that of men.



12.5.11 Women's labour is more likely than men's to be unpaid.

Women and development policies

Women have often been disadvantaged by development policies and projects. These policies have usually focused on export-oriented growth, encouraging the production of cash crops, extraction of minerals and production of industrial goods. It was frequently deemed appropriate to direct any improvements in agricultural technology or employment in new industries towards men. Often little attempt was made to understand the traditional role of women in the community targeted for change. Aid programs focused on male employment and generally excluded women from paid employment.

Conventional planning for development also frequently undervalued the contribution made by women to their families and communities. Indicators of economic success (such as GNI) are frequently used as a tool to measure development. However, national measures based on income ignore the value of unpaid work. Activities of women related to their reproductive role, to caring for children, to home-based forms of production and to informal sector activities (such as street vending) are not easily quantified. Therefore, they are generally not included in national aggregates. It is difficult to calculate the economic contribution of women's unpaid labour but, overall, globally about 60 per cent of unpaid family workers are women. As the work that women do is usually not assigned an economic value, it was neglected in the planning for change. Such plans are usually based on the premise that economic growth, or increasing monetary income, would result in reduced poverty.

Many aid projects assumed that women had plenty of spare time to devote to new projects. These projects aimed to involve women in income-earning activities, such as sewing or handicrafts, adding to their existing burden. Many aid projects and development programs did not consider the needs of women, and as a result lowered many women's standard of living. Women's status, needs and personal aspirations vary tremendously, though it is now commonly agreed that the benefits of development have frequently bypassed women.

SPOTLIGHT

The women of Burkina Faso

Gender inequality impacts greatly on the lives of women in Burkina Faso. It impacts on their health, safety, fertility and vocational possibilities. While the government of Burkina Faso has adopted policies promoting gender equality, there are many areas where women are left unprotected:

- Laws to address domestic violence and spousal rape are largely absent.
- Women are not free to exercise control over their bodies and reproductive lives. This includes access to information and contraception, and how many children they will have, or whether they have them at all. As a result, Burkina Faso has one of the lowest rates of contraceptive use in the world (just 17 per cent).
- Even though it's illegal, forced marriages remain commonplace. Most women in Burkina Faso are married by the age of 19.
- As few as 29 per cent of girls in Burkina Faso are able to go to school. Many are forced to leave school early, either to get married or undertake domestic work.
- Access to healthcare for women is lacking, primarily due to their social and economic dependence on men. Men typically control family finances, so women need to seek permission from their husbands before visiting healthcare facilities (see Figure 12.5.12), particularly if they are seeking contraceptives.

12.5.12 Aid agencies provide basic health education for a remote village in Burkina Faso.

Efforts are being made to reduce the gap in status between men and women by both the local government and foreign NGOs. However, it is obvious that this is no simple task as the inequality is based on a complex system of long-held traditions as well as cultural and social factors.

Even in terms of work, women face inequality. While they play an important role in agriculture, they have difficulty accessing credit and equipment. The unequal inheritance rights between men and women also limit the economic potential and independence of women.

Child labour

Children in the world's poorest communities rarely have access to the opportunities available to most children living in the world's wealthy countries. In poor rural areas, children, particularly female children, work from an early age. They collect firewood, carry water (see Figure 12.5.13), mind animals, assist in agricultural tasks, care for siblings and complete domestic duties. Many children labour in cottage industries alongside the whole family: weaving carpets, making handicrafts, or assisting in simple food-processing or manufacturing activities. Children from urban slum areas are frequently forced to labour in factories for long hours and for little pay. Others are involved in street vending, domestic service, child prostitution, and collecting, recycling and selling refuse. Following is an example of the daily activities of a young girl from Zimbabwe.

Consider Tendai, a young girl in the Lowveld, in Zimbabwe. Her day starts at 4 a.m. when, to fetch water, she carries a 30-litre tin to a borehole about 11 kilometres from her home. She walks barefoot and is home by 9 a.m. She eats a little and proceeds to fetch firewood until midday. She cleans the utensils from the family's morning meal and sits preparing a lunch of *sadza* (porridge made of ground maize or millet) for the family. After lunch and the cleaning of the dishes, she wanders in the hot sun until early evening, fetching wild vegetables for supper before making the evening trip for water. Her day ends at 9 p.m., after she has prepared supper and put her younger brothers and sisters to sleep. Tendai is considered unproductive, unoccupied, and economically inactive. According to the international economic system, Tendai does not work and is not part of the labour force.

For many families, living in countries without established welfare systems, the income earned by their children (see Figure 12.5.14) or the labour they contribute to subsistence activities is essential for survival. The example above describes a fate common to many children from impoverished families in the poor world.

12.5.13 Children from the village of Ngoiroro, on the Kenyan–Tanzanian border, collect water from the local well.

12.5.14 Papplet, a young Indian balloon vendor, touts for customers at a traffic signal in Mumbai. He is one of 50 000 children in the city who spend their childhood earning money to support their families.

Indigenous minorities and the impacts of change

In many countries, indigenous peoples are a minority group whose lives have been disrupted by a succession of invasions of their lands. It is estimated that today there are about 370 million indigenous peoples living in about 90 countries. Like Aboriginal and Torres Strait Islander people, many of these peoples traditionally lived in harmony with their land, depending on the land for survival.

Indigenous peoples are frequently forced to live in a fraction of their former territory. Contact with the dominating culture and the changes it has brought mean that the traditional ways of living of indigenous minority groups have been irrevocably altered. Invasions wiped out many groups whose traditional systems of defence were inadequate to protect them from the colonisers. Imported diseases also had disastrous effects on many communities. Today, assimilation of indigenous peoples into the dominant culture of their country is a continued threat to their survival. In many areas, the very survival of their culture, traditional knowledge and belief systems is under threat.

Responding to changes

The response to the impacts of industrialisation and the commercialisation of agriculture on the environment, has led to renewed interest in the traditional knowledge of indigenous peoples in managing the land. It is increasingly recognised that indigenous peoples lived in harmony with the biophysical environment in an ecologically sustainable manner, and that, in seeking to combat the threats to global biodiversity and reductions in quality of life, the industrialised world can learn much from their land-management skills.

Despite this knowledge, where indigenous peoples form a minority group in the country of which they are now part, they wield little political power. Their claims to traditional lands were usually based on community rather than individual ownership. These claims often remain unacknowledged by national governments and the dominant population group. So, the interests of indigenous peoples are usually secondary to the national interest of export-oriented industry, agriculture and resource extraction. In some countries, indigenous minorities are still being displaced, disadvantaged, intimidated, and forcibly assimilated. In 2017, remote indigenous tribes in the Amazon, Brazil were reported to have been massacred by illegal gold prospectors and forced from their lands by loggers, depriving them of any means to support themselves. All this occurs in the name of national development. In many countries, inequality in access to income and resources between different ethnic groups is evident.

Climate change and development

A new form of global inequity has become apparent in the ability of countries to adapt to problems caused by global climate change.

Development in the form of heightened economic activity, such as industrial growth and increased energy consumption, contributes to environmental damage. Development, therefore, cannot be divorced from ecological and environmental concerns. Important components of human freedoms—and crucial ingredients of our quality of life—are utterly dependent on the integrity of the environment, including the air we breathe and the water we drink. Development must be environment-inclusive. Any consideration of development should also consider adaptation to likely changes in the future resulting from environmental degradation. Again, though, the ability to do so is ultimately linked to broader issues of poverty, global inequity and development.

Bishop Desmond Tutu from South Africa has described a new form of global inequity that he has called 'adaptation apartheid':

- For most people in rich countries, adaptation has so far been a relatively pain-free process. Cushioned by heating and cooling systems, they can adapt to extreme weather with the flick of a thermostat. Confronted with the threat of floods, governments can protect the residents of London, Los Angeles and Tokyo with elaborate climate defence systems. In some countries, climate change has even brought benign effects, such as a longer growing season for farmers.
- Consider what adaptation means for the world's poorest and most vulnerable people—those living on less than US$2 a day. How does an impoverished woman farmer in Malawi adapt when the more frequent droughts and less rainfall cut production? Perhaps by cutting already inadequate household nutrition, or by taking her children out of school. How does a slum dweller living beneath plastic sheets and corrugated tin in a slum in Manila or Port-au-Prince adapt to the threat posed by more-intense cyclones? And how are people living in the great deltas of the Ganges and the Mekong supposed to adapt to the inundation of their homes and lands?
- Adaptation is becoming a euphemism for social injustice on a global scale. While the citizens of the rich world are protected from harm, the poor, the vulnerable and the hungry are exposed to the harsh reality of climate change in their daily lives. Put bluntly, the world's poor are being harmed through a problem that is not of their making. The footprint of the Malawian farmer or the Haitian slum dweller barely registers in the earth's atmosphere… We are drifting into a world of 'adaptation apartheid'.

