PEARSON geography

S.B.

7



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We hope you enjoy the journey you are about to take as much as we have enjoyed preparing for it. We look forward to working with you to implement the Australian Curriculum and to helping you manage your digital aspirations.

We would like to thank our authors for their extraordinary dedication and their contribution to the development of this project.

Ephemeral Lake Carnegie, in Western Australia, fills with water only during periods of significant rainfall. In dry years, it is reduced to a muddy marsh.



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Contents

How to use this book viii
Directive terms x

Part 1: Geography: It's all around us

Chapter 1: Geography: It's all around us 2

1.1 What is Geography? 4
1.2 Why we study Geography 6
1.3 Types of environments 8
1.4 Natural resources 10
1.5 Geoskills: Photographs 12
1.6 Communities and neighbourhoods 14
1.7 Contemporary issues in Geography 16

Chapter 2: Maps and mapping 18

2.1 Types of maps 20
2.2 Elements of maps 22
2.3 Grid and area references 24
2.4 Topographic maps 26
2.5 Geoskills: Interpreting topographic maps 28
2.6 Atlas maps 30
2.7 Latitude and longitude 32
2.8 Spatial technologies 34

Review and reflect 1 36

Part 2: Water in the world

Chapter 3: Weather and climate 40

3.1 Weather and climate 42
3.2 Precipitation 46
3.3 Geoskills: Climate graphs 50
3.4 Case study: Australia's weather and climate . . . 52
3.5 Geoskills: Weather maps 56
3.6 In the field: Measuring weather 58

Chapter 4: Weather hazards and disasters 62

4.1 Hazards and disasters 64
4.2 Severe storms 68
4.3 Tropical cyclones 72
4.4 Tornadoes 76
4.5 Flooding 80
4.6 Case study: Queensland floods, 2010–11 84
4.7 Heatwaves 88
4.8 Drought 90
4.9 Case study: Drought in Australia 94
4.10 Responding to hazards 98

Chapter 5: Water: A renewable resource 100

5.1 Water 102
5.2 The water cycle 104
5.3 Distribution of water 106
5.4 Catchments 108
5.5 Groundwater 110
5.6 Water use 114
5.7 Water footprint 116
5.8 Virtual water 118
5.9 Access to clean water 120
5.10 World water hotspots 124
5.11 A water-based conflict 126
5.12 Irrigation 128
5.13 Case study: Irrigation in Bali 130
5.14 Case study: The Ganges 132

Chapter 6: Water resource management 136

6.1 Water scarcity 138
6.2 Case study: Drought in the Horn of Africa 140
6.3 Managing water resources 142
6.4 Increasing water supply 144
6.5 Big dam projects 148
6.6 Case study: Africa's big dam projects 150
6.7 Case study: Ethiopia 152

Chapter 7: Australia's water resources 154

7.1 Water in Australia 156
7.2 Geoskills: Satellite images 158
7.3 Water scarcity 160
7.4 Indigenous management of water resources . . 162
7.5 Water management 164
7.6 Case study: The Murray–Darling Basin 166
7.7 Case study: Wild rivers of Queensland 170
7.8 Reducing household water use 174

Review and reflect 2 176

Part 3: Place and liveability

Chapter 8: Decisions and liveability 180

8.1 Deciding where to live 182
8.2 Choices people make 184
8.3 Sense of place 186
8.4 Liveability of places 190
8.5 Measuring liveability 192
8.6 Attachment to Country 194
8.7 Perceptions of liveability 198
8.8 Environmental quality and liveability 200
8.9 Access to services and facilities 202
8.10 Crime and liveability 204

Chapter 9: Places people live 206

9.1 Classifying settlements 208
9.2 Location of cities 210
9.3 Urban or rural 212
9.4 Urban housing densities 214
9.5 Transport and cities 216
9.6 Urban consolidation 218
9.7 High-density cities 220
9.8 Case study: Bern, Switzerland 222

Chapter 10: Change and liveability 224

10.1 Change in Australian communities 226
10.2 Australia's population 230
10.3 Geoskills: Population pyramids 234
10.4 Economic activity and population distribution 236
10.5 Changing distribution of Australia's population 240
10.6 Australians and the coast 244
10.7 Case study: Gerringong 246
10.8 Impacts of technology 250
10.9 Case study: Natimuk 252
10.10 Australia's mineral and energy resources 256
10.11 Case study: Paraburdoo 260
10.12 Case study: Venice, Italy 262
10.13 Case study: Costa del Sol, Spain 264

Chapter 11: Enhancing liveability 268

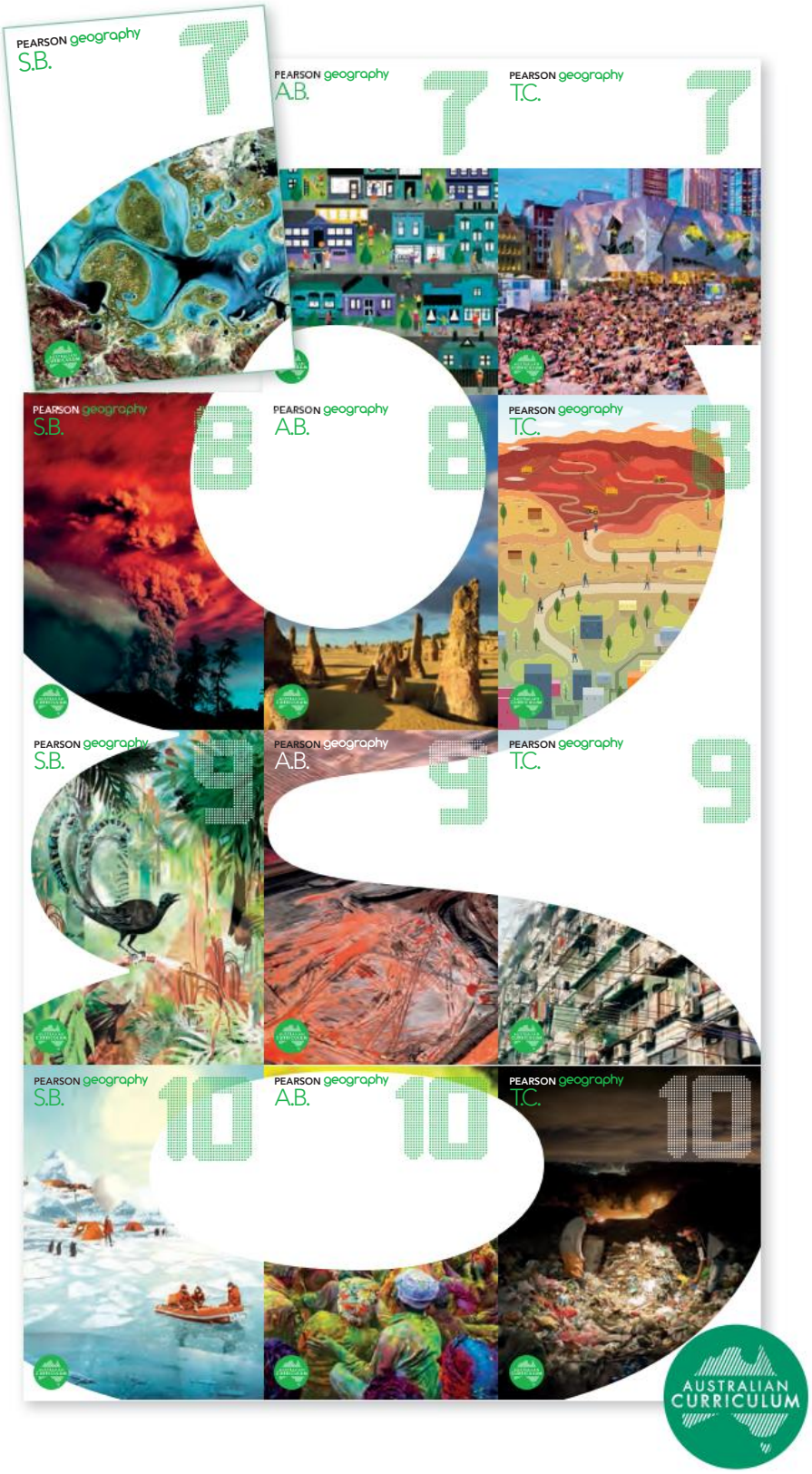
11.1 Methods of enhancing liveability 270
11.2 Taking action 272
11.3 Liveability and disability 274
11.4 Better cities 276
11.5 Better shopping centres 280
11.6 Better recreational spaces and schools 282
11.7 Case study: Manchester, United Kingdom 286
11.8 Geoskills: Using ABS data to compare communities 290
11.9 Comparing communities and neighbourhoods 292
11.10 In the field: Investigating neighbourhoods 294
11.11 Case study: Australia's 'big' towns 298

Review and reflect 3 300

Index 302

Acknowledgements 311

PEARSON geography



Built from the ground up

Pearson Geography has been created from the ground up for the Australian Curriculum: Geography, Years 7–10. It has been written and reviewed by a team of over 20 trained and qualified geography teachers from across Australia, ensuring its currency to teach students in the 21st century.

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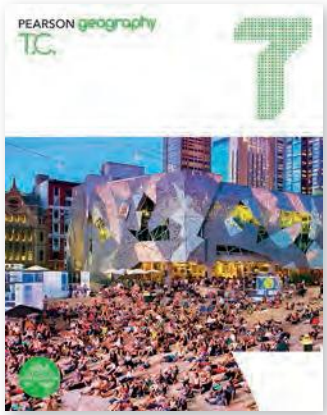
Written specifically to meet the requirements of the Australian Curriculum: Geography, the Student Book acts as a guide for both students and teachers.

Full-colour presentation and contemporary design make the Student Book engaging and accessible for all students.



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The Activity Book is a write-in resource designed to reinforce, enrich and extend the students' learning experience. The book can be used as an independent homework program or for individual classroom learning.



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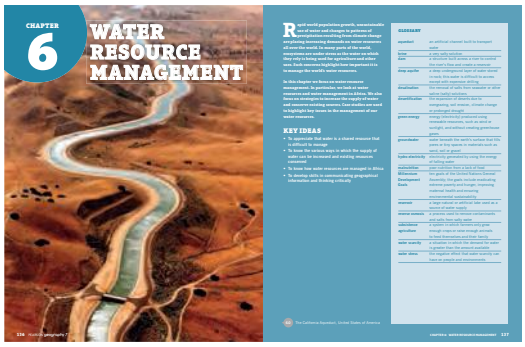
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How to use this book

Pearson Geography has been designed for the Australia Curriculum: Geography course. It includes content and activities that enhance the development of the Year 7 achievement standards within the two interrelated strands of Geographical Knowledge and Understanding and Geographical Inquiry and Skills.

Pearson Geography units are either two or four pages in length, designed to be completed in a lesson. Content is presented through a range of contexts to engage students and assist them. Pearson Geography has an engaging design; and it uses clear easy-to-understand language makes this a valuable resource for students of all interests and abilities.

Chapter opener



The chapter opener image is designed to engage students and provide a visual stimulus to the chapter themes. Also included is an introduction to the chapter and Key Ideas that link the chapter to the Australian Curriculum: Geography. A glossary that provides a ready reference for students to the key concepts and terms in the chapter.

Units

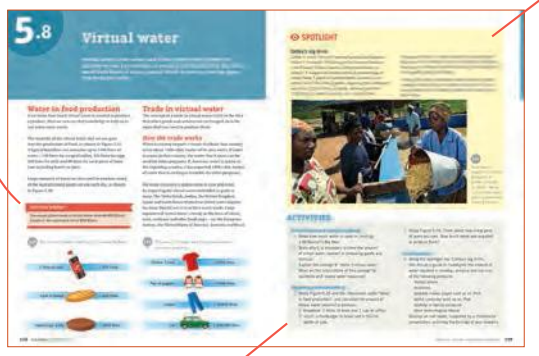
Each chapter of the Student Book is divided into units. Units have been written to develop students' knowledge and understanding of the concepts, skills and processes central to the study of Geography at this level. Unit are written to ensure both strands—'Knowledge and Understanding' and 'Inquiry and Skills' are interrelated as specified by the of the Australian Curriculum: Geography.

Did you know?

Throughout the Student Book, these boxes give additional information and are designed to engage curious learners.

Spotlight

These features focus attention on a place, an issue or a concept relating to the unit.



Skills builder

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

Activity Book link

Use this icon to access an Activity Book worksheet that will consolidate and extend students' learning.

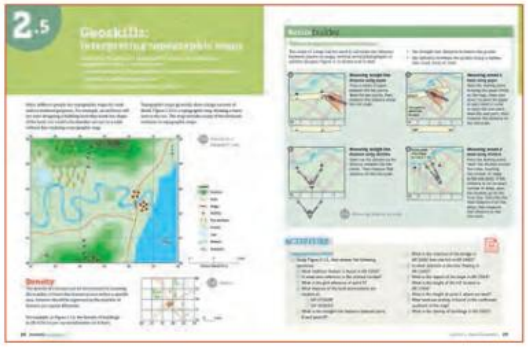


Activities

Each unit ends with a set of activities under selected headings from Bloom's Taxonomy of Cognitive Processes.

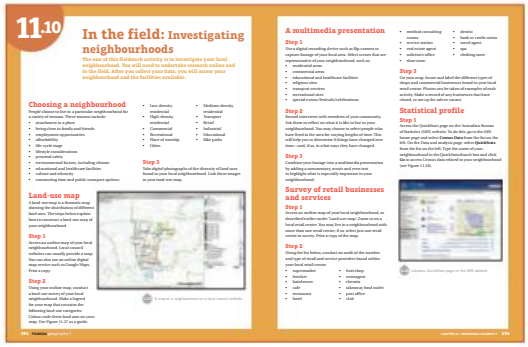
The activities include questions that guide students towards an understanding of the material covered and will extend them in a variety of learning experiences. The activities have been carefully selected to cater for the full range of students. The activities provide an opportunity for students to engage with important geographical issues from a range of perspectives.

Geoskills



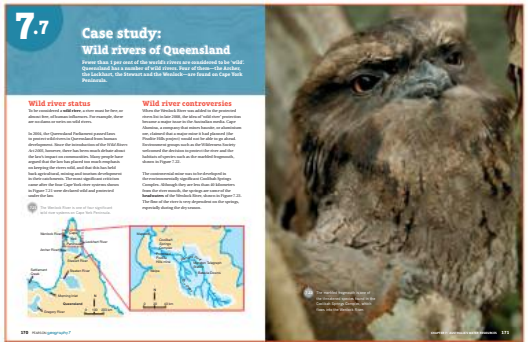
Geoskills units are designed to improve students' geographical skills: mapping, graphing, interpreting satellite images and using ABS data online. These skills relate to the Australian Curriculum: Geography Inquiry and Skills strand.

In the field



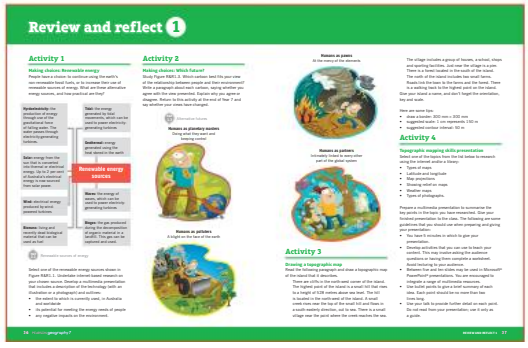
'In the field' units provide a step-by-step guide to undertaking and evaluating fieldwork. 'In the field' units have been written as a guide and are not tied to a specific location. Depending on the fieldwork task, some 'In the field' units can be conducted within school grounds.

Case studies



Case study units relate to a specific event or location. The units are written to extend students' knowledge and understanding. Case studies include examples from around Australia and world examples as specified in the Australian Curriculum: Geography.

Review and reflect



At the end of each of the three sections of the Student Book, a 'Review and Reflect' enables students to revise the key concepts and skills developed the text and complete higher order tasks. Students are encouraged to reflect on their own learning—to challenge their existing thinking and to refine their values and attitudes.

Directive terms

The following directive terms, grouped in a manner consistent with Bloom's Taxonomy, help you to identify the level or type of response required for a question or activity and provide a common language and consistent meaning in Australian Curriculum documents.

Remembering	
Define	State meaning and identify essential qualities
Label	Add annotations to a diagram or drawing
List	Write
Name	Present remembered ideas, facts and experiences
Present	Provide information for consideration
Recall	Present remembered ideas, facts and experiences
Specify	State in detail
State	Provide information without further explanation
Understanding	
Account	Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions
Calculate	Ascertain/determine from given facts, figures or information
Clarify	Make clear or plain
Construct	Make; build; put together items or arguments
Describe	Provide characteristics and features
Determine	Find out the size or extent by measuring, counting or estimating
Discuss	Identify issues and provide points for and/or against
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Gather	Collect items from different sources
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example, a point of view, idea, argument, suggestion) for consideration or action
Rank	Place in order of size, age or as instructed
Recount	Retell a series of events
Summarise	Express, concisely, the relevant details

Applying	
Apply	Use, utilise, employ in a particular situation
Calculate	Ascertain/determine from given facts, figures or information
Demonstrate	Show by example
Examine	Inquire into
Identify	Recognise and name
Analysing	
Analyse	Identify components and the relationship between them; draw out and relate implications
Classify	Arrange or include in classes/categories
Compare	Show how things are similar or different
Contrast	Show how things are different or opposite
Critically analyse/evaluate	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to analysis/evaluation
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note/indicate as being distinct or different from; note differences between
Interpret	Draw meaning from
Evaluating	
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Conclude	Come to a judgement or result based on the reasoning or arguments that you present
Critically analyse/evaluate	Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to analysis/evaluation
Deduce	Draw conclusions
Evaluate	Make a judgement based on criteria; determine the value of
Extrapolate	Infer from what is known
Justify	Support an argument or conclusion
Predict	Suggest what may happen based on available information
Propose	Put forward (for example, a point of view, idea, argument, suggestion) for consideration or action
Recommend	Provide reasons in favour
Select	Select one or more items, features or objects
Creating	
Construct	Make; build; put together items or arguments
Investigate	Plan, inquire into and draw conclusions about
Synthesise	Put together various elements to make a whole

CHAPTER

1

GEOGRAPHY: IT'S ALL AROUND US



Geography is the study of the places that make up our world. It is the subject that answers our questions about why these places have their own special or unique environmental and human characteristics. It explains how and why these characteristics vary from place to place, the ways places are connected and interact, and how and why they are changing.

In this chapter you will learn about the nature and role of Geography; be introduced to the key concepts on which Geography is based; and learn about the elements of the earth's natural, managed and constructed environments. You will also examine what geographers mean by environmental resources, communities and neighbourhoods.

KEY IDEAS

- To be able to investigate the world using geographical tools and skills
- To develop the knowledge and skills needed to build a better world for all through active and informed global citizenship

GLOSSARY

biophysical environment	those environments that are dominated by natural features such as landforms and vegetation; includes the earth's soil, water, air, sunlight and all living things
change	a transformation brought about by environmental, economic, political, social and/or cultural factors
community	a group of people who share a particular space (location), have a shared interest or share a particular form of social organisation
constructed environment	the earth's human-altered landscapes. It includes all those features that are normally associated with settlements, industries and agriculture.
continuous resource	a renewable resource, the availability of which is not affected by human activity; for example, the energy of the sun
environment	our total surroundings, including the living and non-living features of the earth's surface and atmosphere as well as those features that are altered or created by people
Geography	a structured way of exploring, analysing and understanding the characteristics of the places that make up our world
managed environment	environments in which elements of the natural environment are changed for the benefit of humans—for example, farmland or a planted forest
natural resource	anything in the natural environment that people use
neighbourhood	a geographically defined space or area within a larger city, town or suburb
non-renewable resource	a resource that cannot be replaced once it has been used
perspective	a way of viewing the world
renewable resource	a resource that, if it is used sustainably, can be exploited or used again and again; includes fresh water and air, forests and the earth's fisheries
scale	the relationship between the size of an object in a photograph and its real size
sustainably	using the earth's resources in ways that meet the needs of the present generation without affecting the ability of future generations to meet their needs

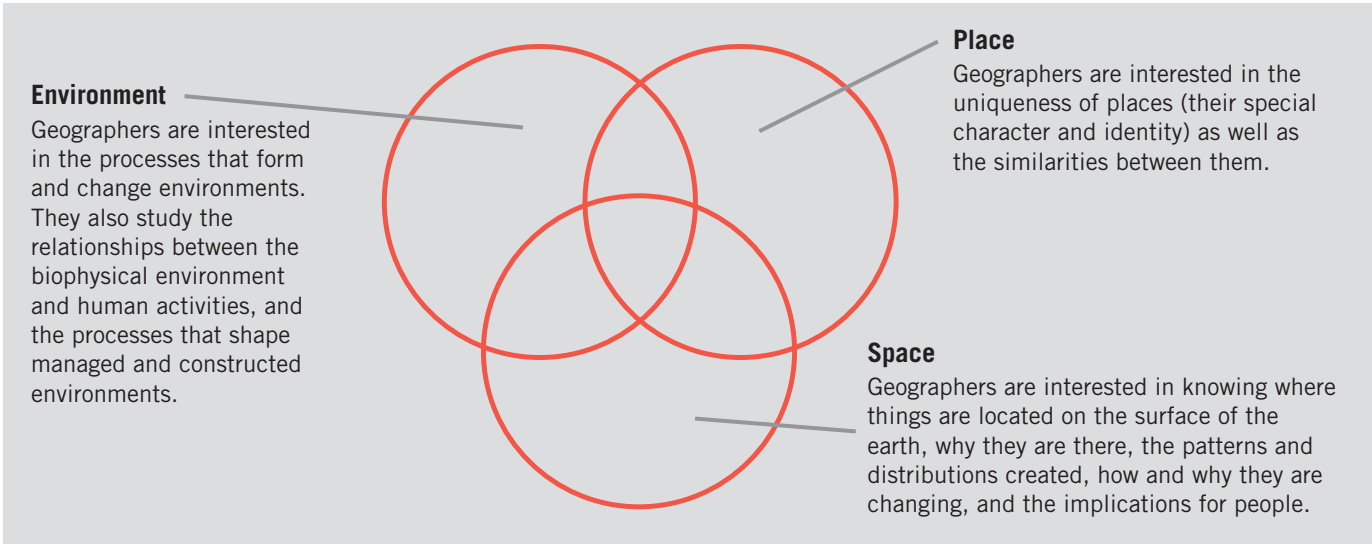
1.0 Earth viewed from space, directly above Africa, 26 May 2012

1.1 What is Geography?

Geography is the study of the characteristics of the places that make up our world. Geography is concerned with the processes that shape the earth's surface and the ways in which people interact with environments. It seeks to explain the character of places and the distribution (spread) of people, features and events on or near the earth's surface.

Geography dimensions

There are three dimensions in **Geography**: place, space and environment. All three dimensions interact, as shown in Figure 1.1.



1.1 Geography's dimensions are where place, space and environment all interact.

Defining environment

The term **environment** is defined as our living and non-living surroundings. We usually refer to environments as being either natural, managed or constructed. We use the term **biophysical environment** to identify an environment dominated by natural features such as landforms and vegetation—for example, Jim Jim Falls in Figure 1.2. It is important to note, however, that there are no longer any purely 'natural' environments—all environments have been **changed** or altered by human activities. For this reason we use the term 'biophysical environment' rather than 'natural environment'.

Managed environments are those in which elements of the natural environment are manipulated for the benefit of humans—for example, farmland or a planted forest.

We use the term **constructed environment** when we refer to those elements of the environment that people have created.

By studying Geography, we learn about:

- our changing world
- our place in the world
- the big issues facing humanity
- the impacts that our actions have on the world.

By studying Geography, we are able to:

- lead more enriched lives
- become effective guardians of our future world
- think spatially
- develop a range of skills demanded by employers.



1.2 Jim Jim Falls, Kakadu National Park, Northern Territory—an example of a biophysical environment

Physical and Human Geography

Geography has traditionally been divided into two areas, Physical Geography and Human Geography

Physical Geography looks at how the earth was formed and how it continues to change. It includes the study of the atmosphere, hydrosphere, lithosphere and biosphere—the four parts of the biophysical environment.

Human Geography looks at people and how, individually or in groups or **communities**, they interact with the environment. It includes:

- the study of urban, industrial and rural land uses
- the development of countries
- population and population movements
- how economic changes affect people
- issues such as global terrorism, human rights, global inequality, child labour and social justice.

ACTIVITIES

1.1

Knowledge and understanding

1 Define Geography.

2 Explain why the term 'biophysical environment' is used in preference to 'natural environment'.

Applying and analysing

3 Distinguish between the biophysical, managed and constructed environments.

4 Collect two images of each of the biophysical, managed and constructed environments and present the images as an annotated collage.

5 a Create a Venn diagram consisting of two intersecting circles. Label one circle with the heading 'Physical Geography' and the other circle with the heading 'Human Geography'.

b Place each of the following topics in the correct circle. You may find that some topics fit into more than one category.

- i volcanic activity
- ii land-use changes in cities
- iii whale migrations
- iv land-use change over time
- v the distribution of HIV/AIDS
- vi how to draw maps
- vii plants and animals in rainforests
- viii a hailstorm
- ix life on the ocean floor
- x agricultural land use in Bali
- xi how rivers shape the land
- xii changing job opportunities

1.2 Why we study Geography

Geography is important because it answers your questions about why places have particular environmental and human characteristics; how and why these characteristics vary from place to place; how places are connected; and how and why they are changing.

Studying Geography

Studying Geography will help you to:

- make sense of a complex and rapidly changing world
- see yourself as part of a wider global community
- understand how your individual actions can impact on the environment
- become informed about important social and environmental issues
- understand that people can have different points of view or **perspectives**
- become active and informed citizens
- develop knowledge and skills that will help you to get a job
- use your leisure time well
- better appreciate the beauty and wonder of the world around you.

The work of geographers

When investigating the character of places, geographers examine the ways in which people interact with each other and with the biophysical environment. As they go about their work, they create and record new knowledge.

The questions geographers ask

When studying places and environments, geographers ask these questions:

- What is it?
- Where is it?
- Why is it there?
- How did it get there?
- How is it changing?
- How do people affect it?
- How does it affect people?
- Should it be like this?
- What may it be like in the future?
- What action is appropriate?