Future challenges

Processes of change have affected—frequently adversely—women, children, indigenous minorities, the rural poor, the urban poor, the environment, and the quality of life in urban and rural places. There have been some collective overall gains for the world's poorer countries. Hundreds of millions of people have been lifted out of poverty in emerging economies of South and East Asia. However, those living in the world's least developed countries have experienced fewer improvements in human wellbeing.

In addition, the gains measured on a national basis are not being distributed equitably. Gains for some often have adverse consequences for others. Frequently, the poor are the losers.

For many local communities, subsistence lifestyles have been irrevocably disrupted, environments degraded and resources exploited in the name of development. However, some initiatives at the local level are based on recognition of the worth of traditional values. For some communities, lower levels of material affluence, accompanied by a return to traditional values of sharing, cooperation and harmonious existence with and within the biophysical environment, may be an appropriate development path. The future challenge is how to balance the priorities of poor communities at the local level with the interests of the country, and of the powerful, as well as the desires for material affluence and the need to meet any international debt obligations.

Future development paths for the world's poorer countries depend in part on the wealthy countries. Their interdependence with poor countries through historical colonial relationships, through trade relationships, transfers of aid, and the international financial system suggests that they too could (and should) play a major part in addressing problems of global poverty and in stimulating ecologically sustainable development.

SPOTLIGHT

How global climate change threatens developing countries

Global climate change is expected to increase the economic disparities between rich and poor countries, especially as temperatures increase. The estimated damage for poor countries partly reflects that they are least able to mitigate the damage and will suffer the most from the ravages of altered weather patterns. Plus they have a weaker adaptive capacity. Hence, although they have contributed the least to the problem, climate change is a major development issue, see Figure 12.5.15.

12.5.15 Although they have contributed the least to the problem, people in developing countries are likely to be the worst affected by climate change.

Climate change could lead to large-scale, possibly irreversible, changes in earth's systems, with effects at the global and continental levels. Though the likelihood and scope of these effects are not well known, they will be significant and so must be reflected in policy-making. Potential effects include:

- reduced crop yields in most tropical and sub-tropical regions and increased variability in agricultural productivity due to extreme weather conditions (droughts and floods)
- increased variability of precipitation during Asian summer monsoons, which could reduce food production and increase hunger
- reduced water availability in many water-scarce regions, particularly subtropical regions, and increased water availability in some water-scarce regions, such as parts of South-East Asia
- increased destruction of coral reefs and coastal ecosystems and changes in ocean-supported weather patterns
- increased exposure to vector-borne diseases (such as malaria and dengue fever) and water-borne diseases (cholera)
- rising sea levels. With a 1-metre rise in sea level, partly due to global warming, Egypt could see 12 per cent of its territory—home to 7 million people—disappear. Rising seas threaten to make several small island countries—such as the Maldives and Tuvalu—uninhabitable, and to swamp vast areas of other countries.

Activities

Understanding the text

1 Identify reasons for the popularity of cash cropping systems in developing countries.

2 List the disadvantages of commercial agriculture.

3 Explain how traditional subsistence agriculture could be regarded as 'more developed' than commercial cash cropping.

4 Outline the nature and extent of rural–urban migration. What role did the growth of cash cropping play in this migration?

5 Outline the disadvantages experienced by poor women living in many developing countries. How do these prevent women from improving their status?

6 Explain why development projects often contribute to the feminisation of poverty.

7 Outline the major threats to the survival of indigenous peoples and their cultures.

8 Explain how developed countries would benefit from the preservation and greater understanding of indigenous peoples and their ways of life.

Working geographically

9 Outline the impacts of the expansion of commercial monoculture in Brazil. What has been the response of the Movement of Small Farmers?

10 Conduct a class discussion. What actions by affluent countries may be necessary to overcome some of the imbalances in the distribution of world resources?

11 Study Figure 12.5.4. Using data from the graph, write a paragraph describing the trends in rural and urban populations between 1950 and 2050.

12 Study Figure 12.5.7. Which of the cities included in the graph are located in developing countries? Which cities will have the greatest proportional increase in population between 2000 and 2025?

13 Write an extended response outlining the push and pull factors driving the process of rural–urban migration.

14 Outline the consequences of rapid urbanisation in developing countries.

15 Study Figure 12.5.8. Describe the living conditions of the occupants of this Buenos Aires informal housing.

16 Using Figure 12.5.9, outline the regional variation in slum population.

17 Using Figure 12.5.10, describe the living conditions in Mumbai's Dharavi slum. How do they differ from the conditions in the city's squatter settlements?

18 View the movie *City of Joy*. The movie will give you an insight into the difficulties facing rural–urban migrants through the story of an Indian family that has been forced away from a traditional subsistence farming lifestyle to search for a means of survival in a city.

19 Undertake library or internet research. Find some background information about India and its history of development, then answer the following questions.

- **a** What underlying issues do you think may be responsible for the social and environmental problems of Mumbai?
- **b** What solutions can you suggest to the problems faced by the city and its people?

20 Complete one of the following tasks.

- **a** Select a major urban centre in a developing country. Conduct some research to find out about the nature and extent of problems associated with rapid urban growth.
- **b** Conduct some research to find out what strategies different national governments have employed to deal with the problems of squatter settlements.

21 Study Figure 12.5.11. Compare the amount of unpaid work performed by women and men in different regions of the world. In which regions is the gap the greatest? In which regions is the gap the smallest?

22 Study the Spotlight box, 'The women of Burkina Faso'. Outline the gender-based inequalities experienced by the women of Burkina Faso. What factors account for this inequality?

23 Prepare and conduct a class debate. Topic: 'In the interests of the common good, the rights of the majority must transcend the rights of indigenous minorities.'

24 Not all countries have elected to pursue development paths based on economic growth. Some have pursued strategies of self-reliance. Select a country that has chosen to pursue the path of self-reliance.

- **a** What are its aims and how have they been pursued?
- **b** In what ways have they been successful?
- **c** What have been their failings?

25 Write a report outlining the potential impacts of climate change on developing countries.

26 Read the quote by Archbishop Desmond Tutu. What does he mean when he talks of 'adaptation apartheid'?

27 Use internet-based research to write a research report that outlines the ways in which climate change threatens developing countries.

28 As a class, discuss the proposition that the poor rarely benefit from changes based on the assumptions of the 'trickle-down' theory.

29 Undertake library and internet research into the development theories of Walter Rostow. How did his theories claim development could be stimulated? What were the shortcomings of these theories?

Exam-style questions

Extended responses

- Examine the nature of development.
- Evaluate the effectiveness of the qualitative and quantitative indicators used to measure development.
- Outline the spatial variations in the level and rate of development at a global scale.
- Explain why countries experience different types and rates of development.
- Outline the factors affecting the nature and rate of development.
- Examine the internal factors that affect the nature and rate of development experienced by countries in the developing world.
- Outline the external factors that affect the nature and rate of development experienced by countries in the developing world.
- Account for the spatial variations in TWO of the following: food, shelter, social support, health and educational opportunity.
- Analyse the role of aid in addressing the needs of people in the developing world.
- Examine the role played by nongovernmental organisations in developing countries.

Glossary

absolute poverty not having access to minimum necessities or essentials for living

cash cropping the growing of crops that, when harvested, are sold to make a quick return in the form of money (compare with subsistence agriculture)

cottage industry a system of employment in which rural labourers or craftspeople, with the help of their families, work at home to produce goods for sale

development a process of change that involves an improvement in the quality of life as perceived by the people undergoing change; it is usually focused on reducing poverty; the nature of development will vary, depending on the context in which it is occurring

export-oriented growth the expansion of industrial or agricultural activities that aim to produce goods for sale abroad as a means of generating national income

gross national income (GNI) per capita the total market value of goods and services produced in an economy over a year, divided by the total population of a country

informal sector the part of a national economy that is involved in providing productive labour or services without formal systems of control and payment, and which usually operates without official recognition

labour-intensive an activity or industry that requires a comparatively large workforce, while usually not needing a large capital investment

monoculture commercial agriculture in which farms or areas produce a single crop or type of livestock, year after year

poverty the inability to meet the basic needs for food, clothing and shelter; the absence of money, goods or the means of subsistence

qualitative indicator a quality that can be used as a basis for comparison between places or things, and which is not easily measured or quantified, such as freedom and happiness

quantitative indicator a numerical measure of something that can be counted or quantified and which can then be used as a basis for comparison between places or things, such as income and life expectancy

relative (comparative) poverty poor in comparison with other members of a society

rural–urban migration the movement of people from rural areas to urban areas

self-sufficient the situation whereby a community or country can meet all its own needs; it is sometimes referred to as 'economic independence'

squatter settlement unplanned, slum-like settlement dominated by makeshift dwellings built of scrap timber, iron and even cardboard; they often develop on the outskirts of a city

subsistence agriculture an agricultural system in which products are produced for consumption by the farmer's household rather than for sale

sustainable development processes of development or change that benefit local peoples but do not interfere with the balanced interrelationships between organisms and their environment, which is essential for the survival of both; processes that are able to continue indefinitely

trickle-down effect the theory that economic growth will ultimately benefit all; according to this theory, investments in industrialisation and economic growth will generate income, the benefits of which will eventually trickle down to the poor

CHAPTER

13 Geoskills

The skills of analysing, interpreting, writing and speaking are essential to the acquisition and communication of geographical knowledge. Developing these skills is just as important as learning the subject matter of geography. This chapter focuses on:

1. The Senior Geography Project
2. Writing an extended response
3. Writing a stimulus-based response
4. Presenting an oral report
5. Multimedia presentations
6. Constructing mind maps
7. Interpreting photographs
8. Interpreting cartoons.