1.3 Fieldwork is usually used to gather data that answers specific questions.

Figure 1.3 shows geographers in action in the field and some of the questions they might be investigating.



SPOTLIGHT

Exploring new frontiers

Humans have explored the earth's frontiers for thousands of years. Explorers such as Marco Polo, Christopher Columbus, Ferdinand Magellan, Vasco da Gama, Leif Eriksson, Hernán Cortés, Sir Francis Drake, James Cook and David Livingstone expanded our knowledge of the world, discovering new lands and peoples. Adventurers such as Douglas Mawson, Robert Scott, Roald Amundsen and Ernest Shackleton sought to test the limits of human endurance by exploring one of the earth's most extreme environments, the Antarctic. Others, such as Sir Edmund Hillary, Junko Tabei and Jacques Cousteau, have scaled the planet's highest peaks and explored its oceans' depths.

Beginning in the 1960s, pioneers such as Yuri Gagarin, Valentina Tereshkova, Alan Shepard, John Glenn and Neil Armstrong explored the new frontiers of space. Today, we send uncrewed spacecraft into space to further expand our knowledge of the universe. The quest to discover and explore the unknown remains one of humanity's defining characteristics. It is also this quality that makes Geography such an interesting subject.

This sense of adventure continues to inspire people. Adelaide-born explorer Duncan Chessell (see Figure 1.4) was inspired by his study of Geography in high school. By the age of 36, he had scaled the highest mountain on each of the earth's seven continents. Today, Chessell runs his own mineral exploration company.

1.4 Duncan Chessell



ACTIVITIES

Knowledge and understanding

1. Outline why it is important to study Geography.
2. Explain what is meant by the term 'perspective'.
3. Describe what geographers do.

Applying and analysing

4. **a** Identify the groups that might have an interest in a local issue such as access to a local beach and its dune system or the construction of a skating park in your neighbourhood.
   b Compile a list of the points of view that might be typical of each group.
   c Share your group's findings with the rest of the class.
   d Draw your own cartoon to illustrate some of the perspectives identified in this activity.

1.3 Types of environments

In Geography, the word 'environment' is used to describe our total surroundings. The environment includes the living and non-living features of the earth's surface and its atmosphere, as well as those features that have been altered or created by people. Geographers divide environments into three kinds: biophysical environments, managed environments and constructed (or built) environments.

Biophysical

Biophysical environments are those dominated by natural features such as landforms and vegetation. The natural environment includes the earth's soil, water, air, sunlight and all living things. These are often referred to as the elements of the biophysical environment (see Figure 1.5). It is important to note that there are no truly 'natural' environments. All environments have, to some extent, been altered by the activities of people.

a



Solar energy: the energy (light and heat) produced by the sun. All life on earth depends on solar energy.

b



Lithosphere: the earth's solid outer shell. Geographers study the processes shaping the earth's crust, and how these processes affect people.

c



Hydrosphere: the earth's store of water and how it circulates. Geographers are interested in how people try to control and manage water resources to meet their needs.

Elements of the biophysical environment

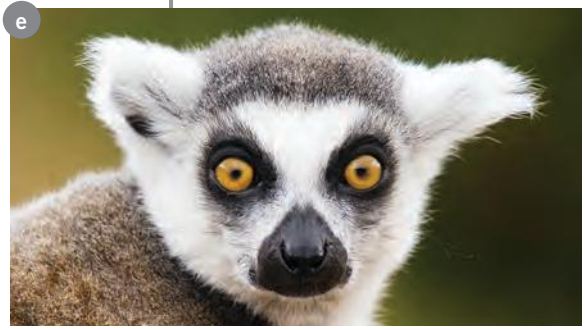
d



Atmosphere: the combination of gases surrounding the planet. Geographers are particularly interested in weather and climate. They investigate:

- how climate affects people, plants and animals
- how the activities of people affect climate.

e



Biosphere: the surface zone of the earth, in which all life exists. Geographers are particularly interested in how living things interact with each other and with the non-living parts of the environment.

1.5 Elements of the biophysical environment

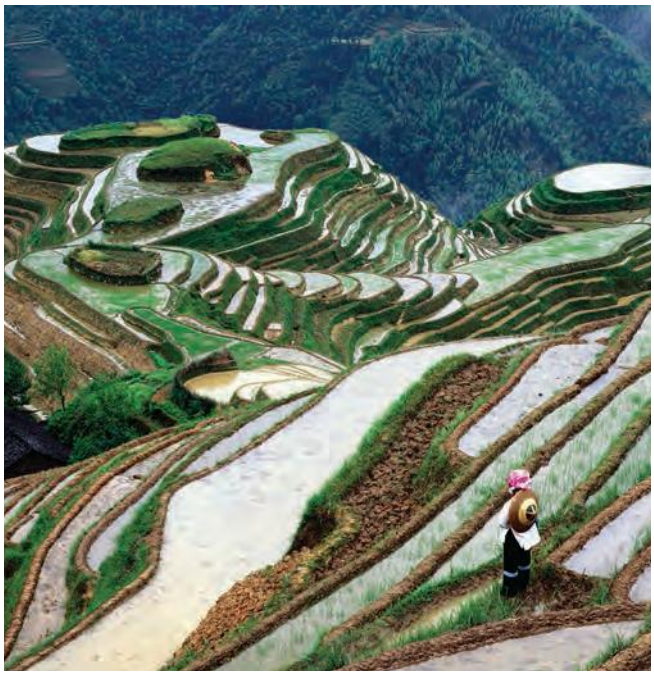
Managed

The managed environment includes human-altered landscapes dominated by elements of the natural environment. Examples are crop and grazing lands (see Figure 1.6), plantations and planted forests.

Constructed

The constructed (or built) environment is best defined as those features of the environment that have been created by people. These include all the features normally associated with settlements, industries and agriculture. Features of the built environment include buildings and transport infrastructure (for example, roads, railways, airports). The managed and constructed environments are a product of the social, cultural, economic and political systems created by humans (see Figure 1.7).

It is important to note that the biophysical, managed and constructed environments always interact. The biophysical environment is affected by the activities of people, and the managed and constructed environments are affected by events within the biophysical environment.



1.6 Terraced rice paddies are an example of a managed environment.

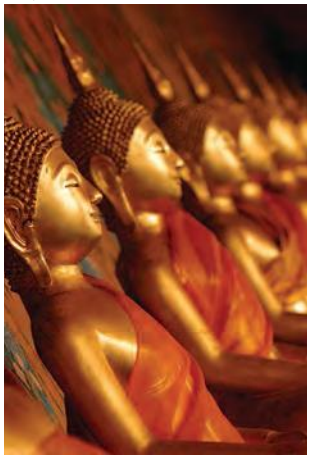
1.7 Elements shaping constructed environments



a Social



b Economic



c Cultural



d Political

ACTIVITIES

1.2

Knowledge and understanding

1. Define each of the following terms: environment, biophysical environment, managed environment and constructed environment.
2. List the elements shaping the constructed environment.
3. Identify the elements of the biophysical environment and explain what each one is.

Applying and analysing

4. Write down as many features of the biophysical environment as you can think of.
5. Describe how you interact with the biophysical environment, the managed environment and the constructed environment in an average day.
6. Write a paragraph describing how your local area might have looked before people settled there. Write a second paragraph describing how people have transformed or changed the area.

1.4 Natural resources

A natural resource is anything in the biophysical environment that people use. Humans cannot make these resources; instead, they gather them from the earth. Examples of natural resources include the earth's air, wind, water, forests, plants and animals; the sun's energy; mineral ores such as iron ore; and fossil-based fuels such as crude oil, coal and natural gas.

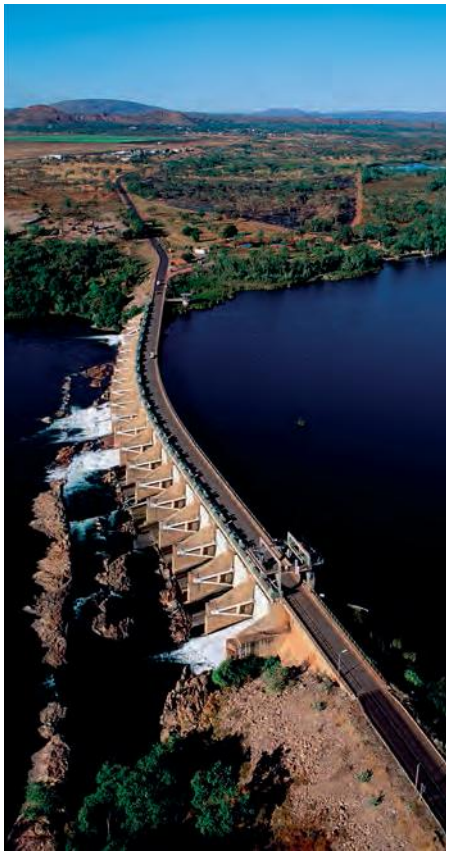
1.8 Natural resources, classified by type

Natural resources

Renewable
- **Fresh air**
- **Fresh water**
- **Fertile soil**
- **Plants and animals** (biodiversity)

Non-renewable
- **Fossil fuels** (coal, oil, natural gas)

Continuous
- **Direct solar energy**
- **Winds, tides, flowing water**
- **Heat of the earth's interior** (geothermal energy)



1.9 The Ord River Dam and Lake Argyle, Western Australia



1.10 A giant open-cut coal mine in the Bowen Basin, Queensland



1.11 Steam and mud in Krisuvik geothermal fields, Iceland

Types of natural resources

We often classify **natural resources** as being either renewable, non-renewable or continuous, as shown in Figure 1.8.

A **renewable resource** can be exploited or used again and again as long as it is managed **sustainably**. Examples include fresh water and air, forests and the earth's fisheries (see Figure 1.9).

A **non-renewable resource** is a resource that cannot be replaced once it has been used. When coal is mined, as in Figure 1.10, then burnt for electricity and energy, we reduce the amount available for future use. It cannot be replaced. Non-renewable resources cannot be recycled.

A **continuous resource** is a renewable resource whose availability is not affected by human activity. Examples of continuous resources are solar energy, the winds and tides, and the heat generated by the earth's interior. Each of these can be used to generate power without reducing the amount of the resource that is available for future generations.

For many non-renewable resources there are renewable or continuous resources that could be used instead. For example, alternatives to coal-fired electricity production include solar, wind, tidal and geothermal power (power generated by harnessing the earth's internal heat, as shown in Figure 1.11.

Because the supply of non-renewable resources is limited, they need to be conserved. The conservation of resources involves managing them carefully to maximise the benefits for present and future generations while also protecting the environment. Renewable resources should be managed in ways that allow the resource to be used forever. As Figure 1.12 suggests, this is not always what happens. Forests, for example, should not be exploited for their timber at a rate faster than the trees can regrow.

Resource distribution

Some natural resources (for example, air) are found everywhere, while others (for example, mineral ores, oil and coal) are found only in specific locations. In other words, they are unevenly distributed across the earth's surface.

When people do not have access to a natural resource that they need, they can either use an alternative resource, or trade with other people—often, in another country—to get the resource. Some natural resources are more common than others. The rarer the resource, the more it tends to cost.



1.12 Robbing from future generations

ACTIVITIES

1.3

Knowledge and understanding

1 Define what we mean by the term 'natural resource'.
2 Explain the difference between renewable, non-renewable and continuous resources.
3 Identify two outcomes of the uneven distribution of the earth's natural resources.

Applying and analysing

4 a In pairs, brainstorm and list some strategies for reducing your school's use of non-renewable resources.
  b Share your ideas with the class.
5 Study Figure 1.12.
  a Write down the idea that the cartoonist is trying to communicate in this cartoon.
  b Do you agree with the cartoonist? Explain.
  c What is an alternative viewpoint to that of the cartoonist?

1.5 Geoskills: Photographs

Photographs are very important to geographers. A photo of an area of the earth can give a geographer an idea of what the area looks like without the need to visit it. Photographs record a landscape as it exists at a particular time; they can be used to record fieldwork observations.

Types of photographs

Geographers group photographs in three different categories, as Figures 1.13–1.15 show: ground-level, oblique and vertical.

1.13 A ground-level photograph of part of Serengeti National Park, Tanzania



Ground-level photographs are taken from the ground. Features in the foreground will appear larger than those in the background. Large objects in the foreground may block out features in the middle and background.

1.14 A vertical photograph of Tokyo, Japan



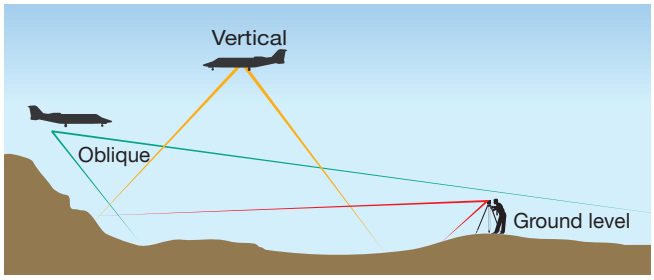
Vertical photographs are taken from above the ground with the camera lens pointed directly down on the area being photographed. Features across the photograph will not be distorted, although it will be hard to estimate their height.

1.15 An oblique photograph of Dubrovnik, Croatia



Oblique photographs are similar to ground-level photographs in that features in the background will appear smaller than those in the foreground. Unlike ground-level photographs, oblique photographs are taken from above the ground. Often a horizon cannot be seen. The camera is pointed at an oblique (slanted) angle to the ground.

1.16 Taking ground-level, oblique and vertical photographs



Interpreting photographs

When interpreting photographs, look for:

- the main features being shown
- relevant information given with the photograph, such as a caption or written information
- evidence of location and time
- clues to **scale** and living conditions
- features that seem out of place, as they may warrant further reading or investigation.

Skillsbuilder

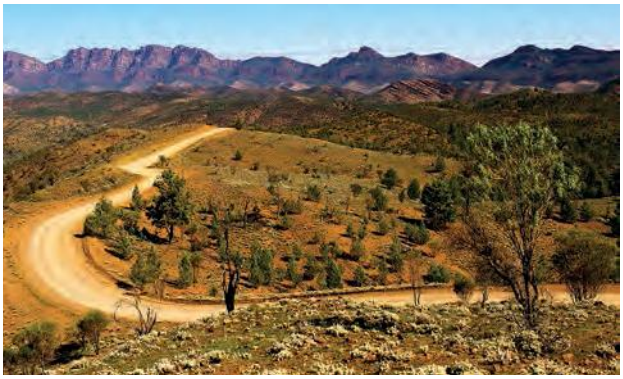
Photo sketching

Being able to sketch from photographs allows you to make a quick summary of the information shown in an image, and to highlight and/or annotate the key elements of the feature or place photographed. Photo sketches can be used to illustrate reports and displays.

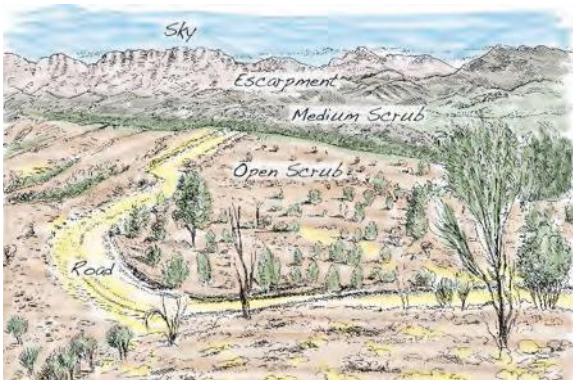
Use a soft pencil on blank paper. A photo sketch should not reproduce everything in the photograph. Pick out the main features of the photograph, and sketch in their shape. Include the features you want to highlight. Always place your sketch within a frame that is in the same proportions as the original photograph. Annotate your sketch to point out the main features, or to indicate a changing feature or some important link between features.

For ground-level photographs it may be useful to divide your photograph into three areas: foreground, middle ground and background. Before you begin sketching, lightly pencil these three areas into your frame. The features of each area can then be sketched in. Begin with the background, followed by the middle ground and then the foreground.

Ground-level photo sketches can be annotated or coloured to highlight particular features. You can see both of these techniques in Figure 1.18, which is a sketch from Figure 1.17.



1.17 A ground-level photograph of the Flinders Ranges, South Australia



1.18 A sketch of Figure 1.17

ACTIVITIES

1.4

Knowledge and understanding

1 Explain why photographs are important to geographers.

2 State how ground-level photographs differ from oblique photographs.

Applying and analysing

3 Study Figures 1.13–1.15, then answer the following questions.

- **a** Which type of photograph:
  - **i** shows excellent detail about the foreground
  - **ii** eliminates any distortion to the shape of an area covered by features
  - **iii** best shows the shape of the landscape?
- **b** Which type of photograph would be most suitable for showing:
  - **i** a plan view of your school
  - **ii** a crowded shopping centre
  - **iii** areas affected by flooding
  - **iv** the height of a new building?

4 Study Figures 1.13 and 1.15. Compare the two locations by interpreting the photos.

Geographical skills

5 Study Figure 1.15, then complete the following tasks.

- **a** Construct a photo sketch of the image. Label Dubrovnik's harbour, marina and fort.
- **b** Describe the site of Dubrovnik.

1.6 Communities and neighbourhoods

Geographers frequently use the terms 'community' and 'neighbourhood'. What do these terms mean?

Communities

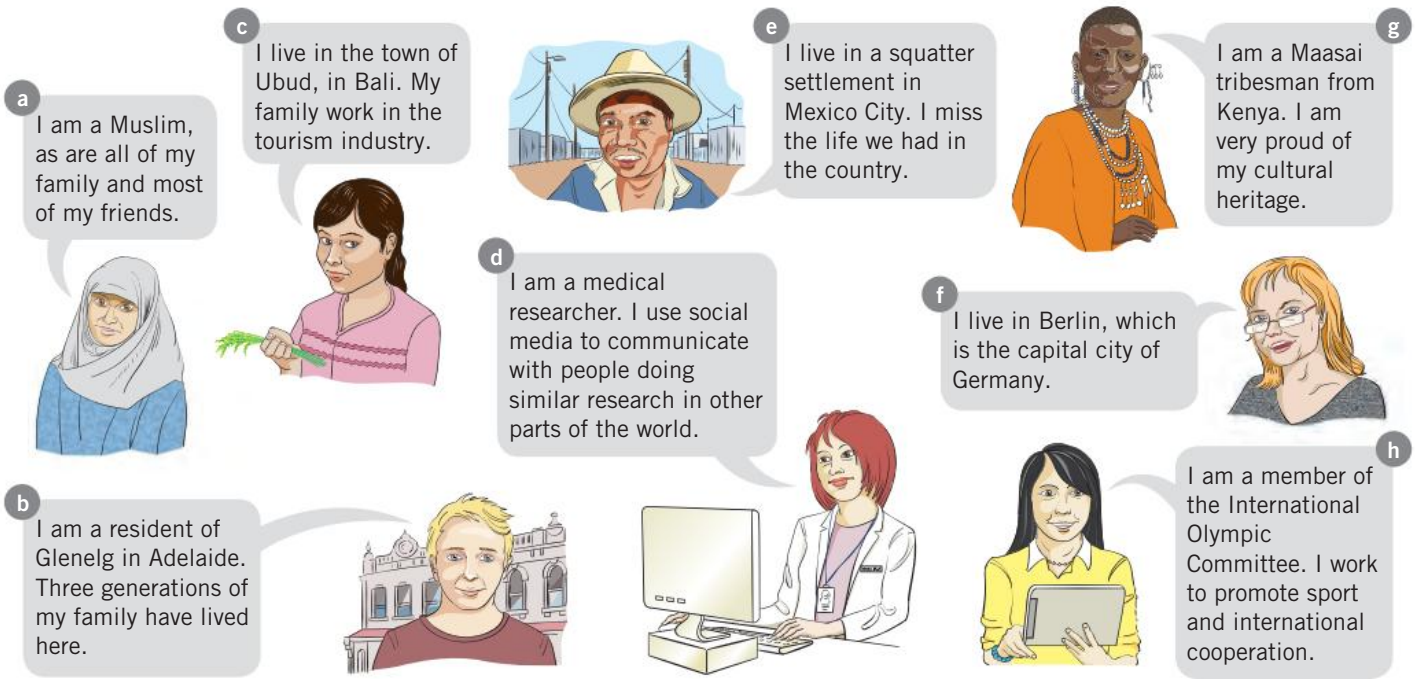
When we study the biophysical environment, we often talk about a 'community of plants and animals'. This refers to a group of plants and animals that interact with each other and with their environment. Many such communities are confined to particular locations. A tropical rainforest community, for example, is only found in those parts of the world that are both hot and wet.

When we focus on people, the term 'community' becomes more complex. Sometimes a community is made up of people who share the same space; for example, people who live in the same neighbourhood, town or village. Other communities are made up of people who belong to the same sporting club; have similar interests; belong to a particular profession, political party or interest group; speak the same language or follow the same religion. Examples are illustrated in Figure 1.19.

Technological advances in communications, such as the internet and email, allow communities to interact across the globe. Members of these communities have links beyond a particular location. Their 'sense of community' is a product of their shared social organisation or interests. For example, environmental activists, who share a common set of concerns about the future wellbeing of the planet, can share ideas and strategies using websites, blogs and Twitter.

Some people believe that social networking websites such as Facebook are the true communities of the twenty-first century. They are a very popular and powerful way for people to interact and voice opinions.

1.19 Different types of communities





1.20 Fremantle, Western Australia, is an example of a neighbourhood that is known for its historic buildings and entertainment facilities. Here, crowds enjoy the annual Fremantle Festival.

Neighbourhoods

A **neighbourhood** is a space or area within a larger city, town or suburb. Within neighbourhoods, there is often face-to-face interaction between community members—for example, at the Fremantle Festival in Figure 1.20.

Neighbourhoods develop a 'character' that makes them special and different from other neighbourhoods. Often this character comes from factors such as:

- socio-economic status (levels of income, education and occupation)
- ethnicity (some neighbourhoods become closely identified with a particular ethnic group)
- social characteristics (for example, areas in which students live)
- demography (for example, neighbourhoods dominated by retirees or young families)
- function (for example, entertainment or artistic neighbourhoods)
- architectural character (for example, historic neighbourhoods and those dominated by a particular type of housing, such as low-density suburban neighbourhoods and medium- and high-density urban areas).

ACTIVITIES

Knowledge and understanding

1 Define what is meant by the term 'community' when we are talking about the biophysical environment.

2 Explain the difference between communities based on shared space and those based on shared social organisation.

3 Outline what a neighbourhood is.

Applying and analysing

4 Study the speech bubbles in Figure 1.19, then answer the following questions.

a What type of community does each person belong to:
- an ethnic community
- an indigenous community
- a sporting community
- a religious community
- a community based on an interest, activity or profession?

b What might the members of each community have in common?

c Is each community based on shared space or shared social organisation?

5 Describe the character of your school neighbourhood using the list of factors in the section 'Neighbourhoods'.

1.7 Contemporary issues in Geography

As responsible citizens, we need to be aware of current events. As this awareness develops, we become better placed to understand the ever-changing nature of the world in which we live, form opinions and develop as global citizens.

Contemporary issues

The study of Geography covers many contemporary issues. Contemporary issues such as those shown in Figure 1.21 are discussed and widely debated in the community because their impacts will be felt in our lifetime and beyond. There are often many different views and opinions about contemporary issues. Examples of contemporary issues include:

- 'Should mining be permitted in Antarctica?'
- 'Should water restrictions be made permanent in Australian cities?'
- 'How do country towns encourage people to stay and not move to bigger towns or cities?'

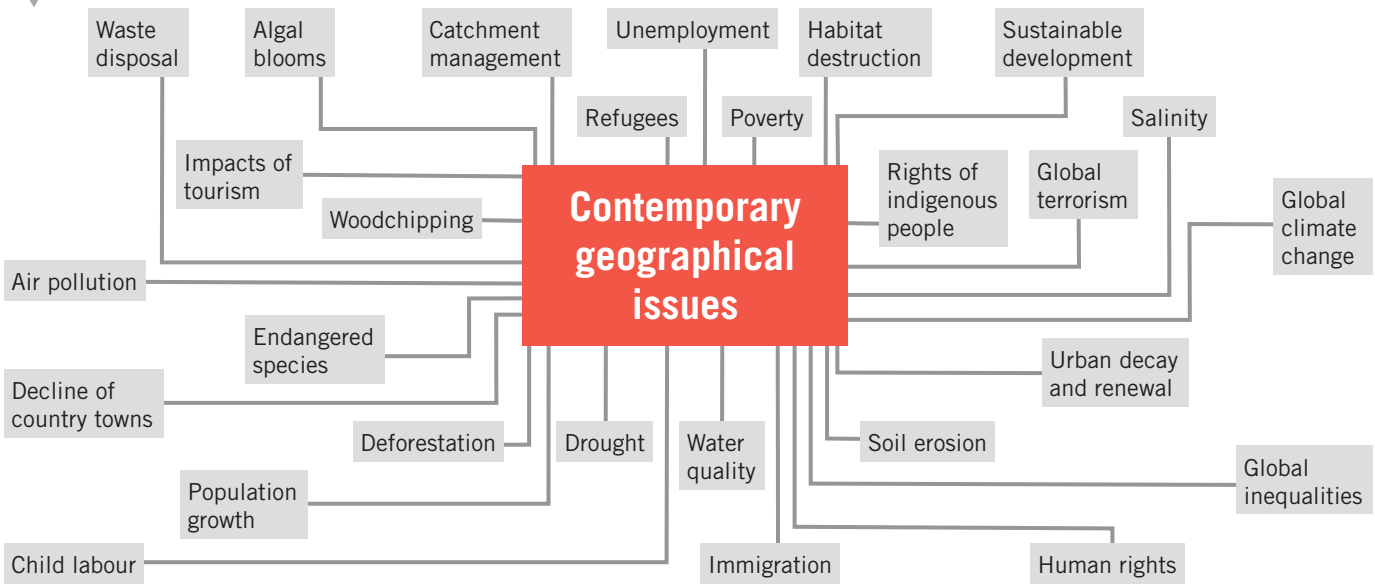
Geography gives us a way of investigating and understanding these contemporary issues. This is one of the most important benefits of studying Geography.

Geographical issues have a spatial dimension. This means that they occur in a particular context, and at a particular time. A geographical issue might, for example, be a local community-based issue (such as a proposal to clear a small area of bushland) that is a focus of people's attention for just a short period of time, or an environmental issue that affects the whole planet and that may be of concern for generations.

People often have different perspectives or points of view on the best way to use resources or manage the environment. Sometimes, people may disagree on how best to address such issues. Disagreement is often healthy, provided we respect the rights of others to express their views even though we might not necessarily agree with them. Being able to identify and evaluate such points of view greatly enhances our own decision-making processes.

Any conclusion drawn about an issue must be based on a sound knowledge and understanding of the process and forces involved.

1.21 A mind map of contemporary geographical issues



Skillsbuilder

Contemporary issues: Research scaffold

When investigating a contemporary issue—for example, 'Should Japan to be permitted to hunt whales in Antarctica?'—you may find it useful to take the following steps to help you develop your knowledge and understanding of the issue.

1. Read or view the material dealing with the issue.
2. Name and briefly outline the issue.
3. Identify the main people and/or organisations involved in the issue.
4. Identify the scale at which the issue is relevant. Is it a global, national, regional or local issue?
5. Describe or map the relevant area.
6. Explain why the issue is of interest to geographers.
7. List the main sources of information about the issue.
8. State whether the sources used present different points of view about the issue.
9. State whether the sources of your information are reliable.
10. Outline the actions people could take to address the issue (as in Figure 1.22). What would be the likely outcome?
11. Consider how the media have influenced your study of the issue.
12. Explain how the study of the issue has affected your own views on the issue.
13. Say what actions you would personally take to address the issue.



1.22 Sea Shepherd anti-whaling protests have proved successful in frustrating the activities of Japanese whaling ships.

ACTIVITIES

1.5

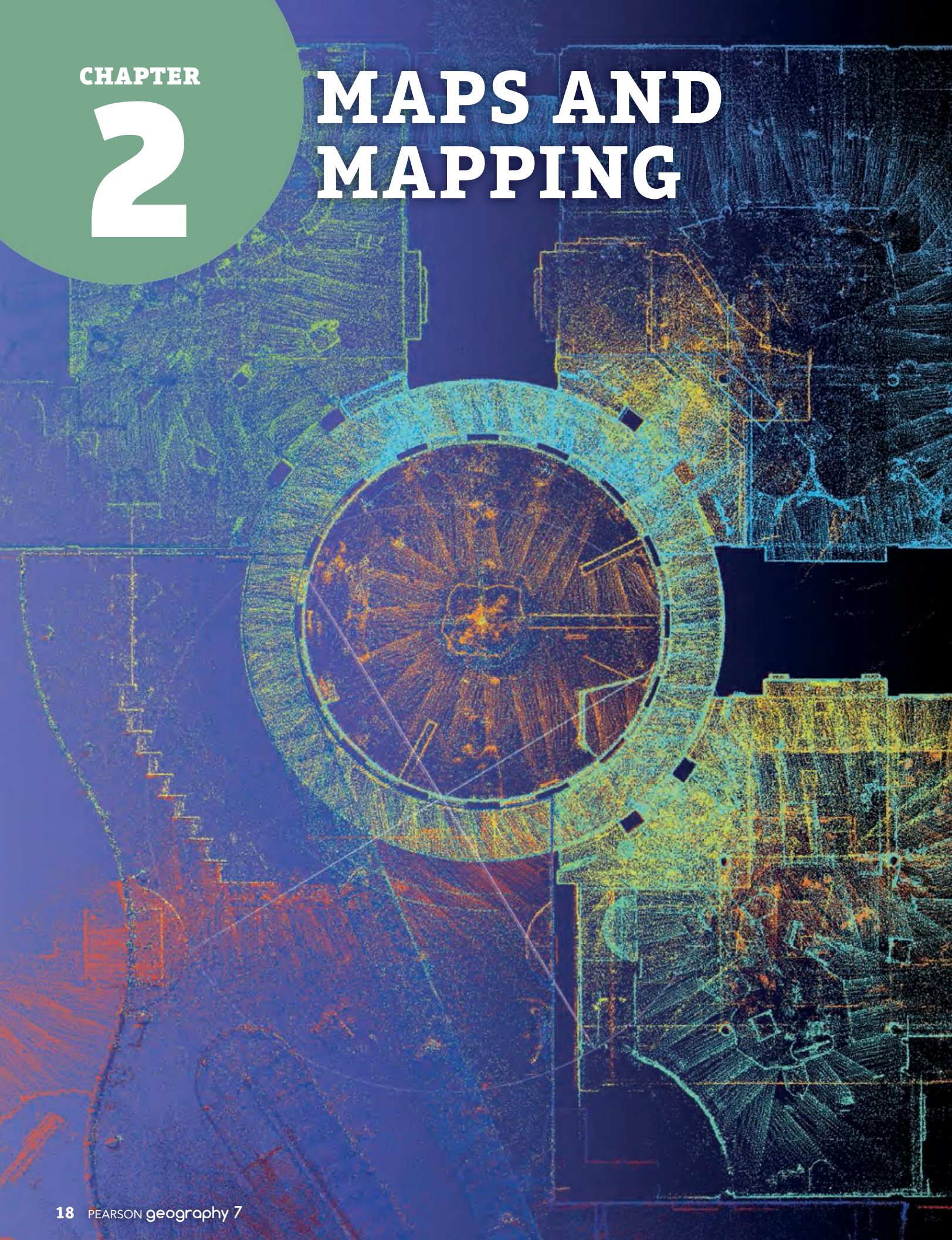
Knowledge and understanding

1. Explain what we mean by a 'contemporary issue'.
2. Choose a contemporary issue (or see Figure 1.21 for ideas) and collect material from the media and other sources dealing with the issue. Using the approach in the Skills builder box, 'Contemporary issues: Research scaffold', prepare a presentation on the issue. Use one of the following formats: a three-minute oral report, a multimedia presentation of four slides, a three-page written report, a poster, a video, a three-minute audio recording or a wall display.

CHAPTER

2

MAPS AND MAPPING



Geographers use many different tools and skills to investigate the world in which we live. Maps are among the most important of these tools.

A map is a representation of the whole, or a part, of the earth's surface. Increasingly, maps are stored in electronic form and can be read on computer monitors, mobile phone screens and in-car navigation systems. The people who make maps are called cartographers.

In this chapter we learn about topographic maps and atlas maps, and their principal elements: latitude and longitude, grid references and area references.

KEY IDEAS

- To know the various types of maps and the conventions used in their construction
- To know the elements of maps
- To understand scale
- To master the skills involved in using topographic maps and atlas maps

GLOSSARY

aspect	the direction that a slope faces
cartographer	a person who draws maps
contour interval	the difference in height between two contour lines on a map
contour lines	lines on a map that join places of equal height above sea level
density	the population or number of objects per unit of area
distribution	the spread or arrangement of geographical features on the earth's surface
elevation	the height of a point or place above sea level
legend	the part of a map that explains the meaning of the symbols used in the map; sometimes referred to as the key
location	the position of a feature or place on the earth's surface
meridians of longitude	imaginary lines drawn around the earth from north to south
parallels of latitude	imaginary lines drawn around the earth from west to east, parallel to the Equator
relief	a general term describing the shape of the land, including height and steepness
scale	the relationship between the distance between two points on a map and the actual distance on the earth's surface
spot height	the exact altitude or height above sea level of a point on the earth's surface
thematic map	a map designed to illustrate a particular theme; for example, annual rainfall or the location of oil resources
topographic map	a detailed, large-scale map illustrating selected features of the physical environment
topography	the geographical features or landforms of an area

2.0 Image taken using a hand-held 3-D mapping laser, Zebedee

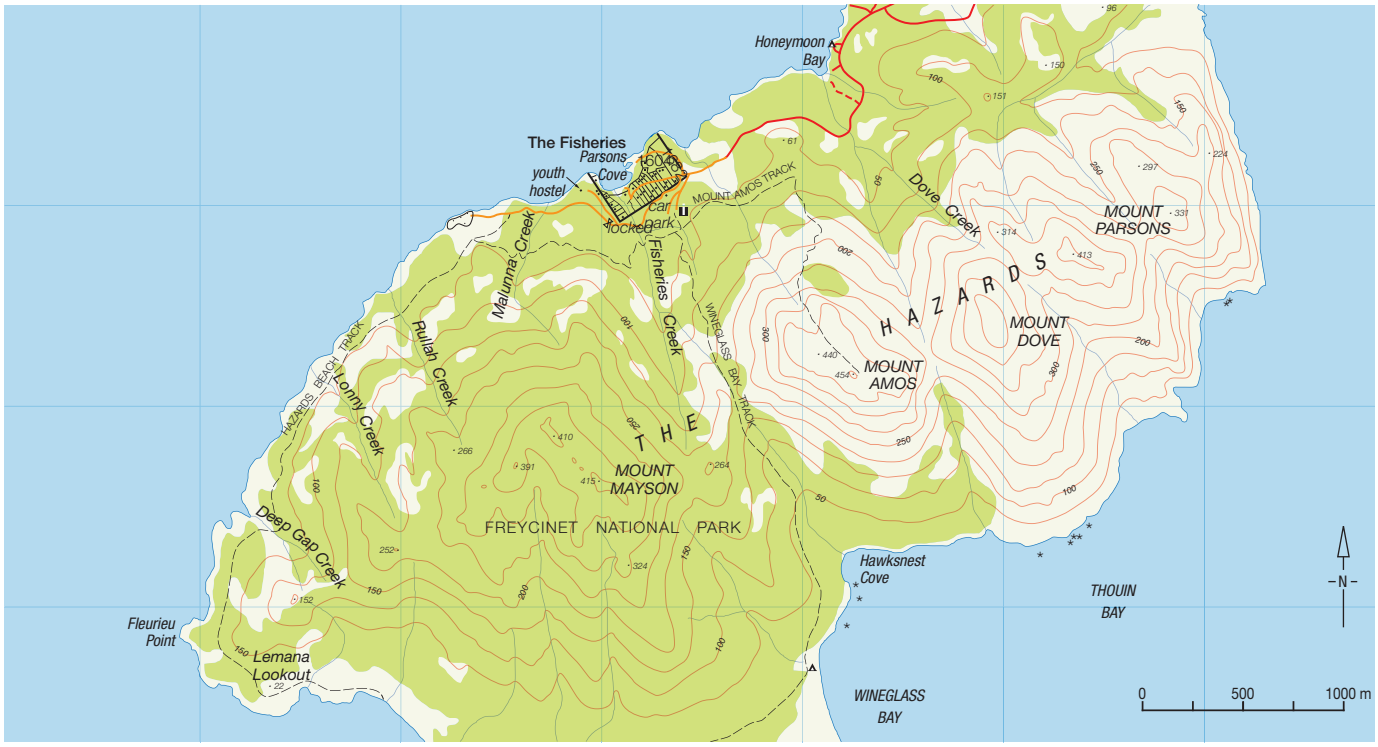
2.1 Types of maps

Geographers use many different types of maps. Topographic maps are particularly useful, but geographers also use atlas maps of regions, countries, continents and the world. Atlases, websites, textbooks, magazines, television programs, computer databases and even some advertisements use many different kinds of maps.

Topographic maps

Figure 2.1 is a **topographic map** and shows a small area of the earth's surface in great detail. It shows the shape of the land (**topography**) as well as different types of natural features (such as rivers and vegetation) and cultural features (such as land use, settlement patterns and road and rail networks). Topographic maps use a variety of symbols to represent these features.

2.1 Topographic map extract, Wineglass Bay, Tasmania



	sealed	unsealed
Road with bridge; with gate		
Walking track (approximate position) with bridge		
Building; Visitor information centre		
Contour with value; Trig station beacon; Spot elevation		
Medium forest		
Tidal rocks or ledge; Offshore rock		
Reserve boundary; Land parcel boundary and number		

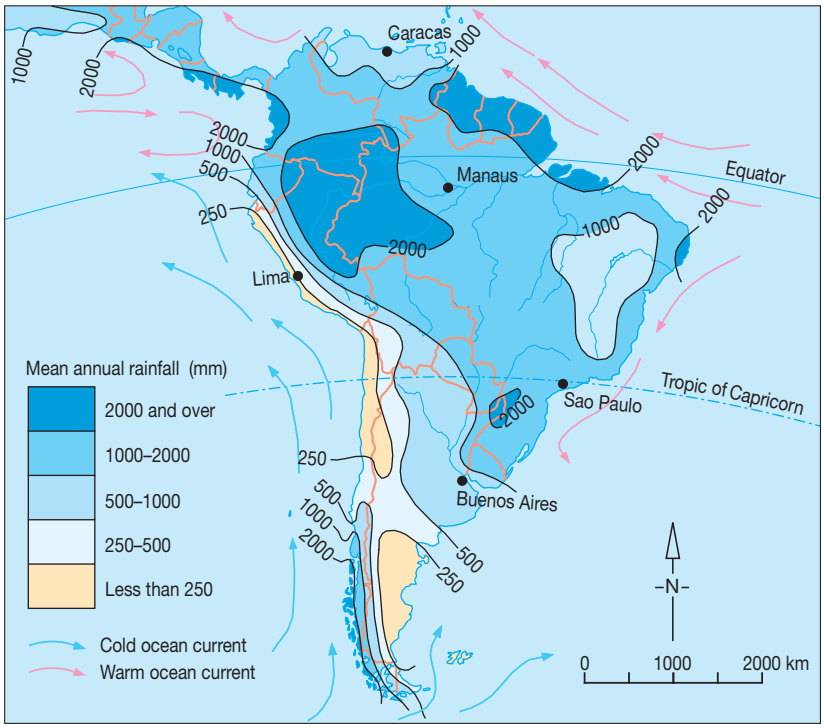
Base image by TASMAP (www.tasmap.tas.gov.au), © State of Tasmania

Thematic maps

Thematic maps are often used to show the **distribution** of one or more of the following: climate, vegetation types, average rainfall, average temperature, population **density**, various development indicators (for example, population growth rates) and agricultural land uses. Figure 2.2 is a thematic map showing average annual rainfall in South America. Thematic maps that use a colour scale or shading to show a pattern are called choropleth maps.

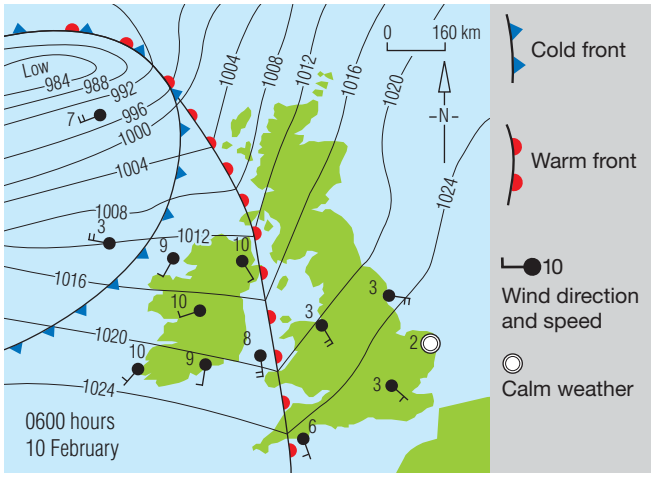
Weather maps

Weather maps show weather conditions over particular areas of the earth's surface at a particular time. In Figure 2.3 you see the condition of the atmosphere (including air pressure and wind direction and strength) at a certain time. You also see the location and direction of warm and cold fronts. From this information, forecasts about the weather can be made several days ahead.



Source: *Heinemann Atlas* Fifth Edition

2.2 Mean annual rainfall, South America



2.3 A weather map of the United Kingdom

Street maps

Street maps show parts of a city or town. Streets are named and important features are shown. These features include schools, police stations, religious buildings, shopping centres, parks and major landmarks. The larger the scale of the map, the greater the variety of information that can be shown. Grid lines are drawn over street maps so that the location of features can be easily recorded and found.

ACTIVITIES

2.1

Knowledge and understanding

1 Complete the following table.

Map type	What it shows	Purpose
Topographic		
Thematic		
Weather		
Street		

Geographical skills

2 Study Figure 2.1. List at least three features of each of the biophysical and built environments shown on the topographic map extract.

3 Study Figure 2.2. Determine the mean annual rainfall for:
- **a** Sao Paulo
- **b** Caracas.

4 Pria is a geographer working as a ranger in her local national park. She is researching the impact of feral cats on the native bird population. What type of map should Pria use to display her findings? Explain why you chose this type of map.

2.2 Elements of maps

Maps play a very important role in the study of Geography. They tell us about places and help us to identify patterns and changes in the landscape.

Maps

Maps range from the very simple to the very complex. No map can show every feature of the landscape, as it would then be impossible to read. Maps need to be selective in what they show. **Cartographers** (map makers) use symbols, shading and colour to show how the features of the earth's surface are arranged and distributed. These techniques also make maps easier to read and explain.

Elements of maps

Map essentials include a **B**order, a direction symbol (**O**rientation), a **L**egend, a **T**itle, a **S**cale and a **S**ource—commonly referred to as BOLTSS.

Border

The border of a map can be described as the 'frame' that surrounds it.

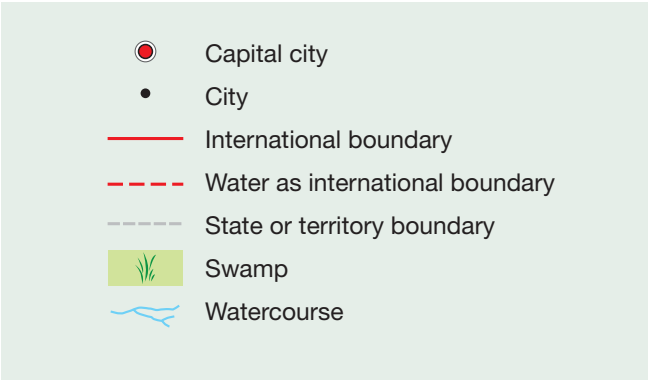
Orientation

To use a map, you need to know where the compass directions are on the map. An arrow shows which way is north. Once you know where north is, you can work out other directions. This process, known as 'orientation', makes it easier to describe the **location** of places.

Legend

The **legend** of a map is also called the key. It lists all the symbols that are used on the map and shows what each of them means.

Map symbols are used to show the location of features on a map. Many symbols look like the features they represent (see Figure 2.4). The colour used for a symbol may also provide a clue to its meaning (blue for water and green for vegetation). The importance of a feature may be shown by the size of the symbol, the thickness of the line or the size of the font used to label it.



2.4 Some common map symbols

Title

A title tells us the purpose of a map. Usually the title has two parts: the name of the place, and what is being shown on the map.

Scale

A map is a graphic representation of part of the earth's surface, drawn to **scale**. The amount and type of detail shown on a map depends on its scale and purpose. For example, a street map of Melbourne with a scale of 1:20 000 (see Figure 2.5a) can show a lot more information about the city than a map of Europe with a scale of 1:20 000 000 (Figure 2.5b). The street map shows a smaller area in greater detail.

Source

If you use information from other sources when you create your own maps, you need to indicate where that information came from. It is important to correctly cite other work.

2.5 Compare these (a) large-scale and (b) small-scale map extracts.



a

Source: *Melway Greater Melbourne Street Directory 2007*



b

Source: *Heinemann Atlas* Fifth Edition

Using scale

The scale on a map shows how much smaller the map is than the actual area. Using a scale, you can measure distances on the map and calculate the distances they represent on the earth's surface.

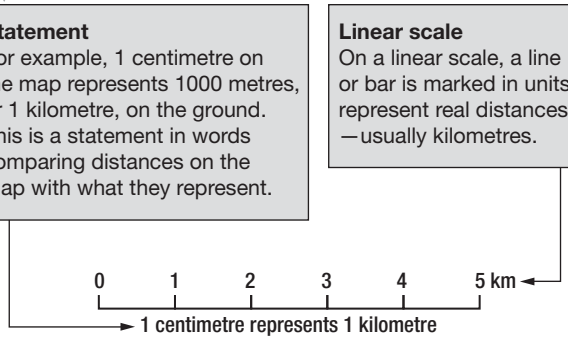
The scale on a map can be expressed in three different ways, as shown in Figure 2.6:

- as a statement; for example, 1 centimetre (on the map) represents 1000 metres (on the ground), or 1 centimetre represents 1 kilometre
- as a ratio or representative fraction; for example, 1:100 000 or $\frac{1}{100\,000}$
- as a linear scale.

2.6 Ways of expressing the scale of maps

Statement
For example, 1 centimetre on the map represents 1000 metres, or 1 kilometre, on the ground. This is a statement in words comparing distances on the map with what they represent.

Linear scale
On a linear scale, a line or bar is marked in units that represent real distances —usually kilometres.



Ratio scale
For example, 1:100000. This tells you that 1 centimetre on the map represents 100000 centimetres (1000 metres or 1 kilometre) on the ground.

ACTIVITIES

2.2

Knowledge and understanding

1 Explain what a map is.
2 Outline the role maps play in the study of Geography.
3 Explain why maps cannot show every feature of the landscape.
4 State what is used to show how features of the earth's surface are arranged and distributed.
5 List the essential elements of a map.

Geographical skills

6 Design suitable map symbols for the following features:
- **a** bicycle track
- **b** bus stop
- **c** fast-food outlet
- **d** football field
- **e** tennis court
- **f** basketball stadium
- **g** swimming pool
- **h** playground
- **i** racecourse
- **j** school
- **k** skate park.

7 Draw a sketch map of your school. Make sure it is to scale and has the essential elements of a map.

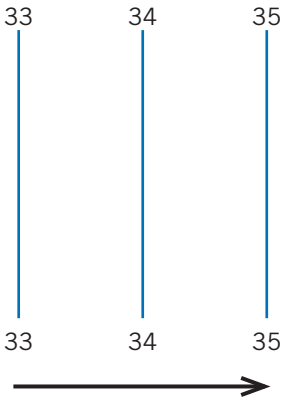
2.3 Grid and area references

You can locate places easily on a map by using the map's grid lines. On a topographic map, vertical grid lines are called eastings because they increase in value as you move eastwards. Horizontal grid lines are called northings because they increase in value as you move northwards.

Grid references

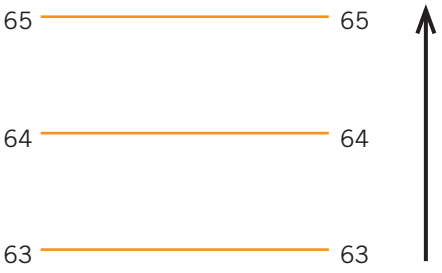
You can locate features on maps by using a six-figure grid reference (GR). The first three digits refer to the eastings and the last three digits refer to the northings shown in Figure 2.7a–b. Each set of three digits is referred to as a coordinate. The first two digits of each coordinate refer to the eastings and northings that surround the map. The third digit needed to complete each coordinate is obtained by dividing each easting and each northing into tenths. In Figure 2.7c, point A is located at GR 335638.

a



These lines are called eastings.
They increase in value as you move east.

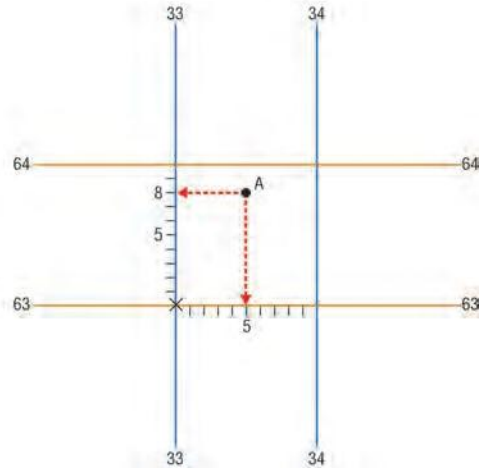
b



These lines are called northings.
They increase in value as you move north.

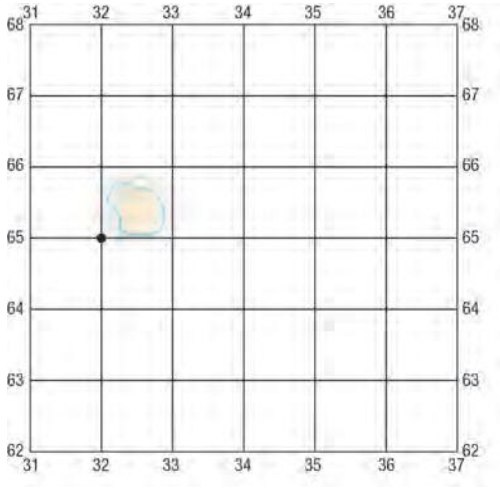
2.7 Eastings and northings

c

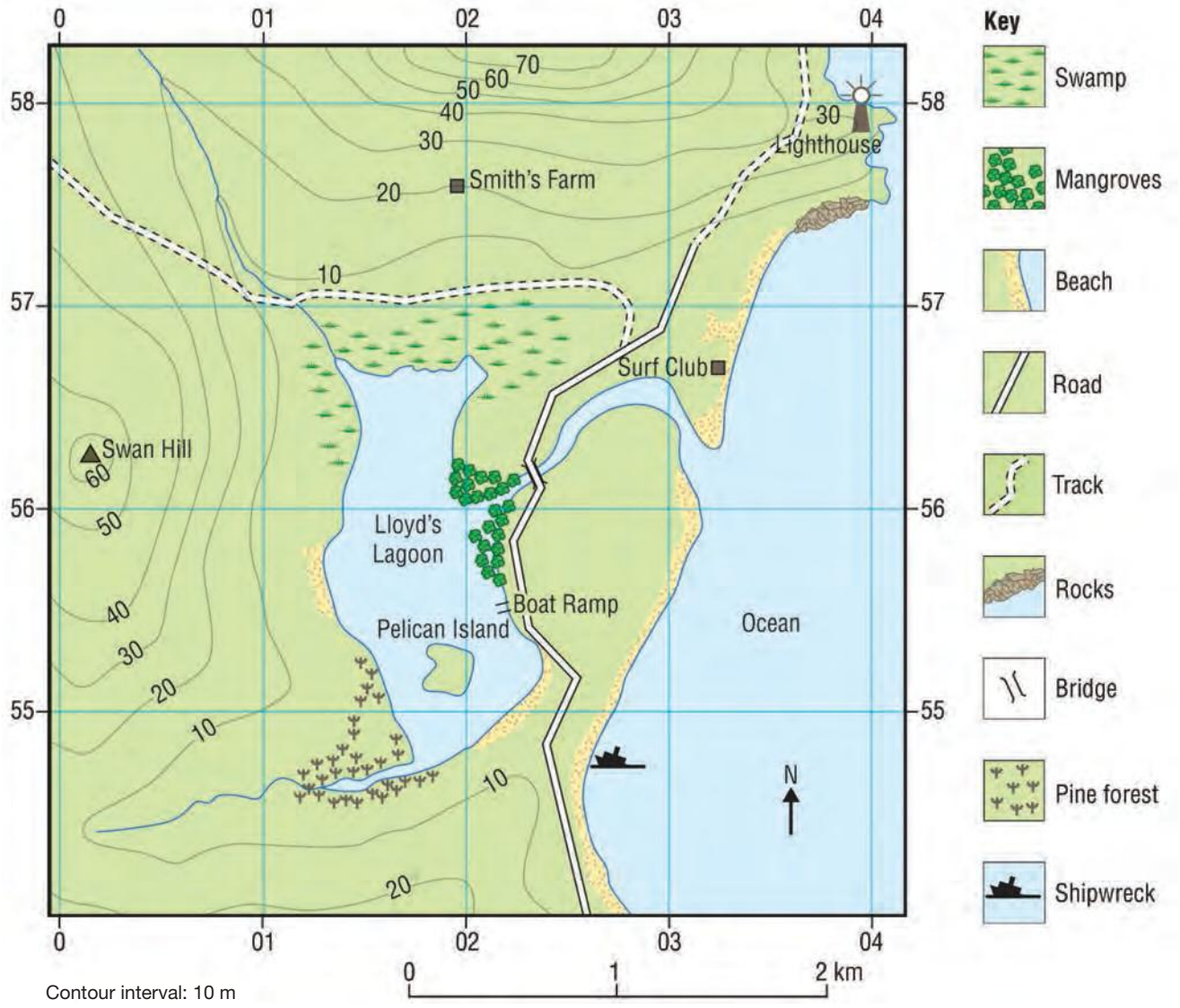


Area references

Features such as a small lake, quarry or village are usually located by means of a four-figure area reference (AR). To find the AR of a feature, use the coordinates of the lower left-hand corner of the grid square in which the feature is located. As in grid references, eastings come before northings in area references. In Figure 2.8, the quarry is located in AR 3265.