13.1.1 Students undertaking fieldwork on a beach

GEOSKILLS 1

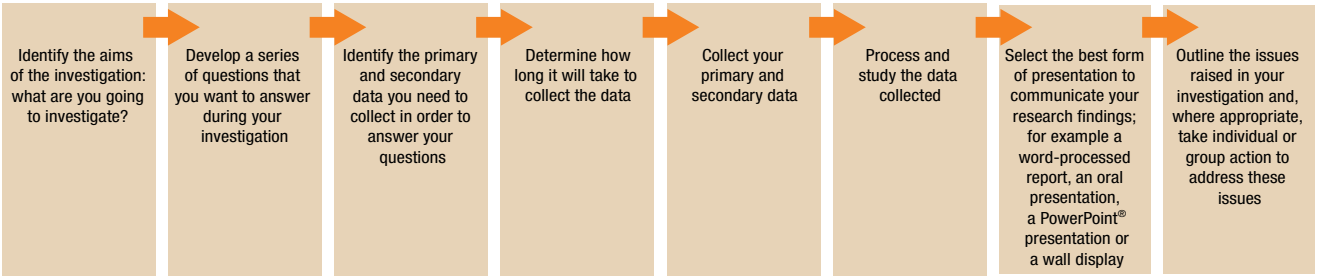
The Senior Geography Project

The Senior Geography Project (SGP) is a compulsory part of the Year 11 course. It provides an opportunity to apply what has been learnt in class to a practical research assignment involving the study of a geographical issue or phenomenon of interest. The SGP enables the development of a range of competencies that are valued in the workplace and in further education.

Students, individually or in groups, should work through the steps shown in Figure 13.1.2.

The SGP should be based on both primary sources (such as fieldwork, interviews, landscape observations, statistics and photographs) and secondary sources (such as existing published materials).

While the manner in which the SGP is assessed will vary from school to school, most assessment will focus on a student's achievement in each step of the research project rather than on the communication of results only.



13.1.2 Steps in completing an SGP

Getting started: selecting the topic

Often the most effective research projects are those that focus on a geographical issue or problem that relates to personal experience and has an impact on the community in which you live.

When selecting a SGP topic a number of key questions need to be addressed. These include:

- Is the problem or phenomenon geographical?

  To answer this question, apply the following questions to the selected topic.

  - Is it to do with location?
  - What is it?
  - Why is it there?
  - How has it changed over time?
  - How does it affect people?
- Is the project achievable in the time available?
- Is the information required to complete the project readily available?

Warning! Many students discover, often too late, that the scope of the topic they have selected is too ambitious to be completed in the time available. It is quite often the small, seemingly straightforward research activity that achieves the best outcome. What is most important is that the SGP demonstrates a sound understanding of the research process: that you can develop, apply and evaluate a research framework. Figure 13.1.3 gives examples of the criteria a teacher might use in assessing the SGP.

Senior Geography Project

Student's name .....

Assessment criteria — Elementary ◄—► Excellent

	1	2	3	4	5
Relevance of topic to geography					
Effectiveness of research techniques utilised					
Relevance of data obtained					
Depth of study					
Explanation of the research process used					
Presentation of the research findings					
Discussion of research findings					
Conclusion					
Ability to evaluate research processes utilised					
Presentation of project					
Sources utilised					

Comment .....

.....

.....

Key

5 Excellent
4 Highly satisfactory
3 Satisfactory
2 More care needed
1 Elementary achievement

Mark

Teacher's signature

.....

13.1.3 Sample marking criteria for an SGP

Note: When selecting a research topic it is always useful to keep in mind the range of topics to be studied during the Year 12 course. Relating the research project to these topics provides valuable insights that may ultimately enhance assessment and exam marks. Making reference to the SGP and fieldwork activities when answering questions in the Year 12 exam is encouraged.

TOPICS YOU MIGHT CONSIDER

Listed in Figure 13.1.4 are research topics that have been selected by students in the past. They may provide ideas or raise other issues of interest.

- Forest management strategies and their impact on the biophysical environment
- Factors affecting vegetation patterns in a local area
- Plant succession on sand dunes
- Plant succession on sandstone plateaus
- Coastal landform studies
- Beach erosion
- Impacts of local flooding
- Land degradation
- The impact of salinity on agricultural production and water quality
- Toxic algal blooms
- Local catchment studies
- Population movements
- Land use patterns in a local area
- Urban decay and renewal
- Impacts of gentrification on inner-city communities
- Sources of pollution in a local community
- Changing patterns of employment in a local community
- The participation of women in a local workforce
- A study of a production unit: farm, factory or service provider
- Impacts of tourism on a particular community or communities
- Impacts of ecotourism on the biophysical environment
- Impact of a business closure on a small community
- Waste disposal
- Waste recycling in a local community
- Effluent disposal in a local community
- Urban run-off patterns
- Energy conservation in a local community
- The impact of community action groups
- Impacts of culture contact within particular urban communities
- Changing patterns of retailing
- The impact of large regional shopping malls on small local shopping centres
- Patterns of movement related to retailing
- Patterns of crime in a local community
- Impact of economic restructuring on the location of industry within large cities
- Socioeconomic studies of local communities using census data

13.1.4 Sample research topics

USING TIME EFFECTIVELY

Thorough planning is often central to the success of the research project. To stay on track, it is useful to develop an SGP action plan; see Figure 13.1.5 for an example to follow. Teachers may assist you in maintaining your effort by monitoring progress.

Warning! Don't leave everything to the last minute. If you do, you are unlikely to realise your full potential in this valuable learning experience.

SGP Action Plan

Name ..... **Topic** .....

Aim

Hypothesis

Objectives

Sources of information/data

Outline of method. In the table below briefly explain your plan of action and indicate when you intend to implement each stage of the plan.

Week	Plan of action	Date completed	Teacher's signature
1			
2			
3			
4			
5			

13.1.5 Sample SGP action plan

Identifying aims, hypotheses and objectives

Clearly stated aims and hypotheses provide the reader with an overview of the research project. They explain what you are attempting to achieve and what you expect to find. They help you to confine your research project within a manageable framework.

The aims of the research project represent a concise statement of what you are setting out to achieve. Aims are usually expressed in terms such as:

- to investigate
- to discover
- to identify
- to analyse
- to consider
- to explain.

An example of the aims for a topic that examines 'Toxic algal blooms in Sharksville Creek' would be:

- Aim 1: 'To identify the causes of toxic algal blooms in Sharksville Creek.'
- Aim 2: 'To investigate the impact of toxic algal blooms on the ecosystem of Sharksville Creek.'
- Aim 3: 'To evaluate the effectiveness of the different strategies used to manage the outbreaks of toxic algal blooms in Sharksville Creek.'

Hypotheses are the expected answers to the questions addressed in the aims of your study, and are based on prior learnings, observations and experiences. Because they are only informed guesses they may be wrong. This does not matter. Researchers have often found that unexpected outcomes have led to important new discoveries.

The number of hypotheses should be the same as the number of aims. For the topic above, examples of appropriate hypotheses might be:

- Hypothesis 1: 'Toxic algal blooms result from increased levels of phosphate in water.'
- Hypothesis 2: 'Toxic algal blooms destroy aquatic ecosystems by greatly reducing the amount of oxygen contained in rivers.'
- Hypothesis 3: 'Only those management strategies designed to reduce the amount of phosphate entering Sharksville Creek are likely to be effective.'

Some assessment criteria may require the identification of objectives. Objectives are the steps taken to achieve aims. These may be quite specific and be closely related to the methodology you develop to test your hypotheses.

For the same topic, examples of objectives might be:

- Objective 1: 'To measure phosphate levels at various sites along Sharksville Creek.'
- Objective 2: 'To assess the level of biodiversity at various sites along Sharksville Creek.'

Gathering and processing information

Collecting and processing data is the 'hands-on' part of the research process. It can involve extensive fieldwork (direct observation/measurement of phenomena) and may require dealing directly with the public. In most survey-based research involving questionnaires, observation or direct measurement, only a sample is taken. This is because of the constraints imposed by time and cost. The sample must be large enough to provide reliable results. Decide whether to target a particular group or base the research on a randomly selected sample. Care should be taken to ensure that the sample includes a range of people in terms of age, gender and occupational groups.

Secondary sources of information (such as published texts, newspaper and magazine articles, government reports, videos and statistical publications) can also be useful. Many secondary sources can be accessed via the internet and/or Geographical Information Systems (GIS).

GATHERING DATA

Gathering data often involves writing letters to people and organisations that may be able to provide relevant information and assistance. Being able to write and set out a formal email letter is an important skill. Ask your teacher for assistance if you are unsure how to go about this.

Warning! It often takes a few weeks for information from companies or government offices to be sent back after you have requested it. To avoid last-minute delays, write requests early in the planning stage.

The ethical responsibilities of conducting geographical research

Conduct research according to accepted ethical conventions:

- Respect the confidentiality and anonymity of those people providing information/data. Always ask permission before naming someone in your report.
- Do not use deception or coercion to obtain information and/or data from people.
- Avoid exposing yourself or others to physical and/or emotional risks or harm.
- Obtain permission before entering private property.
- Minimise any damage to the environment.
- Observe academic conventions regarding plagiarism.
- Store data in a secure place, especially if they are of a sensitive nature.
- Acknowledge the source of information and/or ideas gathered from secondary sources.

PROCESSING RESULTS

Processing results must be done carefully to ensure accuracy. If research is based on a questionnaire, you might find it useful to use a blank copy of the questionnaire to maintain a tally of responses. If you subject your data to mathematical calculations, make sure you check your answers.

Presenting the SGP

FORMS OF PRESENTATION

There are a number of ways in which you can present your completed research project. The form of presentation could include one, or a combination, of the following:

- a written report of no more than 2000 words, supported by appropriate data. (Note: The material included in appendices should not be included in the word count.)
- an audio-visual display, using appropriate information technologies and electronic media
- an oral presentation
- a pictorial essay.

Select the form of presentation that will best enable you to demonstrate the depth of knowledge and understanding you have developed during the project. Students who have well-developed oral communication skills, for example, may find an oral presentation to be the best way of presenting their findings.

An audio-visual display may include one, or a combination, of the following:

- a multimedia presentation and accompanying oral presentation
- a podcast
- a webpage.

A pictorial essay could be presented as a wall display or be set out in an A3-size display book. It could include a wide range of pictorial material, such as maps, photographs, illustrations, cartoons and graphs. These would need to be accompanied by explanatory text.

Most students will elect to present a written report. If this is your preferred method of presentation, it is important that you follow a number of generally accepted guidelines:

- The report should be professionally presented.
- The report contains the following sections:
  - title page
  - table of contents
  - lists of tables and figures
  - aims and hypotheses
  - statement outlining the methodology used
  - statement outlining the research findings
  - conclusion or a discussion of the findings
  - evaluation of the research process
  - bibliography
  - acknowledgements
  - appendix or appendices containing a copy of the research instruments (such as survey forms and observation sheets) and other relevant information.

Note: Check with your teacher that this structure meets their requirements and is suited to the type of research you are undertaking.

Title page

The first page of your report is the title page. It should include the course name, the title of the research project, your name, your teacher's name and the date the project is due. The wording of the title should convey to the reader a concise understanding of what your research project is about.

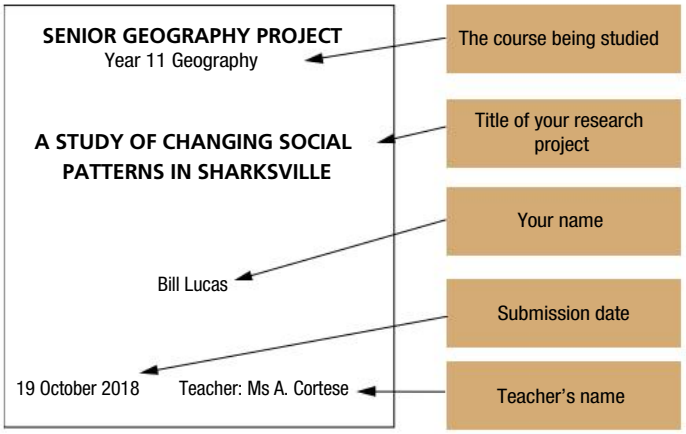
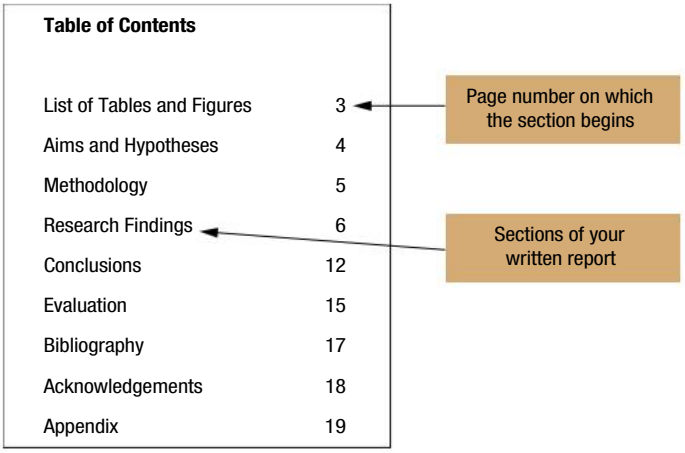


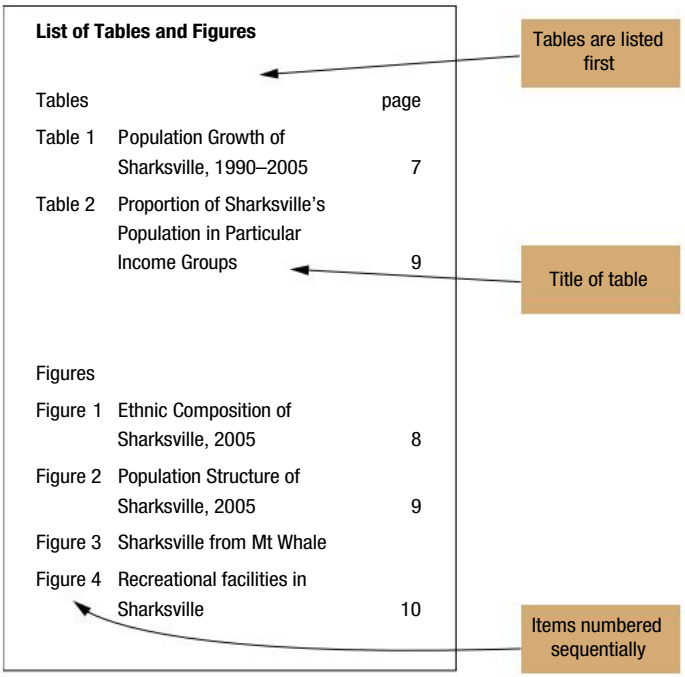
Table of contents

The next page of your report should be the table of contents. This should give the headings for all sections of the report and the page numbers on which they begin. By referring to the table of contents, a person reading the report should be able to see at a glance that you have used the correct report structure.



List of tables and figures

The list of tables usually precedes the list of figures. In each case, the titles should be listed and numbered sequentially. Figures include photographs, graphs, maps, sketches and diagrams.



Aims and hypotheses

The aims and hypotheses can be listed in point form or as discrete (separate) statements. Space these out so each is clear, or use a format that draws the reader's attention to them.

Methodology

In the methodology section, describe how you investigated the geographical issue or problem on which your research focused and how you tested each of your hypotheses. Describe the processes you went through and explain why you adopted your particular approach. Where appropriate, include information such as:

- how you collected your data
- why this method was selected
- the size of your sample
- how the sample was selected
- the duration of the research
- how the data was processed.

Research findings

The research findings section represents the report body, and outlines the research results. This can be done using appropriate graphs, tables, diagrams, photographs and maps but should also include a written description of the results. Make references to the tables and figures used to illustrate the results. This can be done by using statements such as:

- 'The results illustrated in figure 1.2 demonstrate ...'
- 'Figure 1.3 shows that ...'
- 'As shown in table 2.1 ...'.

Take care with graphs, maps and other illustrative material. Use colour and make sure the generally accepted conventions are followed. Ensure each figure is numbered and has a caption or title that identifies what it represents.