2.8 Finding area references



2.9 Map extract: grid and area references

ACTIVITIES

2.3

Knowledge and understanding

1 Explain the difference between eastings and northings.

Geographical skills

2 Study Figure 2.9, then answer the following questions.

a Identify the feature located at each of the following grid references.
- i GR 028548
- ii GR 039580
- iii GR 032567
- iv GR 019553

b What is the grid reference of the following features?
- i Swan Hill
- ii bridge
- iii boat ramp
- iv Smith's Farm

c What type of vegetation is found in:
- i AR 0256
- ii AR 0154?

d What is the elevation of Smith's Farm?

e What is the height of Swan Hill?

f What is the direction of the lighthouse from Swan Hill?

2.4 Topographic maps

A topographic map is a detailed, large-scale map of part of the earth's surface, showing selected features of the physical and human environments: the height, relief and slope of the land; vegetation; and a range of human features. Collectively, these features are known as topography.

Relief, height and slope

Because of their large scale, topographic maps show a greater variety of information about places. Their scale allows topographic maps to show individual buildings, small rivers and creeks, and even dams, fences and telephone lines. In addition, topographic maps show **contour lines**, **spot heights** and hill shading.

Relief is a general term describing the shape of the land, including its height and steepness. The main techniques that cartographers use to show relief are spot heights, contour lines and patterns (outlined in Figure 2.10), layer colouring and landform shading.

Spot heights

Spot heights are shown on maps as black dots with the height written next to them. You can see a spot height in Figure 2.10. A spot height gives the exact height above sea level of the particular location or feature.

Contour lines

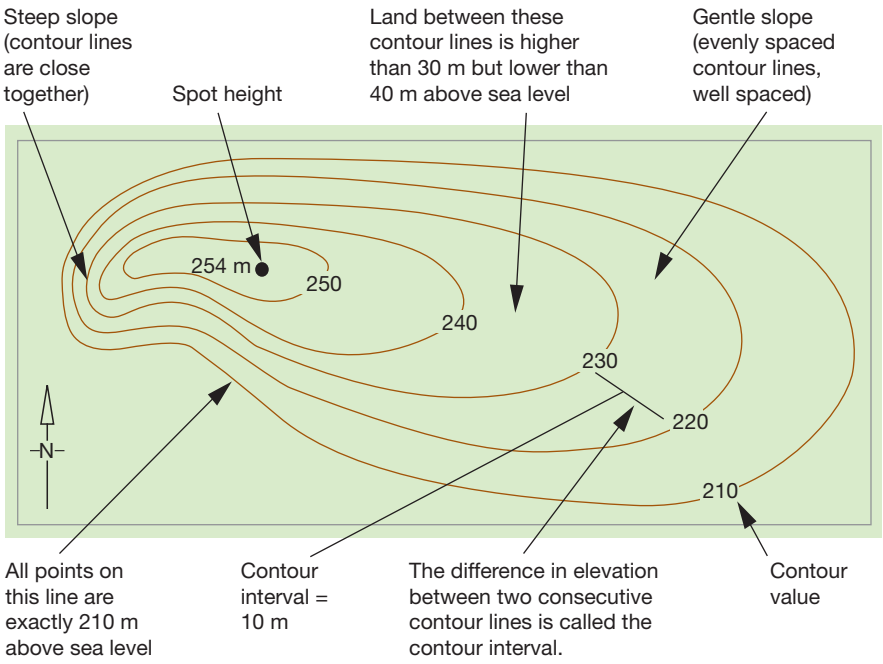
Contour lines join points of equal height above sea level. Contour lines provide geographers with information about the shape and slope of the land and the height of features above sea level. The **contour interval** is the difference in height between two adjacent contour lines.

Contour patterns

Each type of topographic feature is represented by its own distinctive contour pattern. The spacing of the contours on a map shows the steepness of slopes. Areas where contour lines are close together have steep slopes. Areas where contour lines are widely spaced are very flat. This is shown in Figure 2.10.

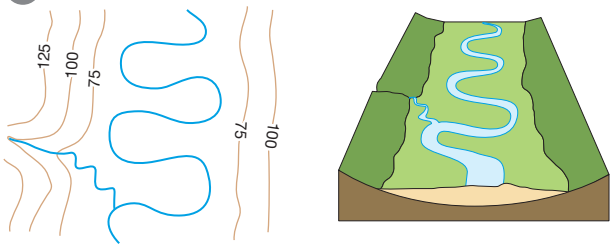
Layer colouring

Layer colouring is a simple and effective way of showing relief on maps. It involves filling in the area between selected contours with different colours. It is often used in combination with spot heights, and sometimes with landform shading.

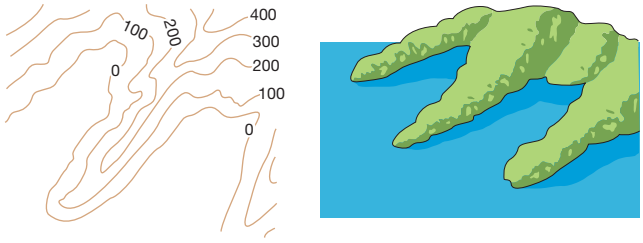


2.10 Contour lines

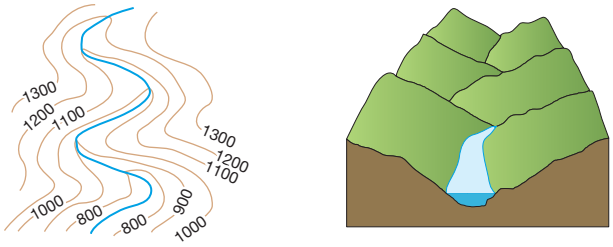
a Flood plain



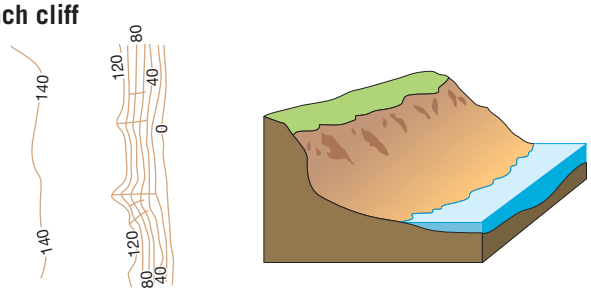
b Drowned coastline



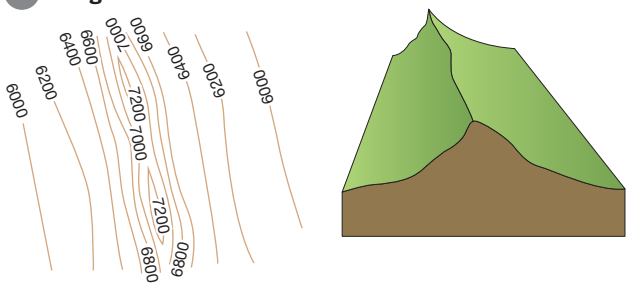
c Interlocking spurs



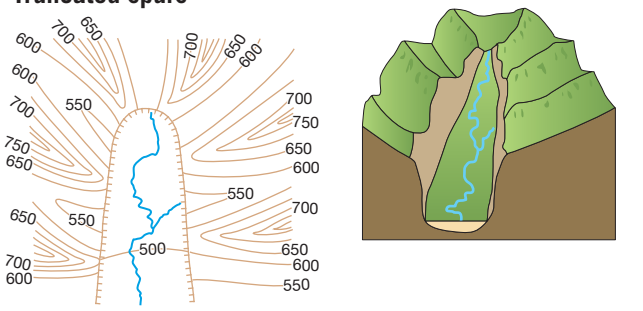
d Beach cliff



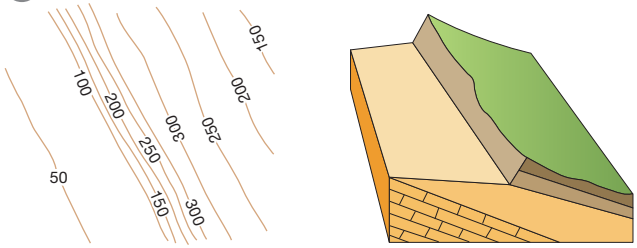
e Ridge



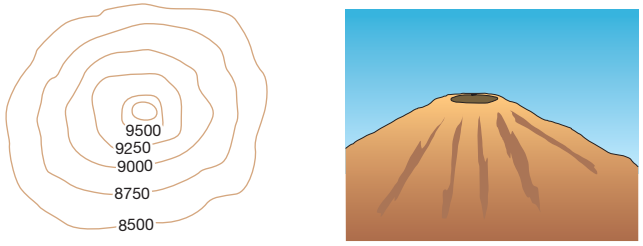
f Truncated spurs



g Escarpment



h Conical mountain



2.11 Reading contour lines can tell us a lot about the nature of landforms.

Landform shading

Shading may be applied to maps so that colours darken as **elevation** increases. Landform shading is sometimes used in conjunction with contour lines.

Aspect

Aspect refers to the direction that a slope faces. The aspect of a particular slope can be determined by examining the height and pattern of contour lines.

ACTIVITIES

2.5

Knowledge and understanding

1. Explain what topographic maps are. What do they show?
2. State what the contour interval is used for.
3. List and explain the various ways relief is shown on maps.
4. State what is meant by the term 'aspect'.

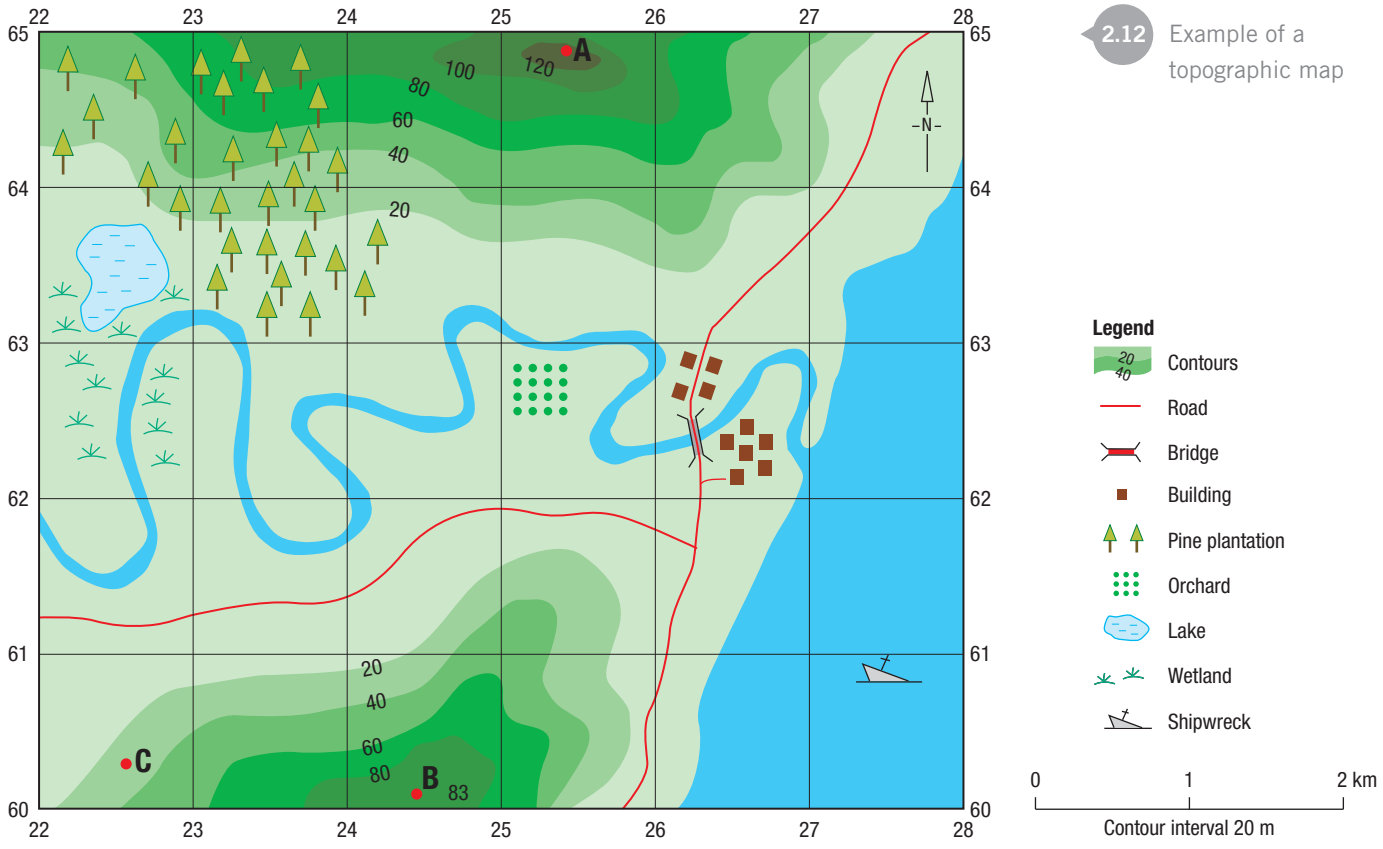
2.5 Geoskills: Interpreting topographic maps

Being able to interpret topographic maps is an important geographical skill. It allows you to:

- **locate features of the biophysical and constructed environments**
- **describe distribution patterns**
- **identify relationships between features.**

Many different people use topographic maps for work and recreational purposes. For example, an architect will not start designing a building until they know the shape of the land, nor would a bushwalker set out on a walk without first studying a topographic map.

Topographic maps generally show a large amount of detail. Figure 2.12 is a topographic map showing a town next to the sea. The map includes many of the elements common to topographic maps.

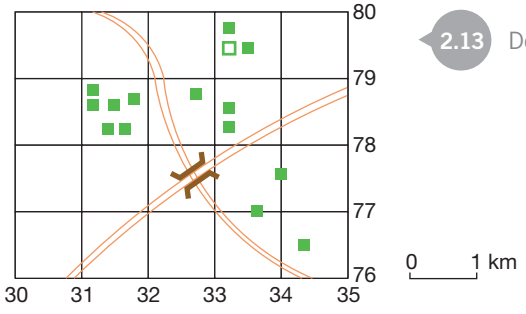


2.12 Example of a topographic map

Density

The density of a feature can be determined by counting the number of times that feature occurs within a specific area. Answers should be expressed as the number of features per square kilometre.

For example, in Figure 2.13, the density of buildings in AR 3178 is 6 per square kilometre (or 6/km^2).



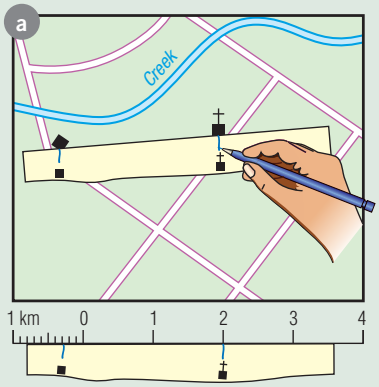
2.13 Density

Skillsbuilder

Measuring distances on maps

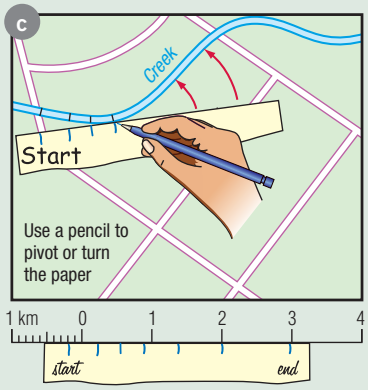
The scale of a map can be used to calculate the distance between places on maps, vertical aerial photographs or satellite images. Figure 2.14 shows how to find:

- the straight-line distance between two points
- the distance between two points along a railway line, road, track or river.



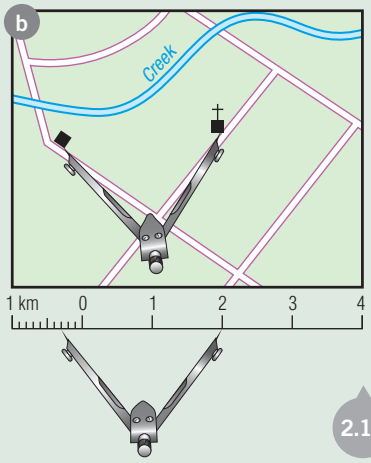
Measuring straight-line distance using paper

Place a sheet of paper between the two points. Mark the two points, then measure the distance along the line scale.



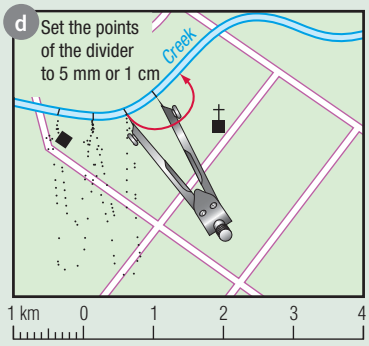
Measuring around a bend using paper

Mark the starting point. Keeping the paper firmly on the map, move your pencil to pivot the paper at each bend or curve to reach the end point. Mark the end point, then measure the distance on the line scale.



Measuring straight-line distance using dividers

Open out the dividers to the distance between the two points. Then measure that distance on the line scale.



Measuring around a bend using dividers

From the starting point, 'walk' the dividers around the curve, counting the number of 'steps' to the end point. If the distance is not an exact number of steps, open the dividers up for the final step. Calculate the total distance of all the steps, then measure that distance on the line scale.

2.14 Measuring distances on maps

ACTIVITIES

2.4

Geographical skills

1 Study Figure 2.12, then answer the following questions.
- **a** What landform feature is found in AR 2263?
- **b** In what area reference is the orchard located?
- **c** What is the grid reference of point C?
- **d** What features of the built environment are located at:
  - **i** GR 275608
  - **ii** GR 263624?
- **e** What is the straight-line distance between point A and point B?
- **f** What is the direction of the bridge in AR 2662 from the hill in AR 2460?
- **g** In what direction is the river flowing in AR 2262?
- **h** What is the aspect of the slope in AR 2564?
- **i** What is the height of the hill located in AR 2564?
- **j** What is the height of point C above sea level?
- **k** What land-use activity is found in the north-west quadrant of the map?
- **l** What is the density of buildings in AR 2662?

2.6 Atlas maps

An atlas is a collection of maps. These maps show physical features, human features or a mixture of both. Atlases also contain world maps and regional maps showing particular themes, such as climate or wealth.

Types of maps

In an atlas there are usually maps of each continent; more detailed maps of regions, showing particular countries; and even more detailed maps of smaller areas, such as cities. Cities are usually shown on maps using dot symbols. Often, different symbols are used to indicate cities of different sizes or a capital city.

There are also many special atlases available. These atlases contain maps linked to a particular place or to a theme such as population and land use. Atlases can be viewed in print form and in electronic form. Advances in computer technology mean that electronic atlases are becoming increasingly sophisticated and interactive.

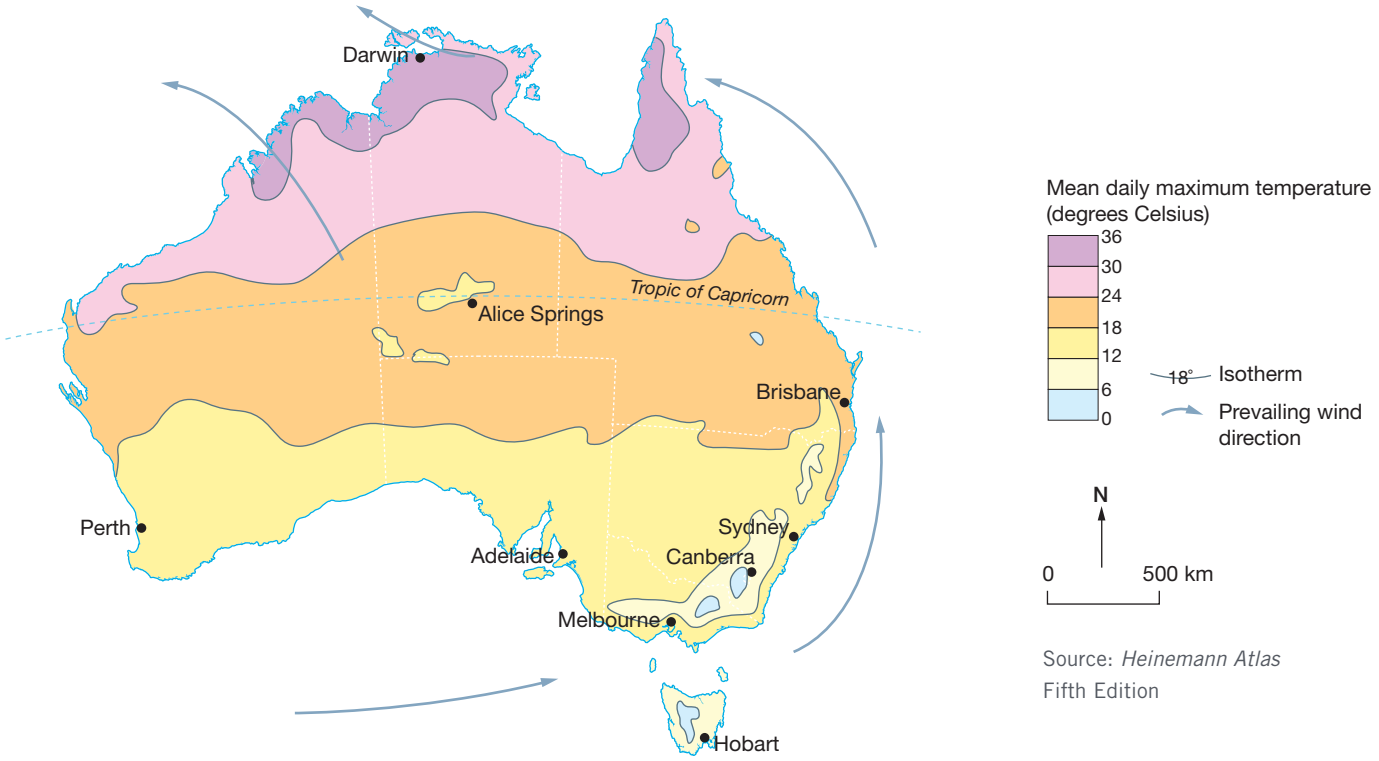
Physical and human features maps

The maps in an atlas are often labelled with human (cultural and political) features such as boundaries, countries and cities. Physical (natural) maps show features such as rivers, mountains, plains and lakes.