If one or more hypothesis is being tested, it is often better to break this section into different parts: one for each hypothesis.

Conclusion

In the conclusion analyse the research results and evaluate them in terms of the stated aims and hypotheses.

Discuss the ways in which the findings reflected, or differed from, what was expected. Offer an explanation as to why particular results were achieved and outline any unexpected or interesting outcomes from the research. If appropriate, reflect on the geographical implications of the research.

Evaluation

Many teachers regard the evaluation section to be the most important part of the SGP presentation. This is an opportunity to demonstrate understanding of research processes by critically evaluating the research framework developed for the project. Disappointing research results can still be used to gain a good grade. Use the results to identify what went wrong and how mistakes could be prevented in a future similar research project.

The evaluation should outline both the limitations and successes of the research project. State the problems encountered and how these affected the final outcome. Common problems encountered by students include:

- the non-return of survey forms
- poorly constructed questions that failed to obtain the information you required
- a sample that proved to be too small
- a lack of appropriate resources
- a reluctance by individuals and institutions to give you access to the information you needed
- a research focus that was too ambitious for the time and resources available.

Balance the discussion by highlighting the successes of the research and the benefits derived from completing the project. These might include:

- an understanding of the research process
- an enhanced understanding of geographical concepts and terminology
- improved communication skills
- skills in the presentation of data
- greater self-confidence
- a sense of achievement from completing the task.

Conclude this section by describing how to improve the project if it were to be repeated.

Bibliography

In the bibliography list the names of the secondary resources that were useful when undertaking research. If this book were to be included in the bibliography, use the following format:

> G. Kleeman, D. Hamper, H. Rhodes, *Global interactions Year 11*, Pearson Australia, Melbourne, 2018

If references to newspaper, magazine and journal articles are included, provide details as in the following example:

> J. Smith, 'Managing Sydney's growth', *Journal of Geographical Studies*, vol. 17, June 2017, pp. 14–22

Acknowledgements

The acknowledgements section is an opportunity to acknowledge and thank those individuals and organisations that have assisted you in your research.

Appendix

The appendix of a report is the place for background information that is of some relevance to your study. It might include newspaper cuttings that deal with the topic, copies of questionnaires used, and tables of data from which the graphs have been constructed to illustrate research findings.

Writing an extended response

Writing an effective extended response requires clear thinking and careful expression. Successful writing depends on:

- an understanding of the question being asked and the directive terminology used
- an understanding of the information on which the question is based
- knowledge of how to structure an effective extended response.

Figure 13.1.6 outlines the dos and don'ts when writing an extended response.

When writing an extended response ...	
Do	**Don't**
■ Plan your extended response. ■ Stick to the question. ■ Answer all parts of the question. The failure to answer even one part of a structured question could affect the quality of your response and lose you marks. ■ Use diagrams, models and sketch maps where appropriate. ■ Use only commonly accepted abbreviations (for example, when referring to organisations). The first time the name or term is used, write it out in full and place the abbreviation after it in brackets. ■ Read over your completed response to check for errors (for example, in punctuation, spelling, syntax or the labelling of diagrams).	■ Don't include references to yourself in your written responses (for example, 'I will now answer the question', 'As I have shown ...' or 'I think ...'). ■ Don't just write down everything you know about the topic. Information that does not relate to the question only detracts from your response. ■ Don't ask rhetorical questions (for example, 'So! What is eutrophication?'). ■ Avoid value judgements (for example, 'All conservationists are hippies') or make sure you support such judgements with evidence or argument.

13.1.6 Dos and don'ts when writing an extended response

Getting started

Read and dissect the rubric and question carefully, making sure you understand what you are required to do. All extended response questions include directive terms that indicate how you should go about answering the question. They also include key words that give an indication of the subject matter you are required to address in your response, shown in Figure 13.1.7. It is always useful to underline the key words and directive terms in the question.

Some questions have a number of parts. These types of questions are usually referred to as structured questions. To achieve the best result you must answer each part of the question.

Warning! Some students believe that if they write all they know on a topic they will cover the question. Others use prepared answers that may not relate to the question being asked. These students rarely gain good marks. The best essays are written by those students who adapt their knowledge and understanding of the subject matter to answer the particular question that has been asked. They select and develop appropriate arguments and use them to address the particular focus of the question.

Common directive terms* used in questions

Term	Meaning	Term	Meaning
Account	Account for: state reasons for; report on Give an account of: narrate a series of events or transactions	Evaluate	Make a judgement based on criteria; determine the value of
Analyse	Identify components and the relationship between them; draw out and relate implications	Examine	Inquire into
Apply	Use; utilise; employ in a particular situation	Explain	Relate cause and effect; make the relationships between things evident; provide the why and/or how
Appreciate	Make a judgement about the value of	Extract	Choose relevant and/or appropriate details
Assess	Make a judgement of value, quantity, outcomes, results or size	Extrapolate	Infer from what is known
Calculate	Ascertain/determine from given facts, figures or information	Identify	Recognise and name
Clarify	Make clear or plain	Interpret	Draw meaning from
Classify	Arrange or include in classes/categories	Investigate	Plan, inquire into and draw conclusions about
Compare	Show how things are similar or different	Justify	Support an argument or conclusion
Construct	Make; build; put together items or arguments	Outline	Sketch in general terms; indicate the main features of
Contrast	Show how things are different or opposite	Predict	Suggest what may happen based on available information
Critically (analyse/ evaluate)	Add a level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality	Propose	Put forward (for example, a point of view, idea, argument or suggestion) for consideration or action
Deduce	Draw conclusions	Recall	Present remembered ideas, facts or experiences
Define	State meaning and identify essential qualities	Recommend	Provide reasons in favour
Demonstrate	Show by example	Recount	Retell a series of events
Describe	Provide characteristics and features	Summarise	Concisely express the relevant details
Discuss	Identify issues and provide points for and/or against	Synthesise	Put together various elements to make a whole
Distinguish	Recognise or indicate as being distinct or different from; note differences between		

*As defined by the NSW Board of Studies

13.1.7 Common directive terms* used in questions

Doing the research

STEP 1: SOURCES

The information on which your written response is to be based can be obtained from a number of sources. These could include texts and reference books, the internet, videos and podcasts, computer databases and your own notes.

To ensure that your information is up-to-date, it is often useful to refer to recent events or examples. Sources of up-to-date information include the internet, newspapers, magazines, journals and government publications.

STEP 2: READ AND MAKE NOTES

Skim read the resources you have collected to ensure the material is relevant to the topic. Then make your own summary notes as you reread the material you have identified as being relevant. Your notes could be organised under a series of subheadings derived from the extended-response question.

STEP 3: ORGANISE THE INFORMATION

Once you have collected your information, it will need to be organised. Decide what should be included, what should be left out and in what order the information should be presented. You may find it useful to write each of the main points on individual strips of paper. These strips can be moved around and grouped, with the groups forming the basis of paragraphs. The groups can then be reordered to give the essay a logical sequence and structure.

Planning the extended response

A plan, which may be no more than a list of key words or pieces of information, helps you to recall information and avoid repetition. It also assists you by giving your written response structure, and by ensuring that your arguments are logically sequenced and well written.

Your plan should also include a list of the points you wish to discuss in your response. These can then be developed into paragraphs.

Your plan should reflect your interpretation of the question and take account of the directive terms. These terms give you an indication of the amount of detail required. For example, terms such as 'briefly', 'list' and 'outline' indicate that your response should be concise. Your plan will also help you avoid aspects of the topic that are not relevant.

Writing the extended response

An extended response has three parts: an introduction, a body, and a conclusion.

REFER TO PLAN

As you write your extended response, keep asking yourself, 'Am I answering the question?' Continue to refer back to the plan and cross off each point as you proceed. This process can often stimulate the recall of ideas that you may have forgotten. These can be included, if appropriate.

As you complete each paragraph, quickly read over it before proceeding onto the next point in your plan. This will ensure that you answer the set question and only include relevant information. Reading over the paragraph will also enable you to quickly correct any obvious errors that might otherwise detract from the quality of your response.

INTRODUCTION

The introduction should 'set the scene' for the reader by introducing the main ideas and significant points on which your arguments are to be developed. It is often useful to include in the introduction the key words used in the question. It is also important to clearly and concisely define the key geographical terms and concepts being addressed by the question.

Warning! In exams it is very important to write a good introduction. The examiner will very quickly determine whether or not you are on the right track. Your introduction should not be too long; it should merely repeat the question and it should avoid narrative, such as 'In this essay I will ...'.

BODY

The body provides the detail of your argument or information. Each paragraph should include one main point or idea that contributes to the development of your argument. This main point or idea is usually summarised in the opening sentence. The rest of the paragraph should expand on the main point by way of explanation or example. Each paragraph should be placed in an order that best develops your answer.

In geography it is acceptable to use subheadings and list points where appropriate. Each set of points must be introduced by a formal sentence. Each individual point should stand as a formal sentence where required, as in the following example.

> *A range of strategies can be used to better manage water resources. These include:*
> - *the introduction of the 'user pays' system*
> - *restricting and regulating consumption*
> - *the construction of more storage facilities.*

Including maps, diagrams and models can be a very effective means of developing your argument and demonstrating your knowledge and understanding of the topic. If a map is included it should have some indication of scale and include a north arrow. This illustrative material should be clear, of a reasonable size and neatly presented. It should be included within the extended response, not at the end, and reference to it made in the text of the response.

References to fieldwork and case studies should be included where appropriate. These enable you to apply your experiences and knowledge to the explanation of geographical phenomena.

CONCLUSION

The conclusion draws together your arguments and ideas. It should focus on the point of view that is expressed in the introduction to the response. Be careful to avoid contradicting what was written earlier.

Extended-response checklist

Use the following steps to ensure that you gain the best possible result for your efforts:

1. Read through your draft to ensure it is coherent.
2. Cross out those parts that seem irrelevant or repetitive.
3. Read your essay out aloud and ensure the sentence structure and punctuation are correct.
4. Check the spelling and take out words and phrases that are not needed. Simplify and clarify by breaking lengthy sentences into shorter, better focused ones.
5. Ask these final questions about your draft:
   - Are the ideas linked?
   - Is there any waffle?
   - Have I been repetitive?
   - Have I answered all parts of the question?
   - Have I defined the major terms?
6. Rewrite the essay in neat, legible handwriting if presenting it in a handwritten form.
7. Consider using word-processing because it facilitates the editing process and makes it easier to correct spelling and grammatical errors.

Using text types and improving your writing

The text types most commonly used in geography include reports, explanations, expositions and discussions. Each is outlined in Figure 13.1.8, including an explanation of grammatical and structural features for each text type.

The word lists in Figure 13.1.9 will help you improve your writing.

Test types and their features

Text type	Purpose	Structure	Language features
Report	A report is used to classify and describe a geographical feature or process. It usually contains facts about the feature or process.	The three parts of a report are: **1** a general introductory statement introducing the subject of the report; it can be a short description or a definition **2** a series of paragraphs about the feature or process; each new paragraph usually describes just one aspect of the feature or process and begins with a topic (or preview) sentence **3** a conclusion that summarises the information presented.	■ Technical language related to the geographical feature or process; for example, 'annual rainfall' instead of 'the amount of rain received each year' ■ Generalised terms ■ Linking verbs, especially when defining the topic ■ Words or phrases that allow for comparisons ■ Use of the timeless present tense
Explanation	An explanation is used to explain how or why something occurs.	The three parts of an explanation are: **1** a general statement about the geographical feature or process being written about; the general statement serves as an introduction **2** a series of paragraphs that tell us how or why; these should be in sequence so that the reader builds up an understanding of the feature or process **3** a concluding paragraph; this signals to the audience that the explanation is finished.	■ Technical language (geographical terms) ■ Words that show cause and effect ■ Use of the timeless present tense
Discussion	A discussion is used to present the different opinions on a particular issue or topic; that is, the arguments for and against.	The three parts of a discussion are: **1** an introductory paragraph that introduces the issue or topic being discussed; it can contain a question or it can state the view of the writer **2** a series of paragraphs that outline the arguments for and against the issue or topic **3** a conclusion that sums up the issue and outlines the writer's own point of view or recommendation.	■ Generic terms related to the topic ■ Words that show a comparison or contrast ■ Words that link arguments ■ Words that qualify, such as 'usually' and 'probably' ■ Words that show the writer's opinions ■ Use of the timeless present tense
Exposition	An exposition argues only one side of an issue. It is used to persuade the reader by presenting a particular point of view.	The three parts of an exposition are: **1** an introductory statement that gives the writer's point of view and previews the arguments that will be presented to support their position; a question or emotive statement is sometimes used to gain the reader's attention **2** a series of arguments that aim to persuade the reader; a new paragraph is used for each new argument, and each new paragraph begins with a topic sentence that introduces a new argument **3** a conclusion that sums up the arguments presented and reinforces the writer's point of view.	■ Generalised noun or noun groups; that is, classes of things rather than specific individuals ■ Words that show the writer's attitude and point of view ■ Words that express feelings (emotive words) ■ Conjunctions/connectives that structure the argument ■ Words that qualify or express tentativeness, such as 'usually' and 'probably' ■ Use of the timeless present tense

13.1.8 Text types

Writers' word bank					
Words that compare	■ also ■ similar to	■ as	■ as do	■ like	■ the same as
Words that contrast	■ alternatively ■ however ■ rather	■ although ■ instead ■ whereas	■ but ■ nevertheless ■ yet	■ by contrast ■ on the contrary	■ differs from ■ on the other hand
Words that show cause and effect	■ an effect of ■ brings about ■ creates ■ gives rise to ■ results in	■ an outcome of ■ brought about ■ culminated in ■ hence ■ so	■ as a consequence of ■ caused by ■ despite this ■ leads to ■ stems from	■ as a result of ■ consequently ■ due to ■ otherwise ■ therefore	■ because ■ contributed to ■ even though ■ produced by
Words that show time and sequence	■ after a while ■ meanwhile ■ shortly ■ first (second, third, etc.)	■ afterwards ■ next ■ soon	■ at this point ■ here ■ next time ■ then	■ before ■ in the end ■ now ■ when	■ finally ■ lastly ■ previously
Words for presenting another argument	■ also ■ likewise	■ as well as ■ moreover	■ besides ■ not only	■ furthermore	■ in addition to
Words for introducing examples	■ as shown by ■ these include	■ for example	■ for instance	■ including	■ such as

13.1.9 Writers' word bank

GEOSKILLS 3

Writing a stimulus-based response

A short-answer response may be no more than 15–20 lines long. These responses require an analysis of statistical data, maps, graphs, diagrams, cartoons, or newspaper and magazine extracts.

When studying the stimulus material ask yourself the following questions:

- What information does the item convey?
- What geographical concepts are related to the stimulus material—what trends or patterns can be identified?
- What are the geographical implications of the information (the identified trends and/or patterns) conveyed by the stimulus material?

The best stimulus-based responses do more than simply describe the stimulus material. Such responses include the underlying processes and draw on the student's knowledge to show that they understand the points made in the material. The answer is well-argued and employs appropriate terminology and concepts.

Three stages

Writing stimulus-based responses involves three stages.

STAGE 1: DESCRIPTION

Provide a statement that outlines the information presented in the stimulus material. The statement should identify the geographical phenomenon being examined or illustrated by the data or graphic representation. It should then outline any trends evident; this can include data from the stimulus material.

STAGE 2: ANALYSIS

Analyse the data and identify the range of geographical concepts or generalisations relevant to the information presented. Demonstrate your understanding of these concepts by using the appropriate terminology in context. Identify the geographical processes responsible for the trends evident and provide explanations for their occurrence.

STAGE 3: IMPLICATIONS

Use your knowledge and understanding of the topic and state or describe the possible results or effects of the patterns, trends or information presented. Use precise geographical terminology, identifying a process or supplying some explanation of the observed trend.

GEOSKILLS 4

Presenting an oral report

Fear of talking to a large group is very common, but there are ways to overcome this. One way is to carefully plan and prepare your presentation. This preparation should include establishing the following:

- A clear understanding of the purpose of the report you are presenting: The most common purpose of an oral report is to inform an audience.
- A knowledge of your audience: The more you know about your audience, the more appropriate and focused your oral report will be. For example, if your audience already has a good knowledge of the topic you may choose to leave out information with which they are already familiar.
- A well-organised body of information: The most successful oral reports have a structure similar to an extended response or essay; that is, they have an introduction, a body and a conclusion.

Structuring the presentation

INTRODUCTION

The first part of your oral report tells the audience what your topic is. It is also important that you do this in a way that gains the audience's attention. A good way to do this is to make a formal opening statement outlining the focus of your report. This statement should be accompanied by some visual material, such as a digital image, poster, video extract or another type of stimulus. On some occasions, humour can be used to gain the audience's attention.

BODY

The body of the oral report should be the focus of your presentation. The main ideas presented need to be developed and supported by examples, quotations, analogies and statistical information. These will make your presentation more interesting and memorable.

CONCLUSION

The conclusion should briefly highlight the main points you have made during your presentation. It is important to make it clear to the audience that you are nearing the end of your presentation by using phrases such as 'in conclusion' or 'to sum up'.