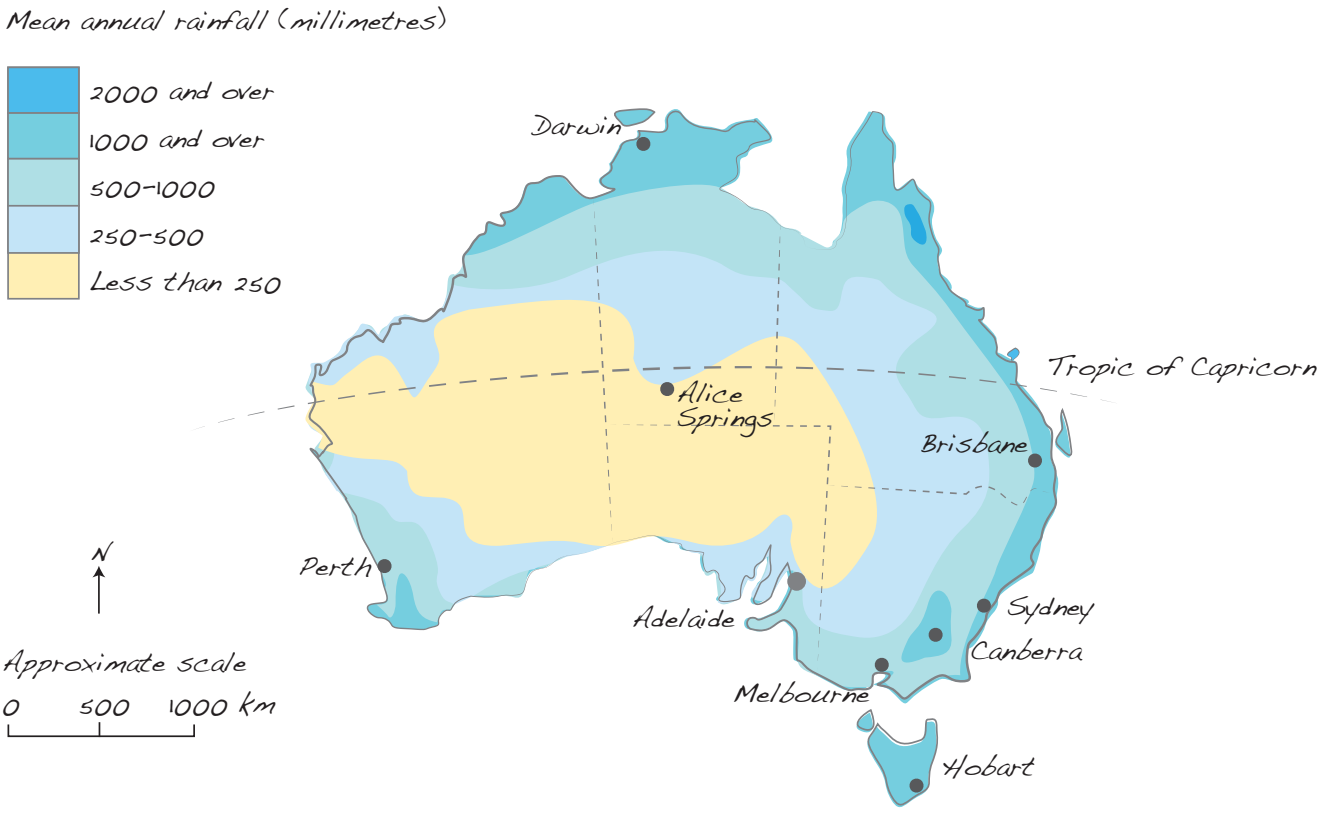
Thematic maps

Atlases contain maps that illustrate particular themes. These maps may show, for example, the annual rainfall, the distribution of ethnic groups or the oil resources of a region or the whole world. Figure 2.15 is a thematic map showing Australia's average daily maximum temperatures.

2.15 Thematic map of Australia showing average daily maximum temperatures



Source: *Heinemann Atlas* Fifth Edition



2.16 A sketch map of Australia's annual rainfall

Sketch maps

Sketch maps (or précis maps, as they are sometimes called) can be made from any map. A sketch map may be a simple map showing where you live or it may be a more complex map that includes a number of features. An example of a sketch map is shown in Figure 2.16.

Sketch maps don't try to show every feature of the landscape. On a sketch map, the scale can only be approximate, but it is an important feature to include on your map. This is because you need to give an idea of the distance between places and the area covered by features. On sketch maps, notes can be added to identify and explain particular features.

Contents page and index

If you want to find a general area, such as North America, or a theme, such as population, you should use the contents page of your atlas. If you want to find a particular place, such as a town or a mountain, the index at the back of your atlas will be most useful.

Every place that is shown on a map in an atlas is listed in the index. Places are usually listed in alphabetical order, like words in a dictionary. This allows you to locate places and features quickly and accurately.

ACTIVITIES

Knowledge and understanding

1 Copy and complete the following table.

Map type	Features shown	Use
Physical		
Political		
Thematic		

Geographical skills

2 Which kind of atlas map (physical, human or thematic) would be the best source of information on the following?

- **a** the capital cities of Europe
- **b** the names of Indonesia's main islands
- **c** the boundaries of countries in South America
- **d** the political divisions of Africa
- **e** the population density of North America
- **f** the landform features of Europe
- **g** the temperature patterns of Australia and New Zealand

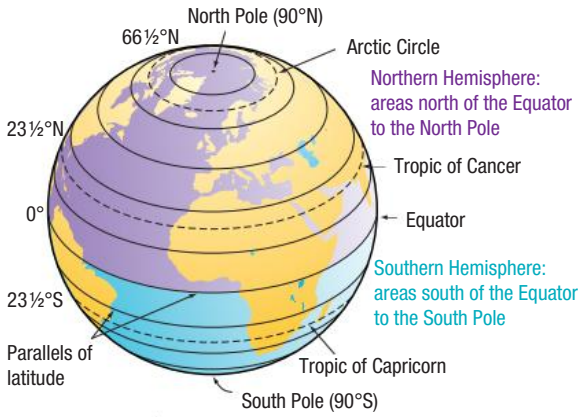
2.7 Latitude and longitude

Most of the maps you will use in your study of Geography include lines of latitude and longitude. These allow you to quickly and accurately locate places and features on the earth's surface.

Latitude

Lines of latitude (see Figure 2.17) are imaginary lines that run in an east–west direction around the earth. Because lines of latitude are parallel to each other, they are often referred to as **parallels of latitude**.

The most important line of latitude is the Equator (0°). The Equator divides the earth into two halves: the Northern and Southern hemispheres. All other lines of latitude are either north or south of the Equator.

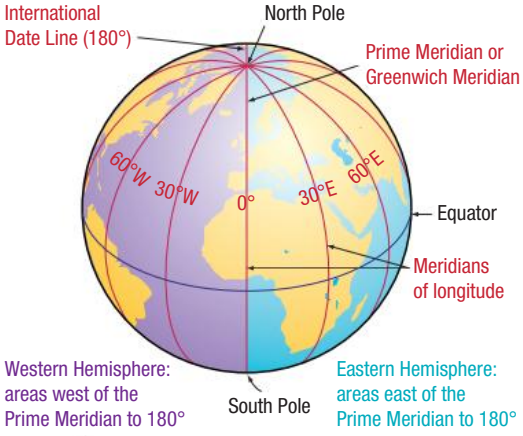


2.17 Lines of latitude

Longitude

Lines of longitude (see Figure 2.18) run in a north–south direction. They are not parallel to one another; they all converge, or meet, at the North and South poles. Any number of these lines can be drawn. These imaginary lines are called **meridians of longitude**.

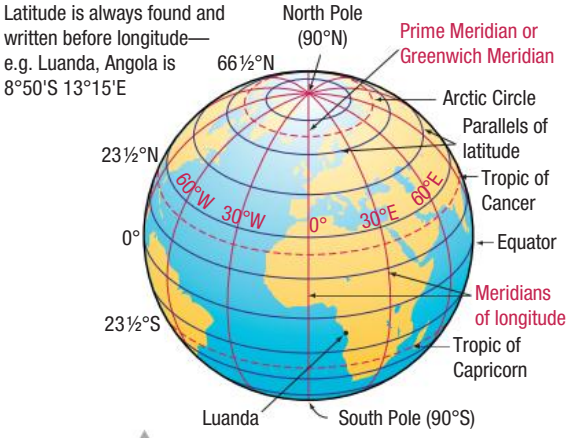
The most important line of longitude is the Prime Meridian (0°), which passes through Greenwich Observatory in London, United Kingdom. All other lines of longitude are located either to the east or to the west of the Prime Meridian. The International Date Line (IDL), is on the opposite side of the world, at 180°. There is a change of day at the IDL. The Prime Meridian and the IDL divide the earth into two halves: the Western and Eastern hemispheres.



2.18 Meridians of longitude

Latitude and longitude

Together, lines of latitude and longitude form a grid that allows you to pinpoint places on the earth's surface (see Figure 2.19).



2.19 Latitude and longitude

Skillsbuilder

Finding places using latitude and longitude

If you are given the latitude and longitude of a place and asked to identify it, follow the steps below.

1. Using a world map, find the general location of the latitude and longitude you have been given.
2. Turn to a map of the region or continent, and locate the latitude and longitude more accurately.
3. Check your answer by finding the placename in the index of the atlas. Most atlas indexes include the latitude and longitude of each place.

Kobe, Japan (see Figure 2.20), for example, has a latitude of approximately 35° north of the Equator and a longitude of approximately 135° east of the Prime Meridian. To be even more accurate, each degree (°) can be divided into smaller units, called minutes ('). There are 60 minutes in each degree. Kobe's location using degrees and minutes is latitude 34°40' north, longitude 135°12' east.



Source: *Heinemann Atlas* Fifth Edition

2.20 A map extract of Japan, showing latitude and longitude, and features of the biophysical and built environments

ACTIVITIES

Knowledge and understanding

1. Define the terms 'parallel of latitude' and 'meridian of longitude'.
2. Explain the difference between parallels of latitude and meridians of longitude.
3. Describe the location and significance of the Prime Meridian and the International Date Line.

Geographical skills

4 a Study Figure 2.20. Name the feature of the physical environment located at each of the sets of coordinates below.
- i 36°05'N 133°00'E
- ii 42°30'N 132°00'E
- iii 35°23'N 138°42'E
- iv 38°20'N 138°30'E
- v 41°20'N 140°15'E
- vi 42°N 129'E
- vii 33°30'N 135°45'E

b Study Figure 2.20. Name the feature of the human environment found at each of the following locations.
- i 35°40'N 139°45'E
- ii 34°23'N 132°27'E
- iii 31°00'N 130°30'E
- iv 38°15'N 140°52'E
- v 43°05'N 141°21'E
- vi 35°02'N 135°45'E

2.8 Spatial technologies

The term 'spatial technologies' refers to any type of computer-based software or hardware that allows people to locate, map and record features of the earth's surface. Geographical information collected by these tools is stored, checked, analysed, manipulated and presented in different ways, the most common of which is a digital map.

Growth of spatial technologies

The increasing power of digital technologies and computers in the last 20 years has influenced rapid growth in the use of spatial technologies. In the 1990s, only high-tech departments within business, government and industry could afford to use spatial technologies, and they required a specialist with a high level of knowledge to operate them. Today non-specialists, including students in the classroom, can download and use software from the internet. Many organisations and industries use digital maps to help in the management of their businesses.

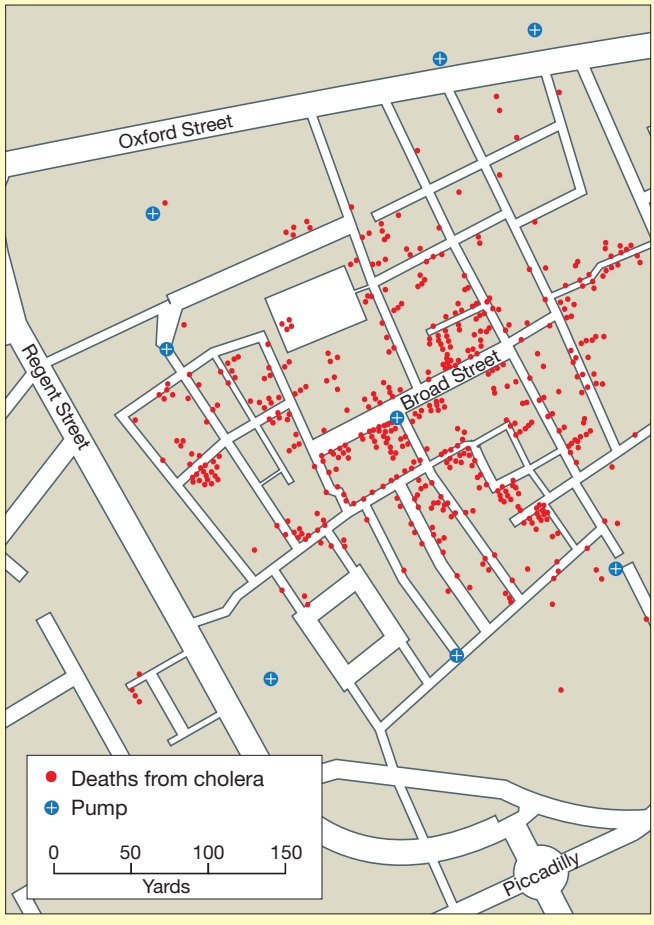
Spatial technologies include geographic information systems (GIS), remote sensing (RS) and global positioning systems (GPS).

SPOTLIGHT

London's cholera outbreak, 1854

The recording of spatial information on maps has been an important part of human history and has been taking place for thousands of years. The earliest known maps are cave paintings that were drawn over 8000 years ago. It is likely, however, that ancient people drew 'mud maps' on the ground long before this.

The benefits of GIS mapping became clear even before there were satellite maps. In 1854, there was a cholera outbreak in London. Dr John Snow, a local doctor, believed that the cause of the outbreak was contaminated water. At this time, people did not have running water in their homes and relied on public water pumps. To prove his hypothesis and rule out the idea that the outbreak was caused by 'miasma' or bad air, Dr Snow drew a map showing the location of the victims' homes and the nearby public water pumps (see Figure 2.21). By combining two pieces of data on one map in this way, he discovered that many of the victims lived close to a particular pump located on Broad Street. After further investigation and much public debate, the Broad Street pump was closed, and the cholera outbreak ended.

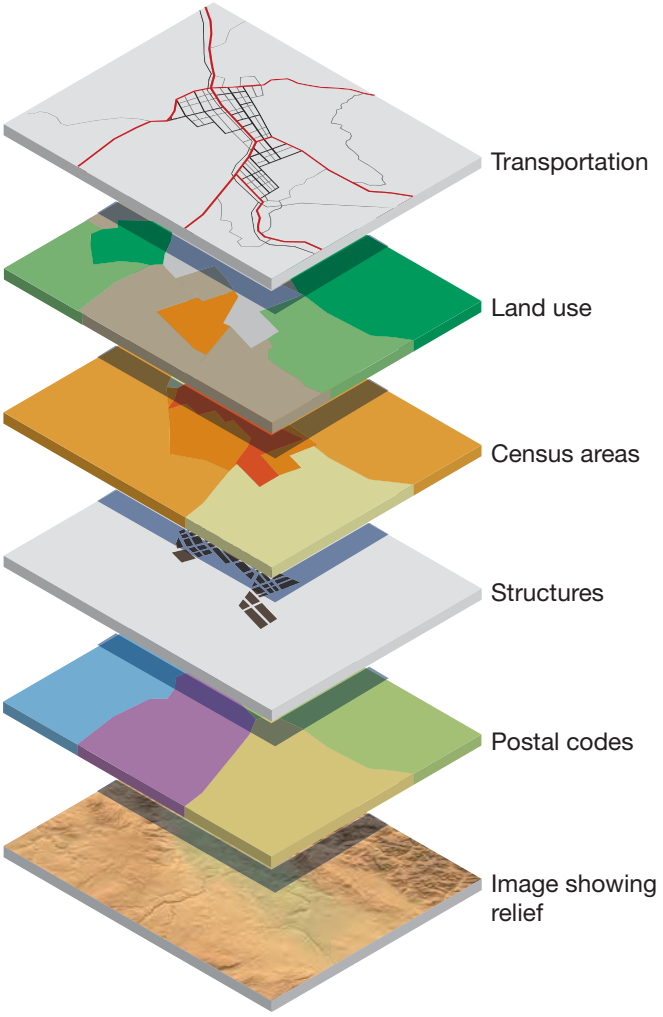


2.21 A modern version of Dr John Snow's map showing the location of cholera outbreaks, London, 1854

Geographic information systems

Geographic information systems (GIS) are the ultimate mapping tool and the most widely used spatial technology in business and industry today. A GIS is best thought of as a system that manages the input, analysis and output of spatial data. In simpler terms, it is a database that can produce maps. Data that is collected using handheld GPS devices, or from satellites, is imported into a GIS and turned into information that is more easily used.

Information is presented in a GIS as a series of layers, as shown in Figure 2.22. Imagine piling a series of different maps of the same area on top of one another, and then analysing the final map, looking for different patterns and relationships. This is what happens in a GIS.



2.22 The layers of a geographic information system

Examples of GIS technologies

There are two ways to access and use GIS technology.

Internet-based GIS

Web GIS uses a web page as its main mapping interface. Examples of web-based GIS map services are Google Maps, Wikimapia, MapQuest, NearMap, Yahoo! Local Maps and Apple Maps. Many of these map services allow the user to find directions from one place to another.

Google Earth and ArcGIS Explorer are programs that can be downloaded from the internet and that stream spatial data direct to display virtual globes. The imagery is very 'rich' in detail and it is possible to 'fly' to any location on the earth's surface. It is also possible to view the earth's surface in three dimensions.

GIS software programs

ArcGIS is the most popular desktop GIS and is used by many individuals and organisations around the world. It is a complete system for creating, managing, analysing and disseminating geographic information. Other popular GIS programs include MapInfo, Idrisi and GRASS GIS.

ACTIVITIES

2.6

Knowledge and understanding

1 State what spatial technologies are. Give examples.
2 Explain what a GIS is.
3 Study Figure 2.21. Explain how Dr Snow's map helped to identify the cause of the 1854 cholera outbreak.

Geographical skills

4 Explore the physical world using one of the internet-based mapping systems. Using the search window, locate the landforms around the world that are found at each of the following coordinates.
   a 19°35'47.52"N, 155°34'6.43"W
   b 24°10'14.03"S, 15°3'44.80"E
   c 36°6'7.90"N, 112°6'11.24"W
   d 35°21'47.20"N, 138°43'48.09"E
5 Explore your world using one of the internet-based mapping systems. Using the search window, locate your home or school and find out the following information.
   a terrain
   b surrounding landforms
   c local landmarks

Review and reflect 1

Activity 1

Making choices: Renewable energy

People have a choice: to continue using the earth's non-renewable fossil fuels, or to increase their use of renewable sources of energy. What are these alternative energy sources, and how practical are they?

Renewable energy sources

Hydroelectricity: the production of energy through use of the gravitational force of falling water. The water passes through electricity-generating turbines.

Tidal: the energy generated by tidal movements, which can be used to power electricity-generating turbines

Geothermal: energy generated using the heat stored in the earth

Solar: energy from the sun that is converted into thermal or electrical energy. Almost 2 per cent of Australia's electrical energy is now sourced from solar power.

Wind: electrical energy produced by wind-powered turbines

Waves: the energy of waves, which can be used to power electricity-generating turbines

Biomass: living and recently dead biological material that can be used as fuel

Biogas: the gas produced during the decomposition of organic material in a landfill. This gas can be captured and used.

R&R 1.1 Renewable sources of energy

Select one of the renewable energy sources shown in Figure R&R1.1. Undertake internet-based research on your chosen source. Develop a multimedia presentation that includes a description of the technology (with an illustration or a photograph) and outlines:

- the extent to which is currently used, in Australia and worldwide
- its potential for meeting the energy needs of people
- any negative impacts on the environment.

Activity 2

Making choices: Which future?

Study Figure R&R1.2. Which cartoon best fits your view of the relationship between people and their environment? Write a paragraph about each cartoon, saying whether you agree with the view presented. Explain why you agree or disagree. Return to this activity at the end of Year 7 and say whether your views have changed.

R&R 1.2 Alternative futures

Humans as planetary masters

Doing what they want and keeping control



Humans as polluters

A blight on the face of the earth



Humans as pawns
At the mercy of the elements



Humans as partners
Intimately linked to every other part of the global system



Activity 3

Drawing a topographic map

Read the following paragraph and draw a topographic map of the island that it describes.

> There are cliffs in the north-west corner of the island. The highest point of the island is a small hill that rises to a height of 528 metres above sea level. The hill is located in the north-west of the island. A small creek rises near the top of the small hill and flows in a south-easterly direction, out to sea. There is a small village near the point where the creek reaches the sea. The village includes a group of houses, a school, shops and sporting facilities. Just near the village is a pier. There is a forest located in the south of the island. The north of the island includes two small farms. Roads link the town to the farms and the forest. There is a walking track to the highest point on the island.

Give your island a name, and don't forget the orientation, key and scale.

Here are some tips:

- draw a border: 300 mm × 300 mm
- suggested scale: 1 cm represents 150 m
- suggested contour interval: 50 m

Activity 4

Topographic mapping skills presentation

Select one of the topics from the list below to research using the internet and/or a library:

- types of maps or photographs
- latitude and longitude
- map projections
- showing relief on maps
- weather maps

Prepare a multimedia presentation to summarise the key points of your topic. Give your finished presentation to the class. The following are some guidelines that you should use when preparing and giving your presentation:

- You have 5 minutes in which to present.
- Develop activities that you can use to teach your content. This may involve asking the audience questions or having them complete a worksheet. Avoid lecturing to your audience.
- Between five and ten slides may be used in Microsoft® PowerPoint® presentations. You are encouraged to integrate a range of multimedia resources.
- Use bullet points to give a brief summary of each idea. Each point should be no more than two lines long.
- Use your talk to provide further detail on each point. Do not read from your presentation; use it only as a guide.
- Use pictures and animations sparingly so that they have an impact.
- Rehearse your talk.

Activity 5

Around-the-world odyssey

a Select eight destinations in the world that you would like to visit. You must:
- visit at least five continents (see Figure R&R1.3)
- visit at least two places in each hemisphere—north, south, east and west
- visit at least one very hot and one very cold climate
- not visit the same country more than once.

b Provide information about each of your destinations. Include information about:
- the climate (rainfall and temperature)
- the human and natural environments
- population statistics.

c Present your 'Around-the-world odyssey' as an annotated visual display (print or digital). Be sure to:
- locate and mark each destination on a map
- present the information in dot point form
- provide images of each destination (see Figure R&R1.4).

Activity 6

Spatial technologies: Where do I live?

In this activity you will create a simple map showing your journey from home to school.

a Select an internet-based mapping system such as Google Maps, Google Earth or Near Maps.

b Find your home.

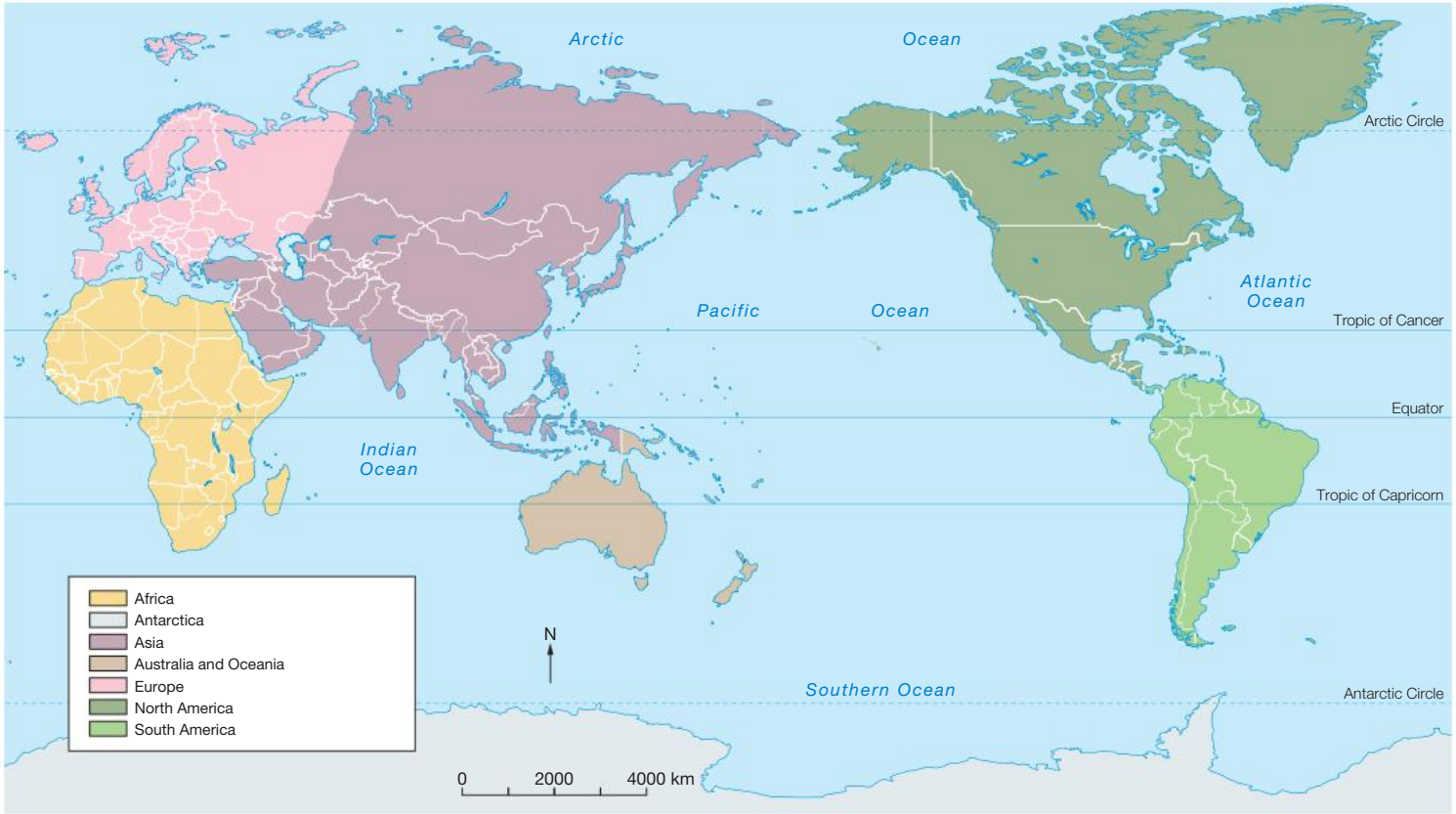
c Draw a line that tracks your journey as you walk, ride or drive to school. Click on the 'Draw a line' tool and then click on your house to begin drawing your line. Track your journey to school and click your mouse every time the line changes direction.

d To complete your line either double-click your mouse or click once on the last point. Your line will finish and a box will pop open allowing you to identify your line and add more details/information to it. You will also see a total distance located in the bottom of this box.

Now that you have completed a map of your journey to and from school you can complete the following activities.

1 List the streets (or suburbs if you travel a long way) that you travel through to get to school.

2 Which street is the longest?



R&R 1.3 World map

3 How long is your journey to school in terms of distance?
4 How much time does it usually take you to get to school?
5 What is your average speed in kilometres per hour getting to school?
6 What are the main landmarks that you pass on your way to school?
7 How do you use these landmarks to help you navigate your way to school?