Presenting

Use speaker's notes and avoid reading a prepared speech. When preparing speaker's notes, consider the following:

1. Write a series of words or phrases that act as cues. Different colours and highlighter pens may prove useful.
2. Write the words and phrases in large print and ensure there are not too many points per page.
3. Number the points so that you do not get out of sequence.

To avoid 'stage fright', consider the following before delivering your report:

- Know your topic thoroughly.
- Use numbered points on speaking cards.
- Practise your speech several times.
- Before delivery, visualise yourself as relaxed and calm.
- Do not rush your presentation.
- Use appropriate gestures and maintain good posture.
- Use a range of visual aids.
- Maintain eye contact with members of the audience.
- Vary your voice throughout your presentation.
- Stand still.

GEOSKILLS 5

Multimedia presentations

Multimedia presentations (including PowerPoint) combine various types of media, including text, graphics, clipart, digital photographs, podcasts, internet links and music.

When planning your multimedia presentation and accompanying oral report, remember the following points:

- Plan carefully.
- Do your research.
- Know your audience.
- Time your presentation.
- Practise your presentation.
- Speak comfortably and clearly.

Tips for constructing effective presentations

The following are tips to help you construct an effective multimedia presentation:

- Use a consistent and simple design template. It is acceptable to vary the content presentation style (such as bulleted lists and number of columns), but be consistent with other elements, such as font, colours and background.
- Limit the number of slides. Presenters who constantly 'flip' to the next slide are likely to lose their audience's attention.
- Limit the number of words on each screen. Use key phrases and include only essential information. In general, use no more than six words a line and no more than six lines a slide. Avoid long sentences. Larger font sizes can be used to indicate more important information.
- Use suitable font sizes—generally from 18 to 48 point.
- Use punctuation sparingly and avoid putting words in all capital letters. Some empty space on the slide enhances readability. Avoid abbreviations and acronyms.
- Use contrasting colours for text and background. Dark text on a light background is best. Busy, patterned backgrounds reduce the text's readability.
- Avoid or minimise the use of flashy transitions, such as text fly-ins.
- Visual elements should balance the slide, enhance and complement the text and not be overwhelming.
- Use good quality (high-resolution) images that reinforce and complement your message.
- Do not read from your slides. The content of your slides is for the audience, not for the presenter.
- Always focus on the audience. Do not turn and focus on your projected slides.
- Learn to navigate your presentation in a non-linear fashion.
- Preview your slides on the screen you will be using for your presentation. Make sure they are readable from the seats in the back row.
- Do not use content that is hard to read or understand.
- Practise by first presenting to someone who has never seen your presentation. Ask for honest feedback about colours, content and effects or graphics.

GEOSKILLS 6

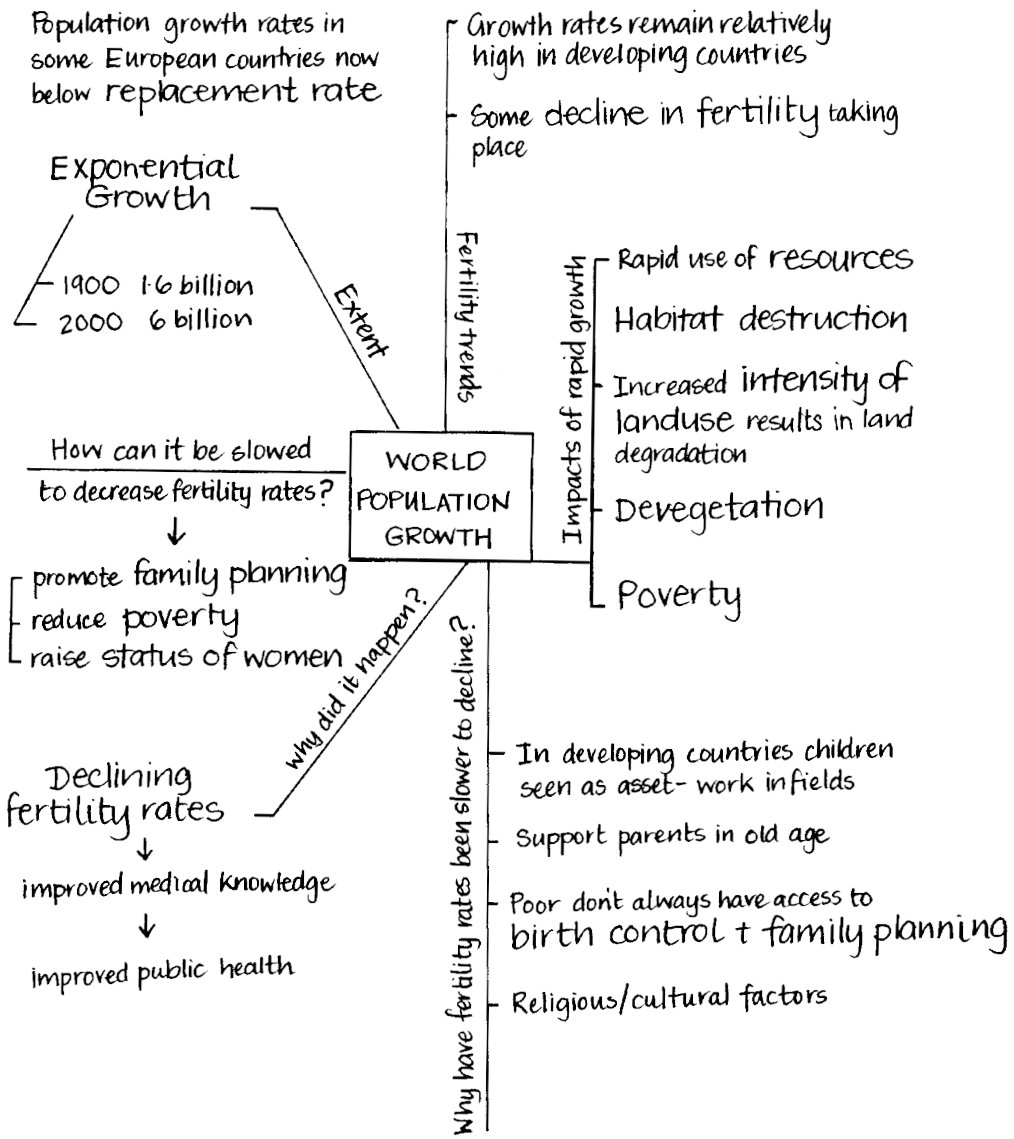
Constructing mind maps

A mind map is a creative pattern of connected ideas that provides a concise 'picture' of the topic. As a study technique, mind maps assist you to clarify and recall information. They can encourage creativity and make revision more enjoyable and effective.

To create a mind map for a whole topic or part of a topic, follow the steps below:

1. Write the topic in the centre of a page and put a box around it.
2. Add branches that radiate out from the central topic box.
3. Add detail to your mind map. Key words and concepts should be highlighted. Add symbols and even small sketches to assist recall or enhance the effectiveness of the mind map as a form of geographical communication.
4. Draw the linkages between related concepts.

Use different-coloured pens or pencils for each branch of the mind map. Use sketches, symbols and abbreviations, and change the size of the words: the more important the word, the bigger it might be. Figure 13.1.10 demonstrates an example of a mind map.



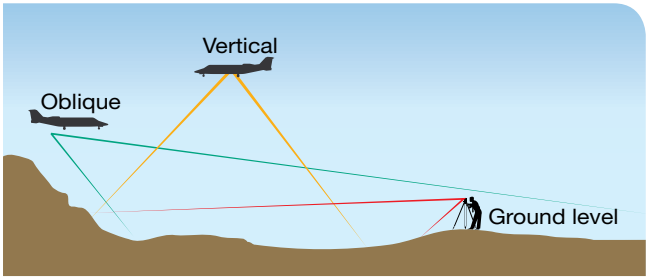
13.1.10 A sample mind map

GEOSKILLS 7

Interpreting photographs

Photographs are used extensively to record and illustrate geographical information. Photographs are useful as they:

- record how a place or environment looks at a particular point in time
- allow us to compare different environments
- allow us to study how places and environments have changed over time
- are easy to interpret, and demonstrate relationships between different phenomena.



13.1.11 Taking ground-level, oblique and vertical photographs

The most commonly used types of photographs are ground-level photographs and aerial photographs (vertical and oblique), as shown in Figure 13.1.11.

Ground-level photographs

Ground-level photographs are taken at ground level with the camera held horizontal to the ground. They are useful for showing features in detail, but do not show the spatial distribution or arrangement of features.

Aerial photographs

Aerial photographs are taken from an aircraft or drone. They provide a vivid picture of a landscape and show relationships between elements of the biophysical and built environments. They are also an excellent way to examine the rate of environmental change.