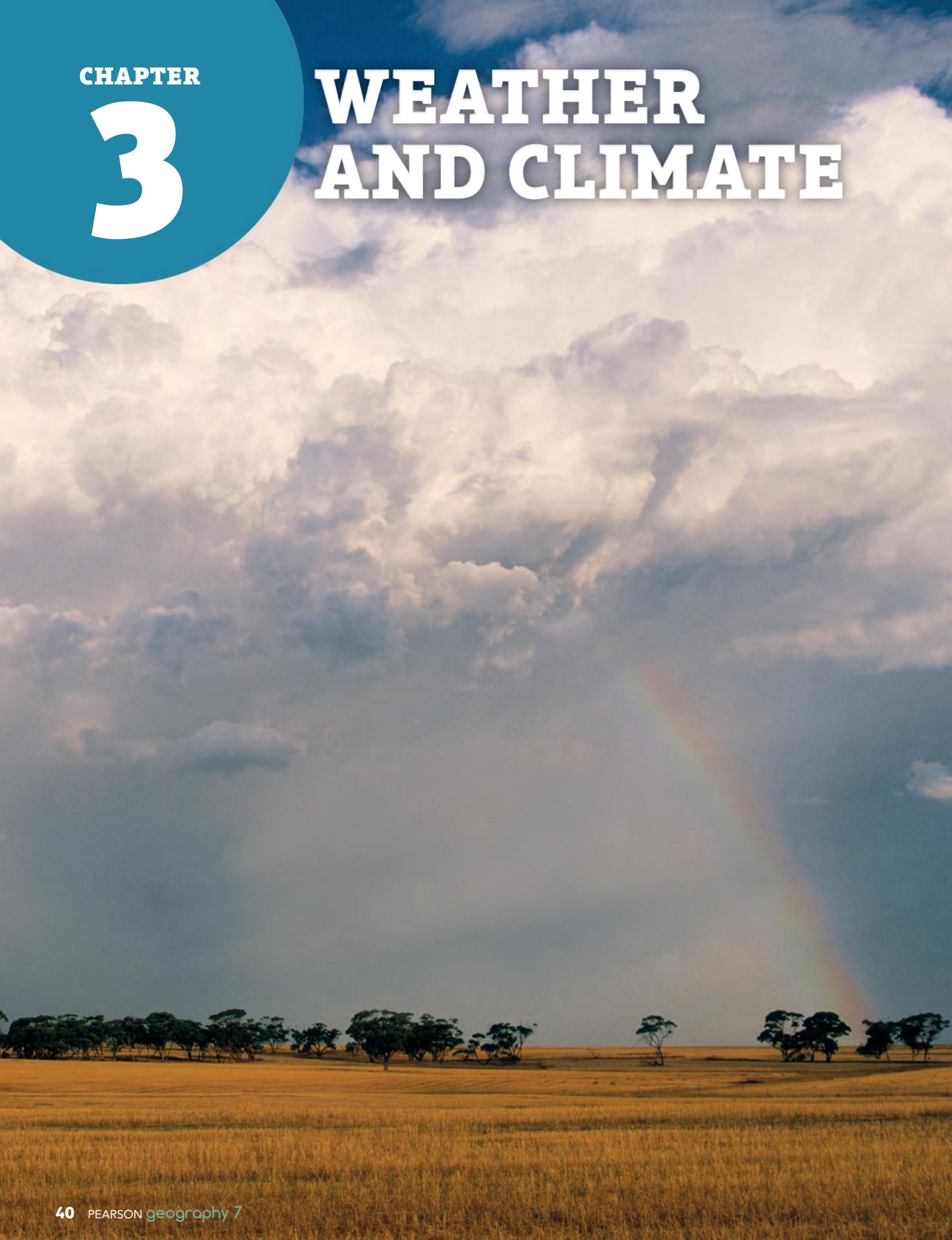


R&R 1.4 Elephant sanctuary, Sri Lanka

CHAPTER

3

WEATHER AND CLIMATE



Weather and climate not only influence our lifestyle; they determine the nature of our biophysical environment and the types of agriculture we can carry out.

To understand the difference between weather and climate, consider the following: climate is what you expect; weather is what you get. Climate is about long-term records, trends and averages, whereas weather is what we experience from day to day.

In this chapter we will begin to develop an understanding of the difference between weather and climate.

KEY IDEAS

- To understand the difference between weather and climate
- To know the factors that determine weather and climate
- To develop skills in collecting and recording weather-related data in the field
- To develop skills in interpreting weather maps and climate graphs

GLOSSARY

air mass	a large body of air that may extend for hundreds of kilometres and that changes as it moves
atmospheric pressure	the weight of the air pressing down on the earth's surface
climate	the long-term weather pattern for a place or region
coalescence	the merging of two or more water droplets or particles into one
condensation	the conversion of water vapour to liquid water in the form of dew, fog or cloud droplets
convectional rainfall	rainfall that occurs as warm, moist air rises and cools, forming clouds
evaporation	the conversion of liquid water to water vapour
freezing level	the altitude at which the temperature is 0°C (the freezing point of water)
front	the boundary between two air masses
frontal rainfall	rainfall that occurs when bodies of air of different temperatures meet
humidity	the amount of water vapour in the air
meteorologist	a scientist who studies the atmosphere and related phenomena, especially weather
orographic rainfall	rainfall that occurs when warm, moist air is forced to rise by a mountain barrier
precipitation	any moisture reaching the surface of the earth, such as rain, hail, snow and sleet
rain shadow	the dry area on the side of a mountain range that does not face directly into the wind
relative humidity	the amount of water vapour in the air, represented as a percentage

3.0 Storm brewing, rural Western Australia

3.1 Weather and climate

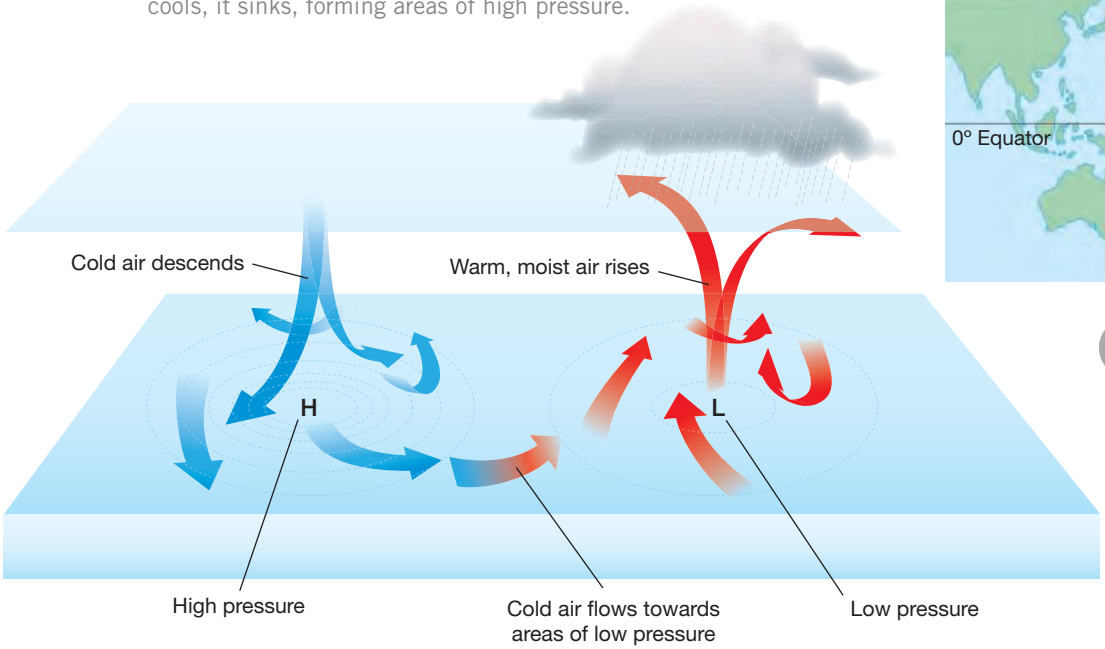
The words 'weather' and 'climate' mean different things. Weather is the day-to-day condition of the atmosphere at a particular place; climate is the long-term weather pattern for a place or region.

Weather

Weather includes all the daily changes in temperature, **precipitation**, wind, sunshine, **humidity** (the amount of moisture in the air) and **atmospheric pressure**.

To understand weather, we need to understand atmospheric pressure. Atmospheric pressure is the weight of the air pressing down on the earth's surface. When air is heated by the energy of the sun, it rises. This forms areas of low pressure. When air cools, it sinks towards the earth's surface. This forms areas of high pressure. The location of high-pressure and low-pressure systems helps us predict the weather. High-pressure systems are usually associated with settled, or fine, weather. Low-pressure systems are generally associated with unsettled weather. Figure 3.1 shows how high-pressure and low-pressure systems form.

3.1 When air near the earth's surface is heated rapidly, it rises, forming areas of low pressure. As the air cools, it sinks, forming areas of high pressure.



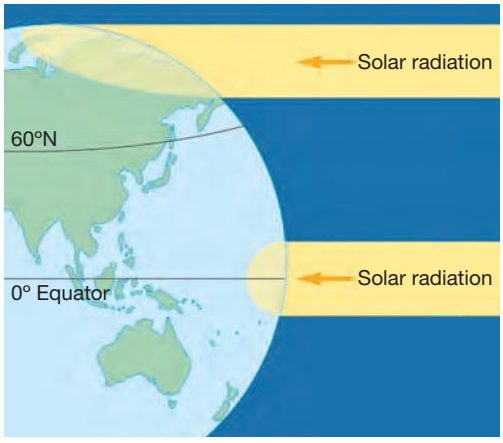
Climate

Climate is the average weather experienced in a place over many years. The climate of a place depends on its latitude, its altitude (height above sea level), its aspect, how close it is to the sea, ocean currents and the season. The factors that contribute to this long-term pattern are discussed below.

Factors affecting temperature

Latitude

As Figure 3.2 shows, solar energy has twice the area to heat at 60° north (and 60° south) that it has at the Equator. Therefore, average temperatures are lower at higher latitudes.



3.2 The impact of latitude on the heating of the earth's surface

Seasonal differences

The angle at which the earth tilts as it revolves around the sun influences:

- the angle at which the sun's rays reach the earth
- the changing seasons
- the number of daylight hours.

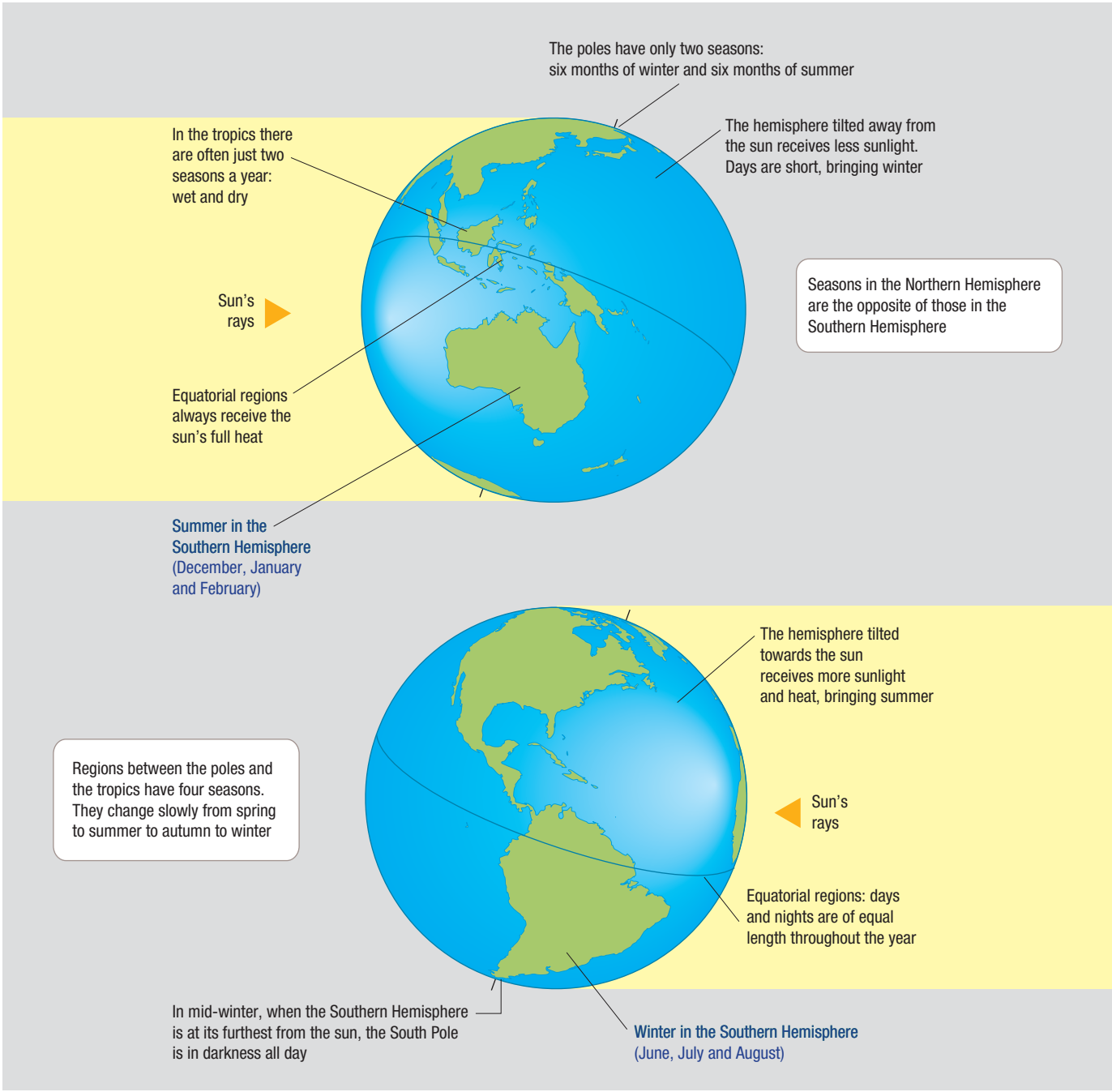
Figure 3.3 shows that from December to February the Southern Hemisphere is tilted towards the sun. From June to August, the Northern Hemisphere is tilted towards the sun. This is why the Northern Hemisphere has its summer in the middle of the year, while Australia is having its winter.

Because the earth's axis is tilted at an angle of 23.5°, there are seasonal differences in the daily number of daylight hours. The shorter the day, the less opportunity there is for the earth and its atmosphere to absorb heat.

Aspect

The direction in which a feature faces is known as its aspect. A feature that faces the sun will generally be warmer than one that does not.

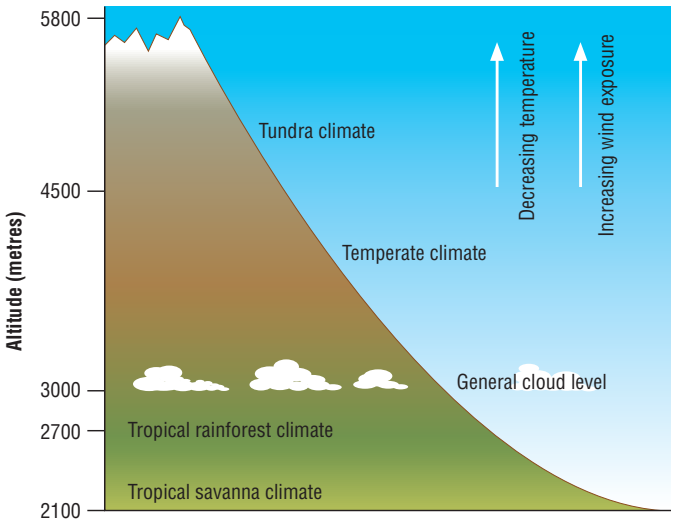
3.3 The seasons of the earth are the result of the earth's revolution around the sun and the tilt of the earth on its axis.



Altitude

Because of their altitude (elevation), or height above sea level, mountain areas are cooler than areas at lower elevations. Mt Kilimanjaro is Africa's highest mountain. At 5894 metres above sea level, its top is permanently covered with snow, even though it is only just south of the Equator. On average, temperature drops by approximately 6.5°C with every 1000 metres of increase in elevation (see Figure 3.4).

3.4 The relationship between increasing altitude and changes in climate



Factors affecting temperature and rainfall

Several factors influence both temperature and rainfall.

Prevailing winds

The prevailing wind direction is the direction from which the wind blows most often. The temperature of the prevailing wind is affected by the area it blows from and over. When prevailing winds blow over warm bodies of water, they often bring rain.

Distance from the sea

Distance from the sea influences both temperature and rainfall.

Temperature

The sea gains and loses its heat much more slowly than the land; the sea maintains more even temperatures. Places near the coast therefore experience smaller differences in temperature than inland places. Places away from the coast can have higher temperatures during the day and lower temperatures at night because of the speed at which land gains and loses heat.

Rainfall

Winds blowing off warm seas carry a lot of moisture. Because of this, places near the coast often receive higher rainfall than those further inland. By the time the winds reach inland areas, they have lost most or all of their moisture.

Ocean currents

The temperature of ocean currents also influences both temperature and rainfall.

Temperature

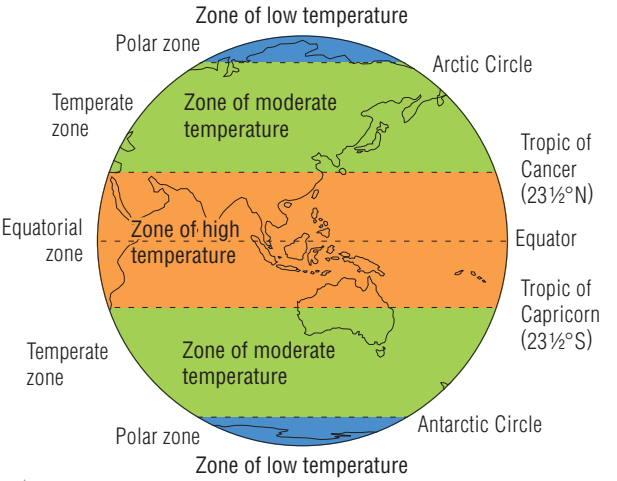
Oceans absorb heat during the day and release it slowly during the night. This helps keep coastal areas much warmer than inland areas.

Rainfall

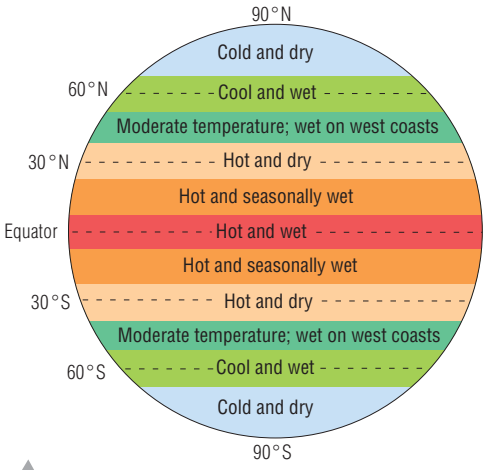
Water evaporates much more quickly from oceans affected by warm ocean currents. As a result, nearby coastal areas are likely to have higher levels of rainfall. Areas affected by cold ocean currents are likely to experience lower rainfall as a result of lower evaporation rates.

Mountain barriers

Mountains act as barriers to the movement of air. When warm, moist air meets a mountain, it is forced to rise. As the air cools, the moisture condenses and rain falls on the windward side of the mountain—the side facing the wind. This process is known as orographic rainfall. The air that then flows over the mountain is much drier. Deserts are often found on the leeward (sheltered) side of large mountain ranges. This is known as the **rain shadow** effect.



3.5 The broad temperature zones of the world



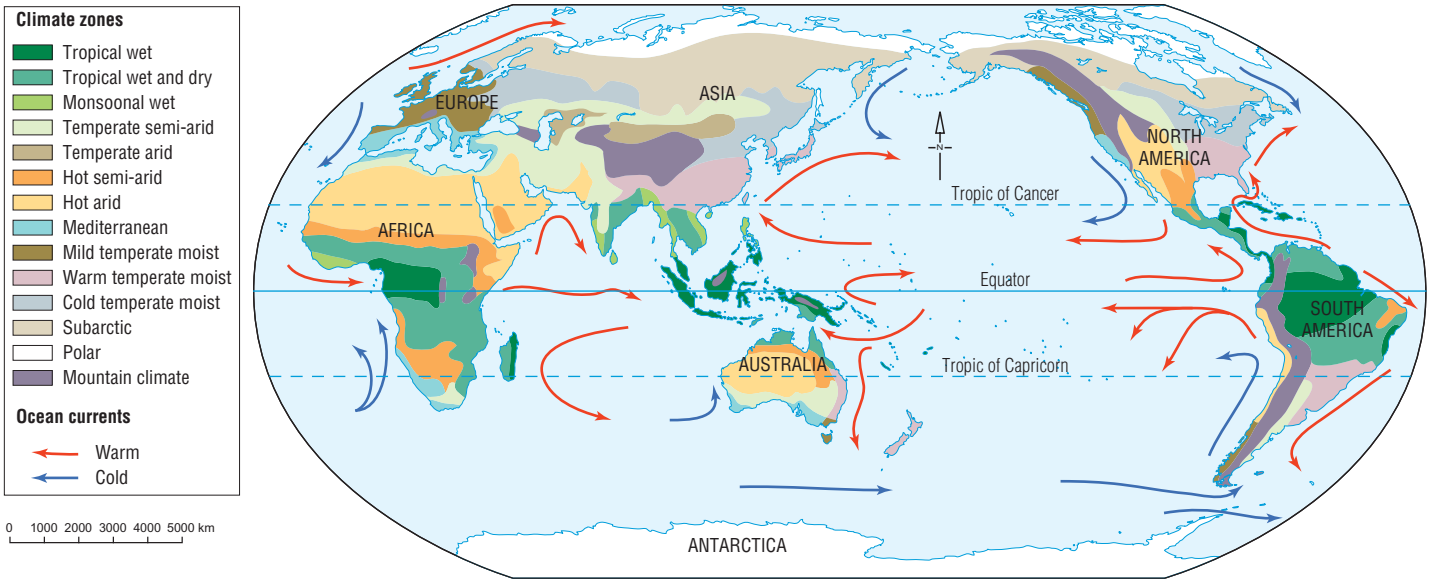
3.6 The broad rainfall zones of the world

World climate pattern

There are three very broad zones of climatic difference across the world. They are shown in Figure 3.5. These differences in climate are caused by the different amounts of heat received from the sun.

These three broad zones are only a general indication of climatic difference. A more specific indication can be made by adding rainfall patterns. Figure 3.6 shows the broad rainfall zones of the world.

The variety of climate zones across the world results from interactions between temperature and rainfall. These zones are shown in Figure 3.7.



3.7 Ocean currents and climate zones

ACTIVITIES

3.1

Knowledge and understanding

1 Explain the difference between weather and climate.

2 Study Figure 3.1 and complete the following table.

	How the system develops	Weather associated with the system
High-pressure system		
Low-pressure system		

3 Explain how latitude, seasonal differences, aspect and altitude affect temperature.

4 Describe how prevailing winds, distance from the sea, ocean currents and mountain barriers affect both temperature and rainfall.

Geographical skills

5 Study Figure 3.7, then complete the following tasks.

- **a** Name the two lines of latitude between which the tropical climate zones are located.
- **b** Identify the continents where the monsoonal climate zones are located.
- **c** Name one continent that does not have a mountain climate zone.
- **d** Identify the types of climates that are associated with cold ocean currents.

3.2 Precipitation

Precipitation is the term given to any form of moisture that reaches the earth's surface from the atmosphere. Rain, hail, snow and dew are all forms of precipitation.

Rain

Rain occurs when growing cloud droplets become too heavy to remain in the cloud and, as a result, fall towards the earth's surface. Rain can also begin as ice crystals that join together to form large snowflakes. As the falling snow passes through the **freezing level** into warmer air, the flakes melt to become raindrops.

The smallest raindrops reaching the earth's surface must be over ten times the size of the average cloud droplet. **Coalescence** is the merging of the smallest cloud droplets to create larger droplets of water. These larger droplets then fall as rain or snow.

3.8 A summer storm brings rain to Sydney.



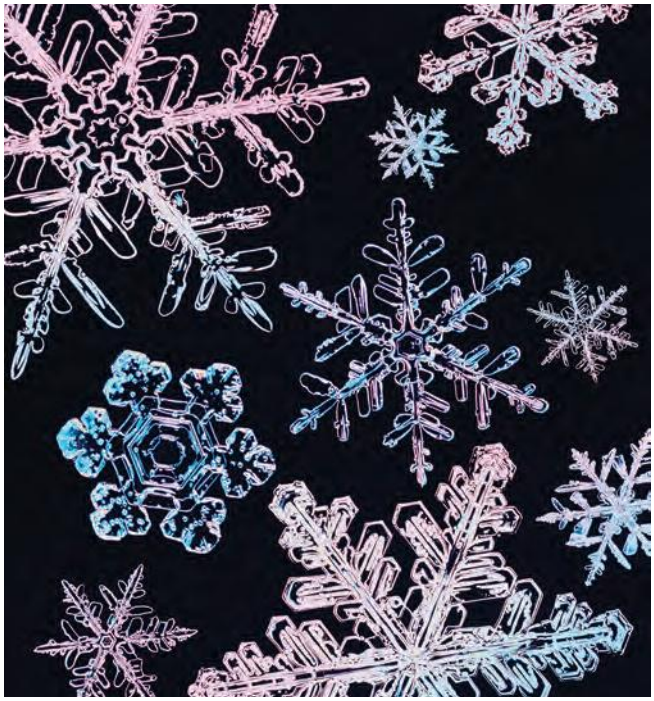
Hail

Hail is made up of hailstones, or large, frozen raindrops that are produced in intense thunderstorms. As water droplets rise rapidly in a storm, they form ice pellets that continue to grow until they begin to fall under the force of gravity. On reaching the bottom of the cloud, some of these ice pellets are carried back to the top of the cloud. As the ice pellets once again fall through the cloud, another layer of ice is added and the hailstone grows even larger. Once the hailstone becomes too heavy to be supported, it falls out of the cloud towards the earth's surface. The hailstone reaches the ground as ice since it does not spend enough time in the warm air to melt before it lands.

Snow

Snowflakes originate as tiny ice crystals in clouds where the temperature is at or below freezing point (0°C). As an ice crystal rises and falls within a cloud, it grows by combining with other ice crystals, and takes on the six-sided shape of a snowflake, shown in Figure 3.9. When the snowflake becomes heavy enough, it falls towards the ground. If the temperature in the lower atmosphere and at ground level is at or below 0°C, snow will gather. In places where the temperatures remain mostly below zero, fallen snow is compressed to form an ice sheet or a glacier, and can sometimes be stored in this form for thousands of years.

3.9 The snowflake is made up of hundreds of tiny ice crystals.



Dew

Water vapour in the air will form droplets known as dew (see Figure 3.10) when the air comes into contact with a cold surface. The temperature at which this occurs is known as the dew point. When temperatures are low enough, dew becomes ice and is called frost.

3.10 Dew forms when moist air comes into contact with a cold surface.



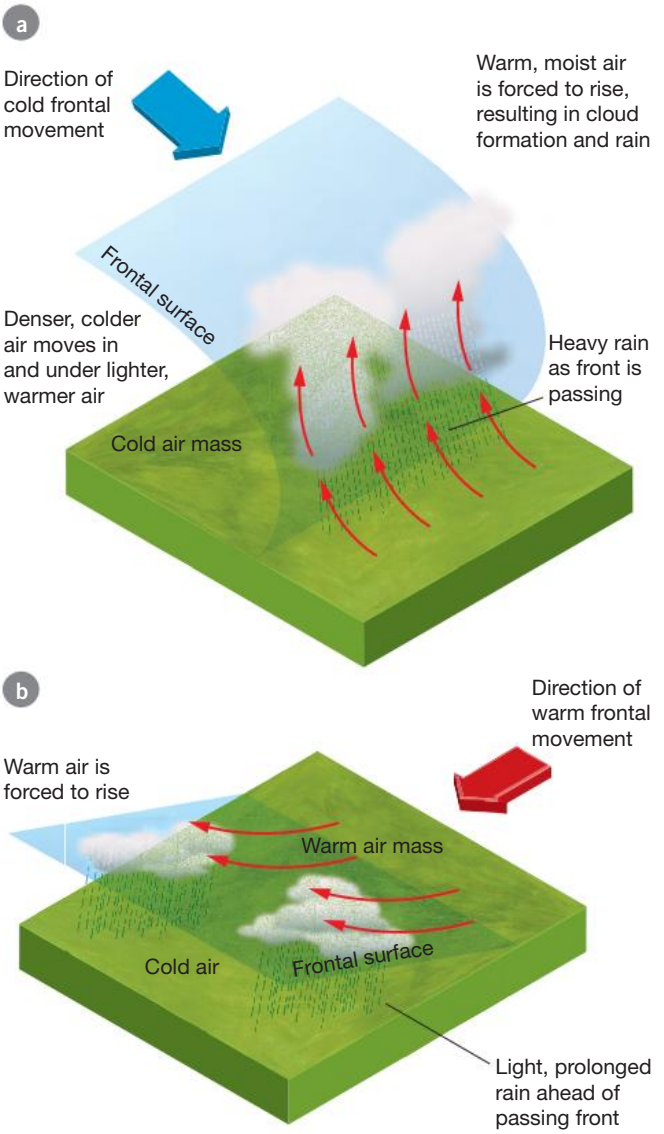
Rising air and precipitation

Under normal conditions, the temperature of the air decreases as altitude increases. Cold air cannot hold as much moisture as warm air. Any water vapour that the rising air cannot hold condenses into water droplets (or ice crystals) and forms clouds. Warm, moist air is pushed up into the atmosphere and forms rain in three ways: through frontal and orographic uplift, and convection.

DID YOU KNOW?

Approximately 505 000 cubic kilometres of water fall as precipitation each year, 398 000 cubic kilometres of this over the oceans. Given the earth's surface area, this means that the globally averaged annual precipitation is 990 millimetres.

3.11 Frontal rainfall associated with the passage of (a) a cold front and (b) a warm front



Frontal rainfall

Frontal rainfall occurs when a cold and a warm **air mass** meet. The point at which they meet is known as a **front**.

When a cold air mass meets a warm air mass, the cold air, which is heavier or denser than the warm air, forces the warm air to rise. As the warm air is pushed upwards, it cools.

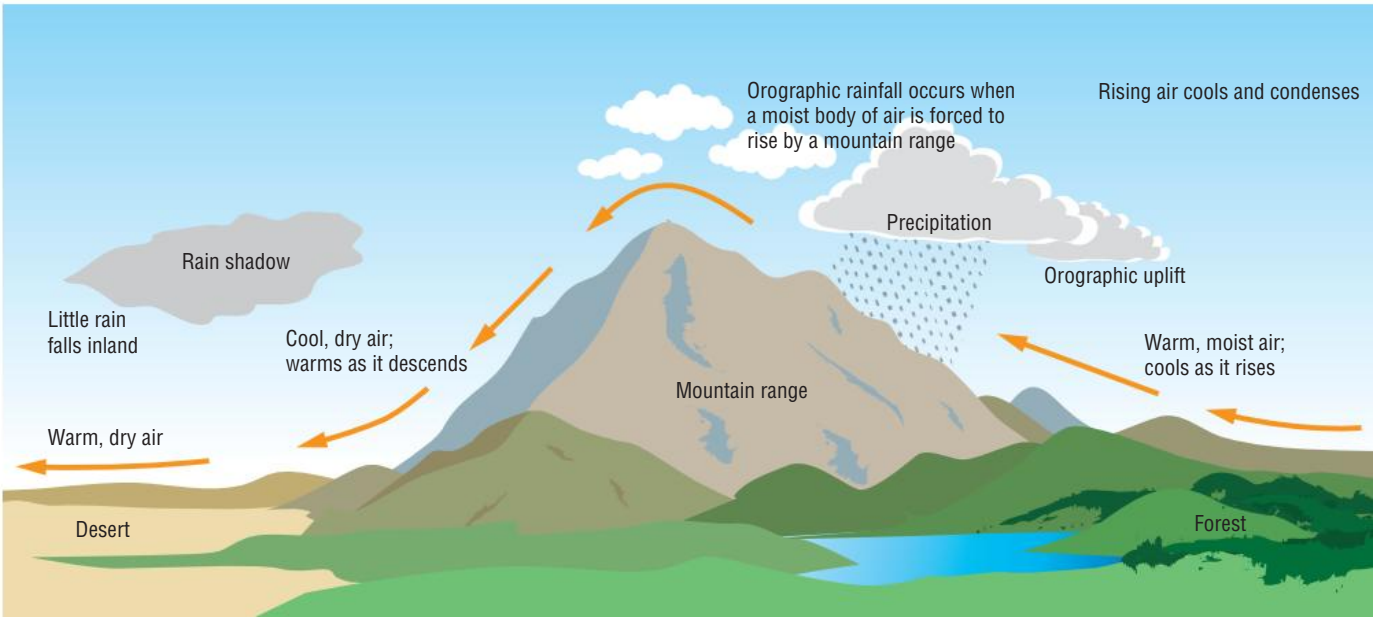
When the air rises and is no longer able to hold all its water as water vapour, it begins to condense and form clouds. This often results in heavy precipitation associated with the passing of storms, as shown in Figure 3.11a.

When a warm air mass meets a cold air mass, the warm air mass (which is lighter and less dense than the cold air) rises above the denser and heavier cold air mass. This resulting rainfall extends over a wide area, as shown in Figure 3.11b.

Orographic rainfall

Orographic rainfall (shown in Figure 3.12) occurs when a moist body of air is forced to rise by a mountain range. As the air rises, it cools. The water vapour then begins to condense and form clouds, and finally falls as rain or snow. Only a little rain makes it beyond the mountain range, producing what is called the rain shadow effect.

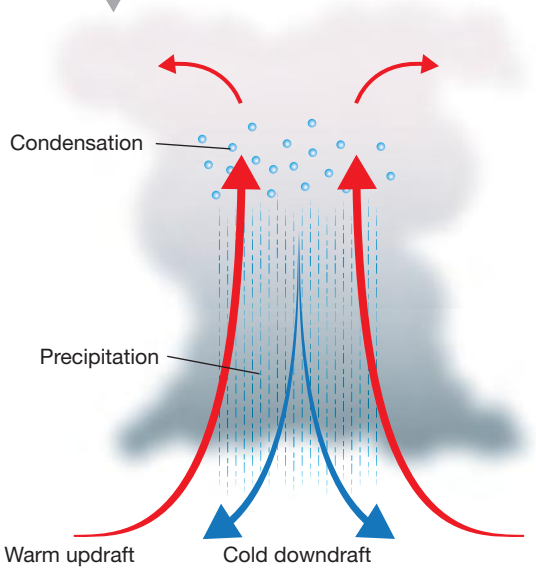
3.12 Orographic rainfall



Convectional rainfall

Convectional rainfall, outlined in Figure 3.13, occurs when the energy of the sun heats the earth's surface and causes water to evaporate (changes it from a liquid to a gas). Warm, moist air then rises, cooling as it does so. Eventually, the air reaches a point called the **condensation** level (or dew point), where it has cooled to such an extent that the water vapour condenses and turns back to a liquid form. This process of condensation high in the atmosphere results in the development of clouds. As the clouds continue to grow, the weight of the water droplets increases, eventually leading to precipitation.

3.13 Convectional rainfall



Rainfall in Australia

The topography of the land, distance from the Equator and presence of ocean currents all influence the location of rainfall in Australia. Figure 3.14 shows the types of rainfall that different parts of Australia experience. Note that some locations experience more than one type of rainfall.

3.14 Distribution of different types of rainfall in Australia



ACTIVITIES

3.2

Knowledge and understanding

1. List the forms of precipitation.
2. Describe the conditions under which rain develops.
3. Explain the process of coalescence.
4. Explain how dew forms.
5. Explain why rising air is important to the process of precipitation.

Applying and analysing

6. Construct an annotated sketch or flow chart explaining convectional rainfall.
7. Draw a raindrop, a hailstone and a snowflake. Next to each, describe the conditions required for its formation and explain how it forms.
8. Study Figure 3.11. Outline how precipitation differs depending on whether it is associated with the passage of a cold front or a warm front.

Geographical skills

9. Study Figure 3.14, then complete the following tasks.
   - **a** Find your present location and name the type of rainfall that occurs there.
   - **b** Describe the locations where the three different types of rainfall are experienced in Australia.
   - **c** Name the type of rainfall that is not found in Australia.

3.3 Geoskills: Climate graphs

Climate graphs show the average temperature and rainfall experienced at a particular place throughout the year.

Climate statistics

In Australia, the Bureau of Meteorology collects weather-related data from more than 1000 sites. Once the Bureau has collected data from any site for 10 years, the data is made available to the public. Many sites have records going back more than 100 years.

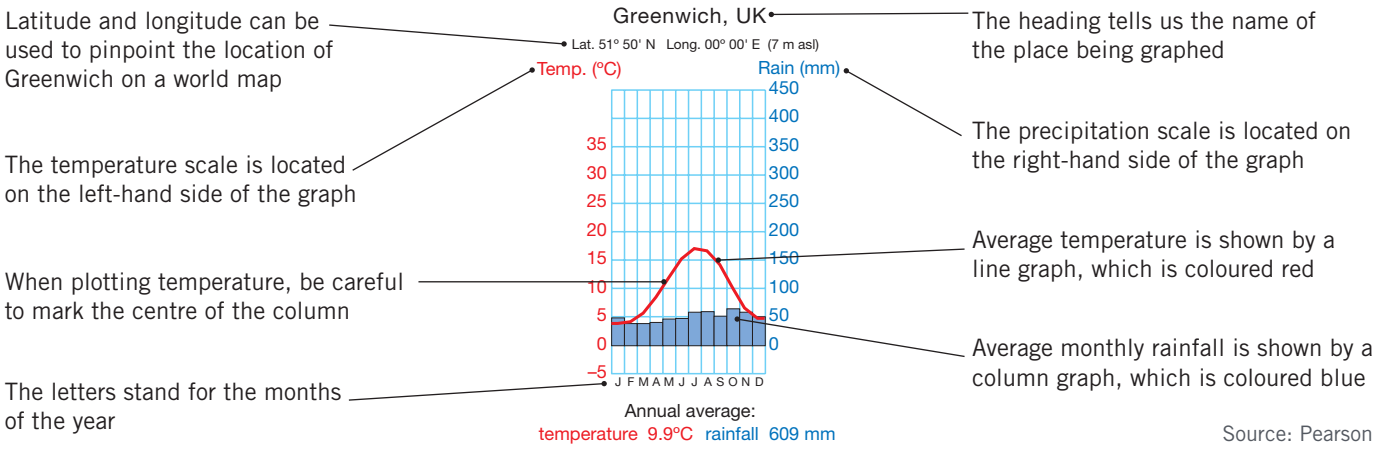
Constructing a climate graph

Climate graphs are constructed using data collected by **meteorologists**. The main features of a climate graph are shown in Figure 3.15.

When constructing a climate graph, follow these steps:

1. Transfer the relevant temperature and rainfall data from your data source into the table at the base of the climate graph. The data used to create the climate graph in Figure 3.15 is shown in Table 3.16.
2. Study the data to identify the wettest month and the highest and lowest temperatures. Use this information to select a suitable scale for both temperature and precipitation.
3. Add a heading that includes the name of the place being graphed and its latitude, longitude and elevation.

3.15 Climate graph for Greenwich, United Kingdom



Source: Pearson

3.16 Climate statistics for Greenwich, United Kingdom

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Average temperature (°C)	3.9	4.2	5.7	8.5	11.9	15.2	17.0	16.6	14.2	10.3	6.6	4.8	9.9
Rainfall (mm)	49	39	39	41	47	48	59	60	52	65	59	51	609

Describing climate

Climate can be broadly described as very hot, hot, warm, cool, cold or very cold. To give a more detailed description, use Tables 3.17–3.19.

- Table 3.17 lists terms that are used to describe the annual temperature range—the difference between the highest monthly average temperature and the lowest.
- Table 3.18 shows that a description of annual rainfall is influenced both by the amount of rainfall and by the broad type of climate.
- Table 3.19 lists terms that are used to describe monthly average precipitation.

For example, Greenwich (see Figure 3.15) has a moderate temperature range: the difference between the highest monthly average temperature (17.0°C) and the lowest (3.9°C) is 13.1°C. The annual average temperature (9.9°C) is classified as cool; because of this, Greenwich's annual average precipitation (609 millimetres) is considered to be adequate. Greenwich has seven dry months and five wet months; it does not have any very wet months.

3.17 Describing annual temperature range

Temperature range (°C)	Description
less than 5	small
between 5 and 15	moderate
between 15 and 30	large
more than 30	very large

3.18 Describing annual precipitation

Amount—cold to warm climates (mm)	Description	Amount—hot to very hot climates (mm)
below 250	slight	below 375
250–500	small	375–625
500–1000	adequate	625–1125
1000–1500	large	1125–1750
above 1500	very large	above 1750

3.19 Describing monthly average precipitation

Amount (mm)	Description
below 50	dry month
50–150	wet month
above 150	very wet month

ACTIVITIES

3.3

Knowledge and understanding

1 Name the data typically featured in climate graphs.

Geographical skills

2 a Construct climate graphs for New York City and New Delhi from the data in Tables 3.20 and 3.21.

b Access Bureau of Meteorology data and create a climate graph for your closest city or town.

c On a blank map of the world, mark in New Delhi, Greenwich, New York City and your closest city or town. Next to each city, write a short paragraph describing its climate.

d Does the location of a city have an impact on its climate? Explain.

3.20 Climate statistics for New York City, USA

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Average temperature (°C)	–0.4	–0.1	4.1	10.1	16.1	21.3	24.3	23.3	19.5	13.5	7.3	1.5	11.7
Rainfall (mm)	83.6	78.8	98.5	93.4	106.0	84.5	105.0	104.3	91.2	83.5	106.6	92.3	1128.9

3.21 Climate statistics for New Delhi, India

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Average temperature (°C)	14	17	22	29	33	34	31	30	29	26	20	15	25
Rainfall (mm)	23	20	15	10	15	68	200	200	123	19	3	10	706

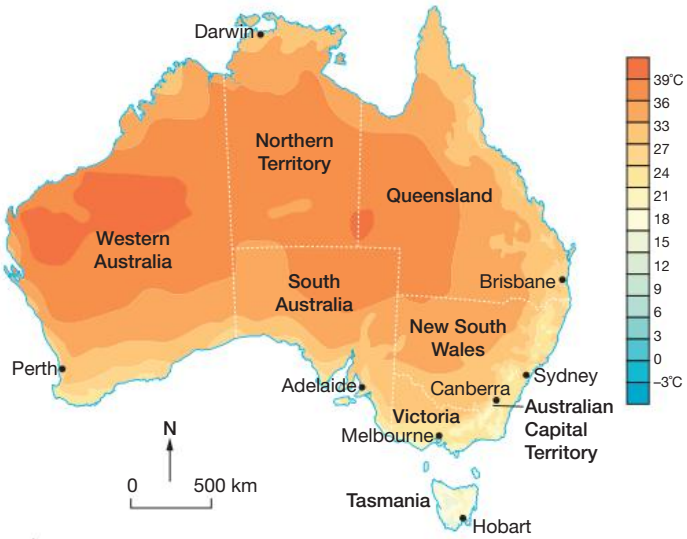
3.4 Case study: Australia's weather and climate

The variety or diversity of Australia's unique biophysical environments reflects the great variation in climatic conditions. The type of vegetation, the mix of flora and fauna, and the soils of an area are a product of the interaction between temperature and precipitation.

Ecosystems

The desert ecosystems of central Australia are a product of low rainfall, high daytime temperatures and high **evaporation**, while Tasmania's temperate rainforests show the influence of high rainfall and more moderate temperatures.

Climate is also a major influence on the Australian lifestyle and land uses. Summer and winter variations in maximum temperature and rainfall, as well as annual averages, are shown in Figures 3.22–3.27.



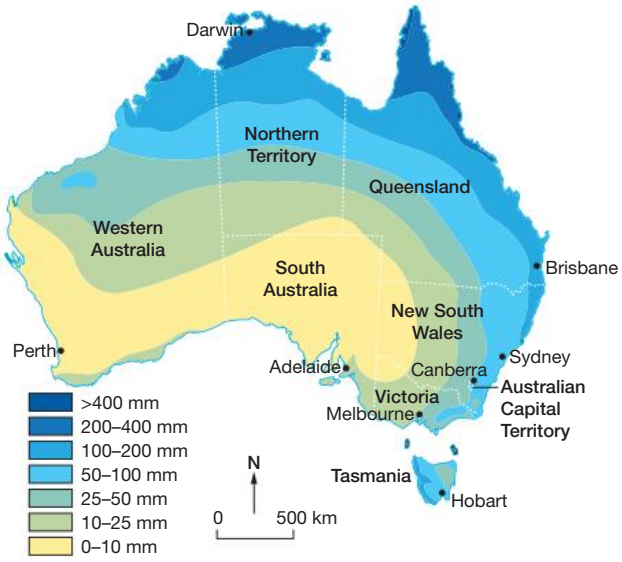
3.22 January average maximum temperature



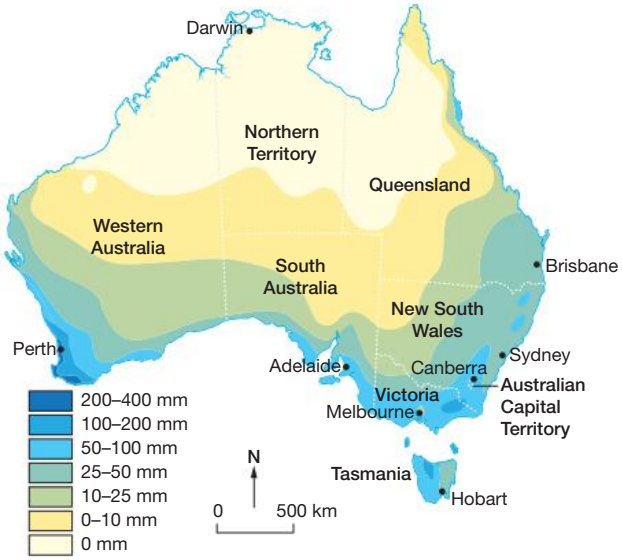
3.23 July average maximum temperature



3.24 Annual average maximum temperature



3.25 January average rainfall



3.26 July average rainfall

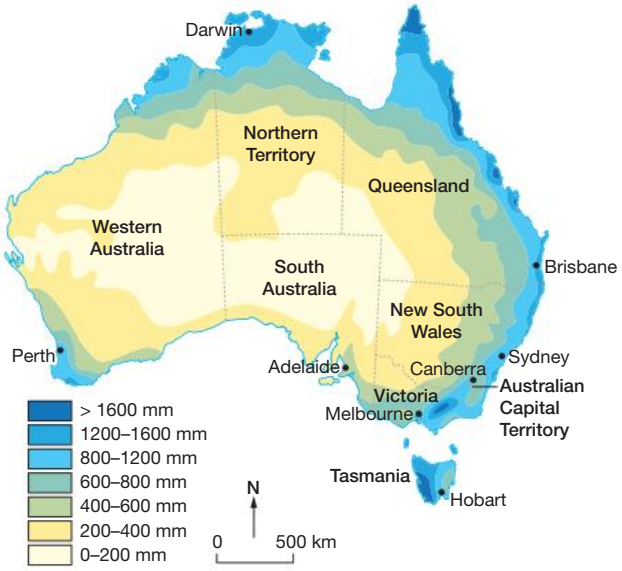
Why Australia is dry

Compared with the earth's other continental landmasses, Australia is very dry. More than 80 per cent of the continent has an annual rainfall of less than 600 millimetres; only Antarctica receives less precipitation than Australia.

Four factors contribute to the dryness of the Australian landmass. These are outlined below.

Cold ocean currents

Cold ocean currents located off the west coast of Australia result in low rates of evaporation from this cold body of water. Consequently, little or no moisture moves onto the continent from the ocean (see Figure 3.28).



3.27 Annual average rainfall

Flat continent

The absence of any significant mountain ranges over most of the continent means that there is little opportunity for rainfall caused by orographic uplift. In the east, the Great Dividing Range limits the amount of rainfall inland.

High-pressure systems

Because of Australia's mid-latitude location (between 20° south and 35° south), its climate is dominated by high-pressure systems. These are usually associated with stable atmospheric conditions; that is, clear skies and gentle winds.

Shape of the continent

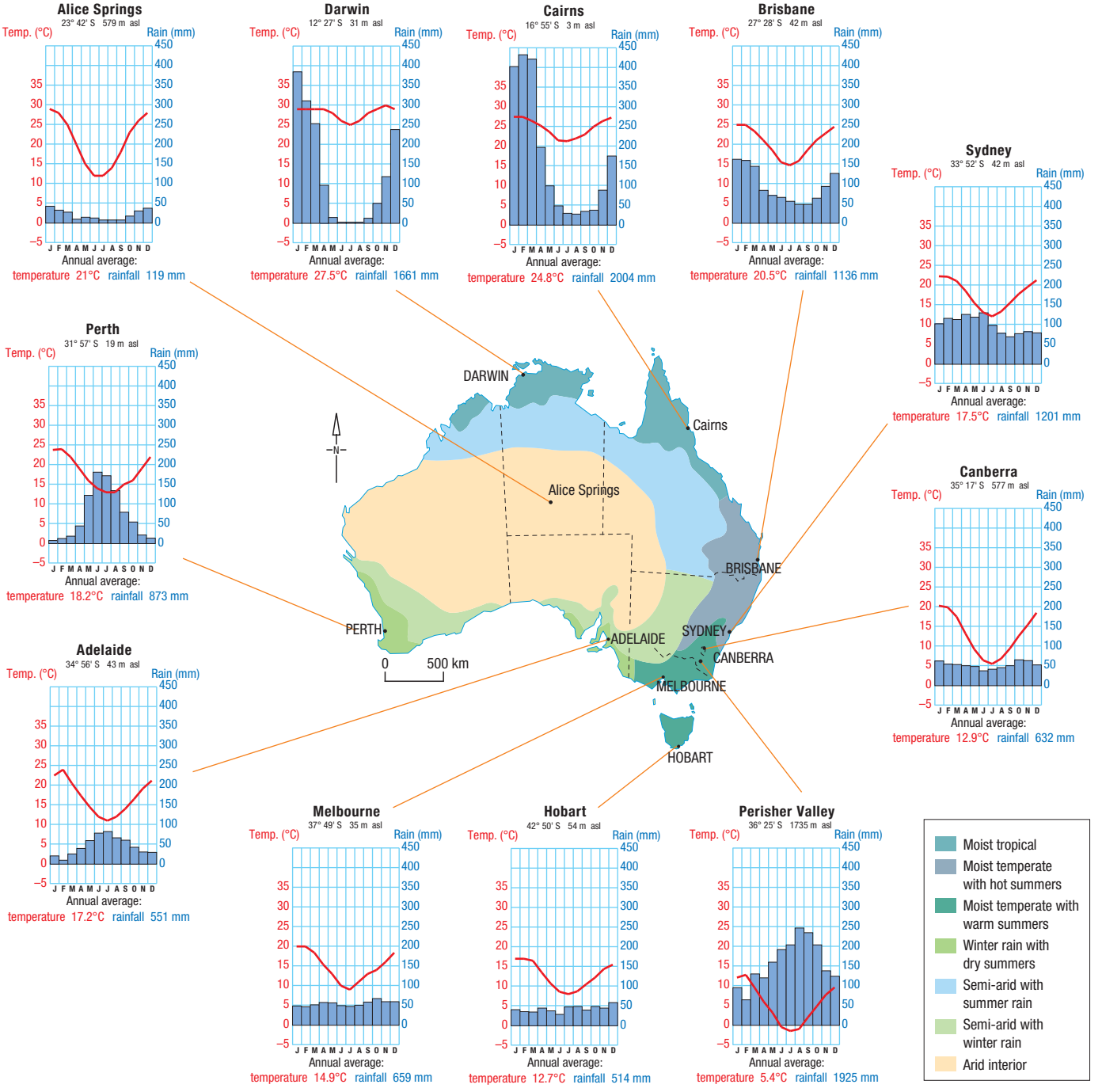
Australia has a compact shape and no significant bodies of water extend very far inland. This means that moist winds do not reach inland Australia, and this keeps rainfall low.



3.28 Because of the dominance of cold ocean currents, deserts extend right to the coast in parts of Western Australia.

Climate statistics

The pattern of Australia's climate is shown in Figure 3.29. The climate graphs show the average rainfall and temperature for Australia's capital cities and other selected locations.