VERTICAL

Vertical aerial photographs are taken with a camera pointing directly towards the earth's surface. Because the photograph is taken from directly above, spatial patterns are clearly visible. However, specific features may be difficult to identify because only a plan view is seen.

OBLIQUE PHOTOGRAPHS

Oblique aerial photographs are taken from an aircraft or drone with the camera pointing at an oblique angle to the ground.

Oblique aerial photographs are often easier to interpret than vertical aerial photographs because the sides of objects can be seen as well as the tops. In addition, the photographs are often more detailed because they are taken at a lower altitude.

The main disadvantage of oblique aerial photographs is that there is no consistent scale. Features in the foreground appear larger than those in the background.

Taking useful photographs

Taking photographs that are useful involves:

- deciding what the photograph is going to show
- choosing what is to be included and excluded
- including a generally recognised feature that gives the viewer some indication of scale
- choosing the appropriate distance between the camera and the subject
- ensuring that the feature being photographed is centred, and is the focus of the viewer's attention
- ensuring that the technical aspects of the photograph are correct (lighting is adequate and the picture is in focus).

Interpreting photographs

When interpreting photographs, follow these steps:

1. Examine the photograph carefully. Is the photograph an oblique or vertical aerial photograph or has it been taken at ground level? Look for familiar built features that will give you some indication of scale.
2. Identify the photograph's main features. These may be grouped under the following headings:
   - features of the biophysical environment—landforms, climate and vegetation
   - features of the built environment—land use, transport networks and settlement (rural/urban).
3. Ask the following questions:
   - Is the area predominantly characteristic of the biophysical or built environment?
   - What is the biophysical nature of the environment; for example, fluvial, coastal, arid, or mountainous?
   - To what extent has the area been modified?

GEOSKILLS 8

Interpreting cartoons

In order to interpret cartoons, the reader needs to understand the signs and symbols that are used to construct meaning. The reader also needs to appreciate that these symbols make us understand things and react in particular ways. The reader needs to analyse the ways in which images are constructed and their intended purpose. Figure 13.1.12 summarises the tools used by cartoonists to communicate an idea or opinion.

Cartoon analysis scaffold

Newspaper, magazine or URL: _____

Cartoonist: _____

Visual elements
Identify any symbols or visual metaphors by the cartoonist. What do these symbols and visual metaphors represent?

paste the cartoon here

Has the cartoonist used caricature? If so, identify the people featured in the cartoon. What physical features has the cartoonist deliberately exaggerated? What is the impact of this exaggeration? What does it suggest about the people shown?

Is there evidence of stereotyping in the cartoon? If so, describe it.

Text-based elements
Does the cartoon have a caption and/or title? If so, write it in the space below.

List any words or phrases used by the cartoonist to identify objects or people in the cartoon.

Which words or phrases in the cartoon appear to be the most important? Justify your selection.

General
Identify the issue addressed in the cartoon.

Explain, in your own words, the opinion or perspective being advanced by the cartoonist.

What interest groups would agree/disagree with the point of view advanced by the cartoonist?

13.1.12 Elements used to convey meaning in an editorial cartoon

Elements of cartoons

CONTEXT

The context is the circumstances that 'surround' the issue being addressed in the cartoon. The context might include the political, social, cultural, historical or institutional factors that influence the way we understand an issue.

Note: Institutions are structures and mechanisms of social order and cooperation governing the behaviour of people; examples include the institutions of marriage and religion as well as legal and economic systems.

SYMBOLISM

Symbols have the ability to communicate often complex, emotionally rich ideas in a concise manner. The use of symbolism involves the inclusion of representational forms or images that have meaning beyond what is obvious and immediate; in other words, a sign or object is used by the cartoonist to stand for something other than itself. The effectiveness of such references depends on the presumption that its meaning can be understood by the reader. Commonly used examples of symbolism include the dove or olive branch (to symbolise peace); the Statue of Liberty (freedom and democracy); a heart, cupid or Venus (love); Uncle Sam and the 'Stars and Stripes' (the United States); a bear (Russia); and a dragon (China).

STEREOTYPING
Creating an oversimplified, or even biased, image of a particular group of people is known as stereotyping. Cartoonists often use stereotyping when seeking to highlight the dangers of generalising. Alternately, they use it as a 'shorthand' way of communicating generalisations. Cartoonists must be careful when using stereotypical symbols. They have the potential to reinforce and perhaps inflame harmful prejudices.

CARICATURES
Caricatures are humorous illustrations that exaggerate or distort the prominent physical features of a subject to create an easily identifiable visual likeness. This enables public figures to be identified quickly. The best caricatures provide an insight into the character of the person being drawn. Examples of features that are subject to exaggeration in caricatures include Donald Trump's orange skin and hair flick.

EXAGGERATION AND DISTORTION
Cartoonists often exaggerate or understate the size of people and objects they draw. They do so to emphasise the relative power, importance and vulnerability of an individual, group or social force. It can also be used to draw attention to aspects of an issue being addressed.

CAPTIONS
Captions are text-based statements that are sometimes used to reinforce and put in context a cartoon's non-verbal elements. They complement, rather than make obsolete, the other elements of a cartoon. When considered together, all elements communicate a social or political opinion.

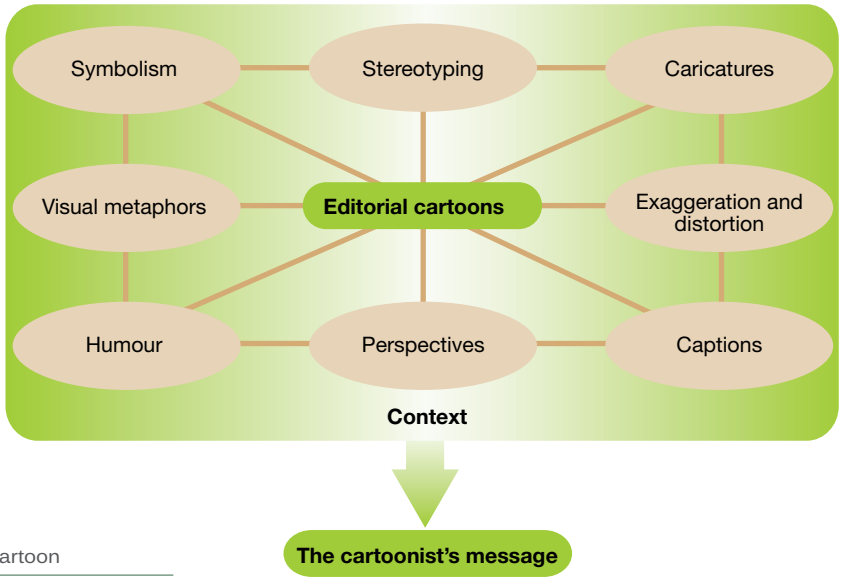
PERSPECTIVE
The cartoonist's perspective is the position, stance or point of view they adopt. The cartoonist might take the opportunity to advance their own view on a particular issue or topic, or they might seek to portray (often in a satirical way) the perspective associated with a key player. The mood or tone created by a cartoon provides important insights into the cartoonist's attitude towards the subject and the audience.

HUMOUR
Cartoonists often employ irony and satire to give a cartoon a humorous edge. Irony is an expression in which the true meaning is the opposite of the literal meaning. Satire involves the use of ridicule or scorn, often in a humorous or exaggerated way, to expose vices and follies. These devices can be used to poke fun at public figures or create a dynamic that draws the reader into a more active engagement with the issue being addressed in the cartoon.

VISUAL METAPHORS
Visual metaphors are artistic devices used to help our minds come to grips with complex ideas by relating them to something more familiar and readily understood. Examples of visual metaphors include:

- a sinking ship, a wilderness (desert) setting, or a wagon circled by bandits to suggest that a government or political party is experiencing a downturn in its electoral fortunes
- a storm as a metaphor for chaos, confusion, fear and destruction
- the grim reaper, vulture, shroud, or skull and crossbones as a metaphor for evil, disease and death.

Interpreting cartoons
Figure 13.1.13 shows the questions to consider when interpreting a cartoon.



13.1.13 Questions to consider when interpreting a cartoon

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UN Stats - United Nations Statistics: United Nations, p. 187; World Population Prospects: The 2015 Revision/United Nations, p. 190; World Population Prospects: The 2017 Revision/United Nations, pp. 188–189, 191–192, 196.

UN Water: World Water Development Report 4, World Water Assessment Programme (WWAP), March 2012, UN Water., p. 46.

UNEP - United Nations Environment Programme: Pascal Peduzzi, UNEP/GRID-Geneva (2012), p. 49.

United Nations Development Programme (UNDP): Human Development Report 2016/United Nations Development Programme, p. 383; Human Development Report/United Nations Development Programme, p. 383; Sustainable Development Goals/UNDP, p. 385.

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