3.29 Australia's climatic regions

ACTIVITIES

3.4

Knowledge and understanding

1 List Australia's climate regions.
2 Name the climate region of Australia in which you live.

Applying and analysing

3 Explain why summers in northern Australia might be described as 'uncomfortable'.
4 As a class, list the ways in which climate affects the activities of people in Australia.

Geographical skills

5 Plan a trip around Australia for the following activities. Explain which region of Australia you will visit for each activity, and in which month(s) of the year.
   a a beach holiday
   b skiing and snowboarding
   c alpine bushwalking
   d waterskiing
   e cross-country mountain biking
6 Sketch an outline map of Australia, and draw on it the boundaries of each climatic region. Annotate your map with a brief description of the climate experienced in each region.
7 Study Figure 3.29 and then complete the following activities.
   a Describe the distribution of the following climatic regions:
      i moist tropical
      ii moist temperate with hot summers
      iii moist temperate with warm summers
      iv winter rainfall with dry summers
      v semi-arid with summer rain
      vi semi-arid with winter rain
      vii arid interior.
   b Describe the different climates you would experience on a journey directly from:
      i Adelaide to Darwin
      ii Brisbane to Alice Springs.
8 Study Figure 3.29 and then complete the following tasks.
   a Which location has the lowest average annual rainfall?
   b Which location has the highest average annual rainfall?
   c Which location has the lowest average temperature?
   d Which location has the highest average temperature?
   e Which location has the smallest annual range of temperature?
   f Which location has the largest annual range of temperature?
   g Estimate the average July temperature experienced by Darwin, Brisbane, Sydney and Hobart. Comment on the pattern shown. Account for this pattern.
   h Describe the seasonal distribution of rainfall received in Darwin and Cairns.
   i Describe the seasonal distribution of rainfall received in Adelaide and Perth.
   j Divide the climate graphs into those that show:
      i most rainfall in summer
      ii most rainfall in winter
      iii even rainfall distribution throughout the year.
9 Study Figures 3.22–3.24, then complete the following tasks.
   a Write a paragraph describing the January pattern of maximum temperatures.
   b Write a paragraph describing the July pattern of maximum temperatures.
   c Write a paragraph describing the annual pattern of maximum temperatures.
10 Study Figures 3.25–3.27, then complete the following tasks.
   a Write a paragraph comparing the January and July patterns of rainfall.
   b Write a paragraph describing the pattern of average annual rainfall.

3.5 Geoskills: Weather maps

A weather map, or synoptic chart, is a record of the weather conditions across part of the earth's surface at a particular point in time. It includes information about air pressure, wind speed and direction, and the distribution of rainfall.

Reading weather maps

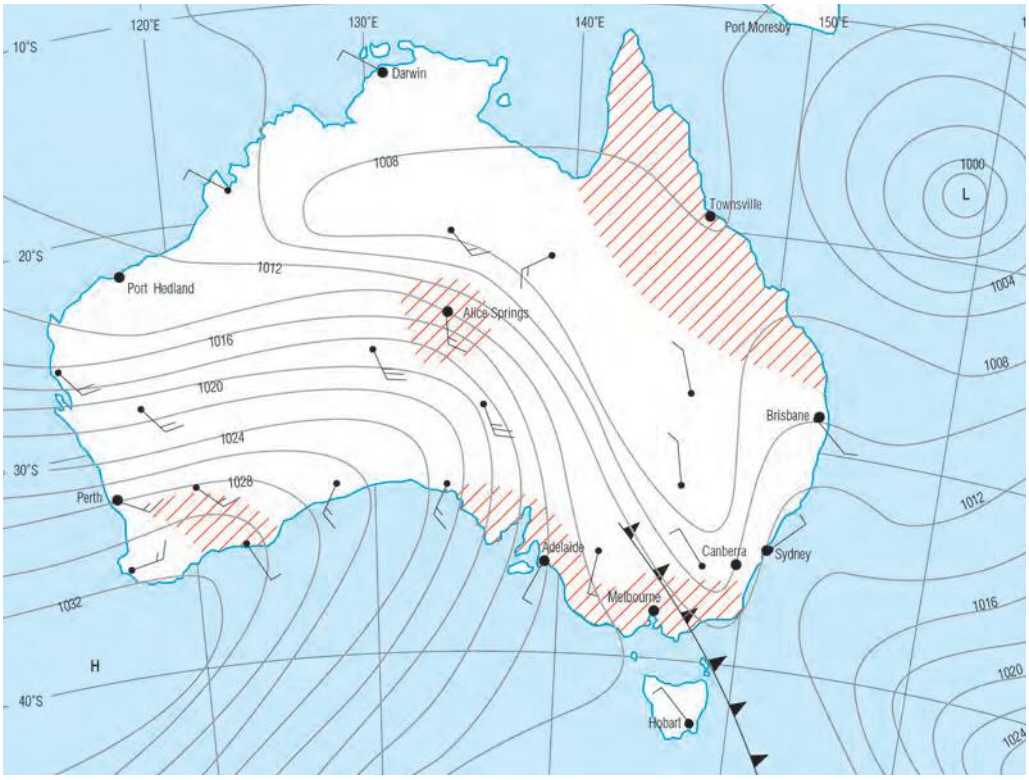
Being able to read weather maps is an important life skill. Australian farmers, for example, use weather maps to help them plan their farming activities. With the aid of weather maps and satellite photographs, meteorologists are able to identify hazardous weather conditions, including storms, temperature extremes and cyclones.

Warm fronts occur when a warm parcel of air overtakes a colder, denser air mass, and is forced to rise. As with a cold front, rain often results as air rises. Warm fronts are not common in Australia.

Cold fronts occur when a mass of cold, dense air pushes in under a mass of warm air, forcing it to rise. As the warm air rises, it cools and condensation takes place. Lower temperatures are experienced once the front has passed.

Ⓛ Low-pressure systems form when warm air rises rapidly. They are typically associated with unstable weather conditions: cloudy skies, rain and relatively strong winds.

Ⓗ High-pressure systems are typically characterised by stable atmospheric conditions: gentle winds, clear skies and little chance of rain.



3.30 A weather map, or synoptic chart, records the conditions in the atmosphere at a particular time.

Rainfall areas are shown by shading or cross-hatching.

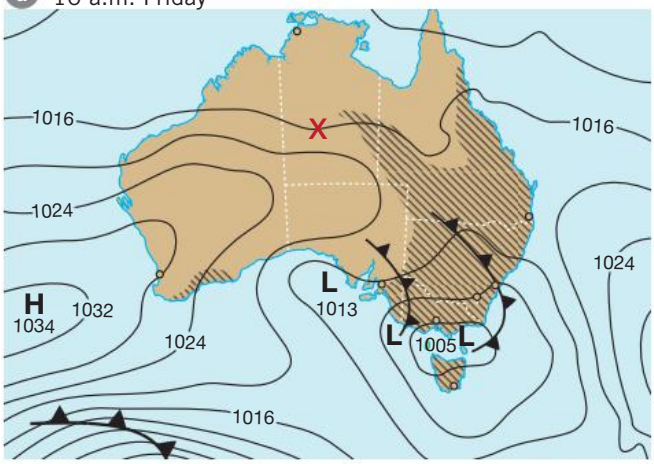
—1212—

Isobars join places with the same atmospheric pressure. Air pressure is measured in hectopascals (hPa). Isobars are usually drawn at intervals of 2 hPa. Isobars that are well spaced indicate only gentle winds. Isobars close together indicate relatively strong winds.

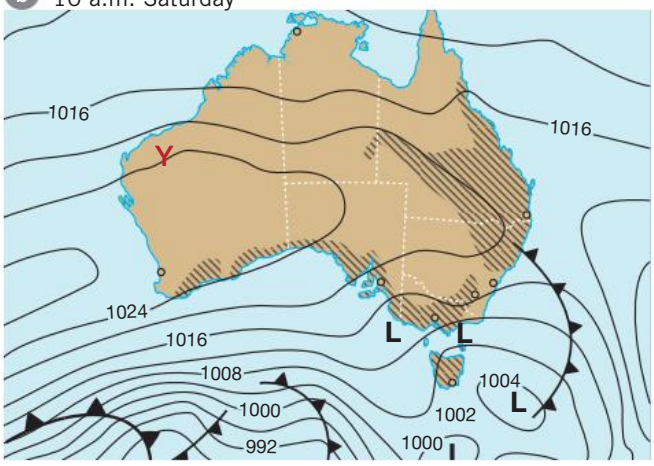
Winds (km/h)
calm
1.14
5.13
14.23
24.32
33.41
42.51
52.60
61.68

Wind direction and strength are shown for selected locations using lines with small barbs or tails. Winds are named after the direction they blow from; for example, Alice Springs is experiencing a moderate southerly wind.

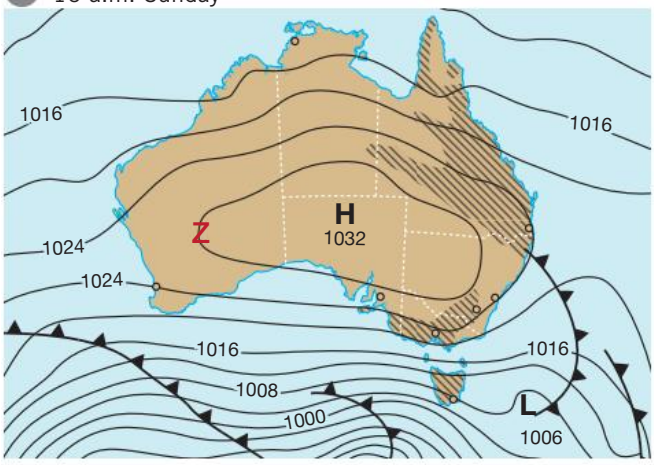
a 10 a.m. Friday



b 10 a.m. Saturday



c 10 a.m. Sunday



Mean Sea Level Pressure Prognosis
Issued: July 11
Updated daily between 2 p.m. and 3 p.m. EST
All times Eastern Standard Time (EST)

cold front; developing front; monsoon trough; isobar-hectopascal (hPa); capital city
warm front; decaying front; trough; forecast rain 1mm or more

Forecast rainfall is for the 24-hour period preceding the chart time.

3.31 A three-day weather forecast from the Bureau of Meteorology

ACTIVITIES

3.5 3.6

Knowledge and understanding

1 Explain why the ability to interpret weather maps is an important 'life skill'.
2 Outline the weather conditions typically associated with high- and low-pressure systems.
3 Describe the wind conditions when isobars are:
  a close together
  b further apart.

Geographical skills

4 Use Figure 3.30 to answer the following questions.
  a Which capital cities received rainfall in the previous 24 hours?
  b What were the wind conditions for the following cities?
    i Perth
    ii Brisbane
    iii Adelaide
  c Which capital city had gentle winds?
  d Predict what the weather will be like in Perth in the next 24 hours.
  e Predict what the weather will be like in Melbourne in the next 24 hours.
  f What is the air pressure in the following cities?
    i Sydney
    ii Adelaide
5 Use Figures 3.31a, b and c to answer the following questions.
  a At 10 a.m. Friday, which capital cities are predicted to experience rainfall in the next 24 hours?
  b At 10 a.m. Friday, what type of weather system crosses the southern half of Australia?
  c What is the atmospheric pressure in hectopascals at X?
  d What is the pressure in hectopascals at Y?
  e What is the atmospheric pressure in hectopascals at Z?
  f At 10 a.m. Saturday, what is the air pressure at the centre of the low off the south-east coast of Tasmania?
  g At 10 a.m. Sunday, in which states is no rainfall forecast?
  h Predict the weather for your region of Australia at 10 a.m. on Monday.

3.6 In the field: Measuring weather

The aim of this fieldwork activity is to measure and record weather-based data in the school playground. Once the data has been collected and recorded, you will compare it with weather data from the Bureau of Meteorology.

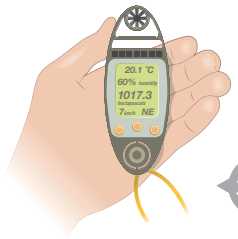
How to record weather data

A variety of instruments can be used to record weather data for a specific location. You can use:

- traditional weather-recording instruments
- a handheld weather-recording device (see Figure 3.32)
- a handheld digital tool (such as an Apple iPhone or iPad or an Android device) that has the ability to record weather data at your location. You may need to add weather-recording applications to your digital tool.

To ensure the accuracy of your weather data, ensure that the site you select to record your data is:

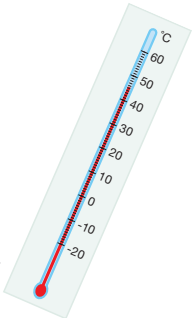
- in the open and not under cover
- free from obstructions, such as overhanging trees or walls and fences
- not close to heating or cooling vents.



3.32 A handheld weather-recording device

Temperature

A thermometer (see Figure 3.33) is used to record air temperature.



A thermometer 3.33

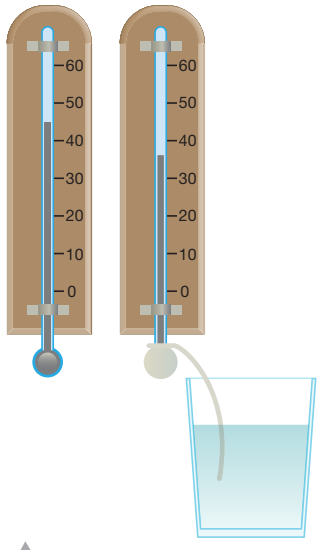
Method

Using a thermometer or handheld weather-recording device, record the temperature.

Note: If using a thermometer, do not hold it by the bulb, as your body heat may affect the temperature reading.

Relative humidity

A wet–dry bulb thermometer (see Figure 3.34) is used to measure and record relative humidity. **Relative humidity** is the amount of water vapour in the air. A wet–dry bulb thermometer is a standard mercury-in-glass thermometer. The thermometer bulb is wrapped in muslin, which is kept wet. The evaporation of water from the thermometer has a cooling effect, so the temperature indicated by the wet–dry bulb thermometer is less than the temperature indicated by a normal thermometer. The rate of evaporation from the wet–dry bulb thermometer depends on the humidity of the air: evaporation is slower when the air is already full of water vapour. For this reason, the difference between the temperatures indicated by the two thermometers gives a measure of relative humidity.



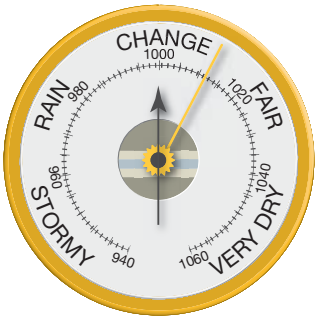
3.34 Wet–dry bulb thermometer

Method

Using a wet–dry bulb thermometer or handheld weather-recording device, record the relative humidity.

Air pressure

You can use an aneroid barometer (see Figure 3.35) to measure atmospheric pressure (air pressure). An aneroid barometer contains a sealed box from which most of the air has been removed. Any change in pressure will make the box shrink or expand. Levers magnify these changes, causing a pointer to move on a dial. Air pressure at sea level is generally around 1013 hectopascals (hPa). It can drop to 970 hPa during severe storms. In a high-pressure system it can reach 1040 hPa. A drop in air pressure, measured over a day or two, indicates that unsettled weather is coming.



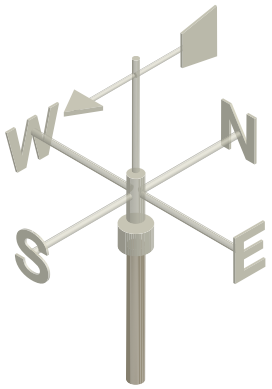
3.35 An aneroid barometer

Method

Using a barometer or handheld weather-recording device, record the air pressure.

Wind direction

A wind vane shows the direction from which the wind is blowing. Winds are named after the direction from which they blow. A wind blowing from the south, for example, is called a southerly.



3.36 A wind vane

Method

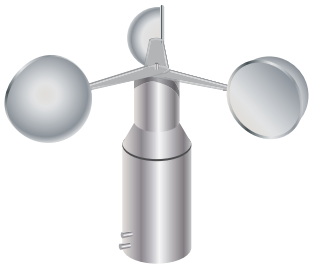
Using a wind vane (see Figure 3.36) or handheld weather-recording device, record the wind direction.

Wind speed

An anemometer (see Figure 3.37) is used to measure wind velocity (wind speed). An anemometer works by spinning in the wind: the higher the wind speed, the faster the anemometer spins. Wind speed is calculated by counting the number of revolutions per hour.

Method

Using an anemometer or handheld weather-recording device, record the wind speed.



3.37 An anemometer

Note: If you don't have an anemometer or handheld weather-recording device, estimate the approximate wind speed by observing the surrounding conditions and comparing these with the descriptions given in the Beaufort scale (see Table 3.38). This will give you the approximate wind speed.

3.38 The Beaufort scale

Wind strength	Speed (km/h)	Description
Calm	0–2	Smoke rises vertically
Light air	2–5	Smoke drifts
Light breeze	5–10	Leaves rustle, vane moves
Gentle breeze	10–20	Leaves and small branches move
Moderate breeze	20–30	Small branches move, dust and paper are lifted
Fresh breeze	30–40	Large branches move, wave crests appear on water
Strong breeze	40–50	Large trees move, umbrellas are difficult to use
Moderate gale	50–60	Large trees sway
Fresh gale	60–75	Branches break off trees
Strong gale	75–90	Large branches come down
Full gale	90–100	Trees are uprooted, structural damage to buildings

Skillsbuilder

Making and using a simple rain gauge

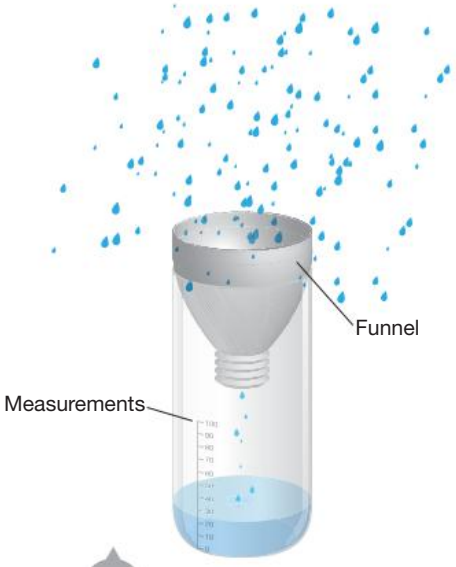
Making a rain gauge

To make a rain gauge (see Figure 3.39), you will need an empty clear-plastic 2-litre drink bottle and a ruler.

1. Cut the empty drink bottle in half, turn the top part upside down and push it into the bottom part to act as a funnel. The larger opening of the funnel should be the same size and shape as the bottom of the bottle.
2. Measure out and mark a scale in millimetres (mm) on the outside of the bottle. Alternatively, you could tape the ruler to the outside of the bottle. Either way, make sure the scale is vertical and that zero is at the bottom.

Measuring rainfall

1. Find a location for the rain gauge where it will not collect any run-off of rainwater—for example, from overhead trees, roofs or signs. There is a minimum distance that official rain gauges must be from such obstructions. For example, if a nearby tree is 5 metres tall, the rain gauge must be at least twice that distance (i.e. 10 metres) away.
2. To measure rainfall, hold the rain gauge so that your eye is level with the top surface of the water. Read the rainfall in millimetres from the scale (or the ruler) on the outside of the bottle.
3. To measure precipitation in the form of hail or snow, remove the funnel. Allow the ice or snow that collects in the bottom of the bottle to melt, and then measure it as in Step 2 (above).
4. Record your rainfall data and include the date and time of measurement.



3.39 A simple rain gauge

Rainfall

A rain gauge is used to measure the amount of rainfall received in a twenty-four hour period. Rainfall is measured in millimetres. A funnel collects the rainfall and directs it into a measuring tube.

Method

1. Place a rain gauge outside, free from obstruction.
2. Measure the amount of water in the rain gauge. After you have measured the water, empty the rain gauge. You will need to measure rainfall at the same time each day.
   Note: If you do not have access to a rain gauge, you can create your own. See the Skills builder box, 'Making and using a simple rain gauge'.

DID YOU KNOW?

Different types of clouds are given names derived from Latin words that describe their appearance—for example, cirrus (a lock of hair), cumulus (a heap), stratus (from *stratum*, a blanket or covering)—or other characteristics, such as nimbus (a shower of rain).

How to access weather data

Bureau of Meteorology

The Bureau of Meteorology (BoM) is Australia's national agency for weather, climate and water. The BoM has numerous monitoring stations throughout Australia to record weather, climate and water data. You will find the weather station closest to where you recorded your weather data.

Method

1. Go to the Bureau of Meteorology (BoM) website. On the home page, select **Climate and Past Weather**, then click **Weather & climate data** to go to the Climate Data Online page.
2. In section 1 of the **Select using Text** tab, choose **Weather & climate** from the drop-down menu. Under Statistics, click the **Monthly** button.
   In section 2, type in the box the location where you recorded your data. Click the **Find** button. Click to select your location from the list, then click the weather station closest to your location.
   In section 3, click the **Get Data** button.

ACTIVITIES

Aim

To investigate weather data and the extent to which weather varies in an area.

Method

1. Select a suitable site in the school grounds or local community at which to record weather data. Ensure you use the same location each day at the same time.
2. Select the weather-recording device or instruments that you will use to collect your data.
3. Collect weather data on temperature, relative humidity, air pressure, rainfall (precipitation), wind speed and wind direction over a five-day period.
4. Copy the fieldwork data table below and record your findings. Include a description of the weather for each day.

Fieldwork data table

Date: _____ Time: _____

Location: _____

	Day 1	Day 2	Day 3	Day 4	Day 5
Temperature (°C)					
Relative humidity (%)					
Air pressure (hPa)					
Precipitation (mm)					
Wind speed (km/h)					
Wind direction					
Weather description					

5. Access the Bureau of Meteorology website and select your nearest capital city or the main town closest to your school or local community. Copy the table below into your workbook and add in the average monthly weather data on temperature, relative humidity, air pressure, rainfall (precipitation), wind speed and wind direction.

Average monthly data table

Date: _____ Location: _____

	Monthly average
Temperature (°C)	
Relative humidity (%)	
Air pressure (hPa)	
Precipitation	
Wind speed (km/h)	
Wind direction	

Evaluation

6. Analyse the weather data you collected by answering the following questions.
   - **a** Is there a link between air pressure and the weather? Explain.
   - **b** How do wind speed and direction affect the temperature?
   - **c** Can you see any patterns in the information you collected?
   - **d** Compare the weather data you collected with the monthly average for the area. Is there a similarity or a difference between them? Explain.
   - **e** Why do you think there might be a similarity or a difference?

Conclusion

7. What do the results of this activity tell you about weather conditions between, and within, areas?

CHAPTER

4

WEATHER HAZARDS AND DISASTERS



Humans have always attempted to control their environment. With the aid of technology we can move mountains, clear vast forests, change arid lands into fertile fields and divert the flow of rivers. There are, however, elements of our surroundings that remain beyond our control. From time to time, nature reminds us of its power and our own vulnerability. Extreme events within biophysical environments can destroy whole communities.

We cannot control the weather, but we can study the processes that cause weather hazards and disasters. This allows us to better predict extreme weather events and to develop better ways of managing their effects.

In this chapter we explore the ways in which weather-related natural hazards impact on communities. In particular, we focus on storms, tornadoes, tropical cyclones, floods, heatwaves and droughts.

KEY IDEAS

- To investigate the impact of weather hazards and disasters
- To understand the causes of floods and drought in Australia
- To compare the different types of floods
- To develop skills in creating pie graphs

GLOSSARY

air pressure	the weight of the air pressing down on the earth's surface at a particular location
desertification	the expansion of deserts due to overgrazing, soil erosion, climate change or prolonged drought
drought	a prolonged period of below-average rainfall
flash flood	a flood resulting from an intense storm dropping large amounts of rain in a short time
flood	an event in which land that is normally dry becomes covered by water; a flood is caused by an overflow of water from a river or stream or the release of water from a dam
heatwave	a short period (usually no longer than a few days) of well-above-average temperatures
hyperthermia	overheating of the body
inundate	to cover with water
land degradation	a decline in the condition or quality of land as a result of misuse or overuse
natural disaster	serious disruption to a community or region caused by a natural hazard
natural hazard	an event in the biophysical environment such as a storm, cyclone, flood or drought
rapid-onset flood	a flood that occurs with little or no warning; sometimes referred to as a flash flood
run-off	the movement of surface water down slopes
slow-onset flood	a flood that may last for one or more weeks—sometimes months
storm surge	a rapid rise in the height of the ocean along a coastline caused by storm winds pushing water towards land
tornado	a violent, rotating column of air extending from the base of a thunderstorm to the ground
tropical cyclone	an intense low-pressure system over tropical waters, usually with strong winds and heavy rain

4.0 Tornado, New Mexico, United States of America

4.1 Hazards and disasters

As we go about our daily lives it is easy to forget that our biophysical environment contains potential threats to life and property. Many of these threats are related to weather and climate. They include severe storms, tropical cyclones, tornadoes, flooding, heatwaves and drought.

Hazards and disasters

Natural hazards are extreme and unusual natural events. When natural hazards impact on people, they are referred to as **natural disasters**.

It is important to remember that weather-related hazards and disasters are only one of several types of natural hazards that affect people. Other natural hazards and disasters include events associated with the earth's surface and those associated with the ocean. Table 4.1 lists different types of natural hazards and Figure 4.2 shows examples of weather-related hazards.

4.1 Natural hazards

Events associated with the earth's atmosphere (weather-related hazards)
• Major floods: the result of prolonged heavy rain
• Flash floods: the result of heavy and intense downpours
• Tropical cyclones: high-speed winds, heavy rain and storm surges
• Droughts: prolonged periods of below-average rainfall
• Bushfires: the result of dry conditions, high temperatures and high winds
• Storms: high winds, lightning and heavy rainfall
Events associated with the earth's surface
• Earthquakes and tremors: sudden, often violent movements in the earth's crust
• Landslides and slumps: sudden downhill movements of soil and rock
Events associated with the ocean
• Coastal erosion: the result of storm-induced waves
• Storm surges: large waves caused by storms
• Tsunamis: very large, earthquake-induced waves

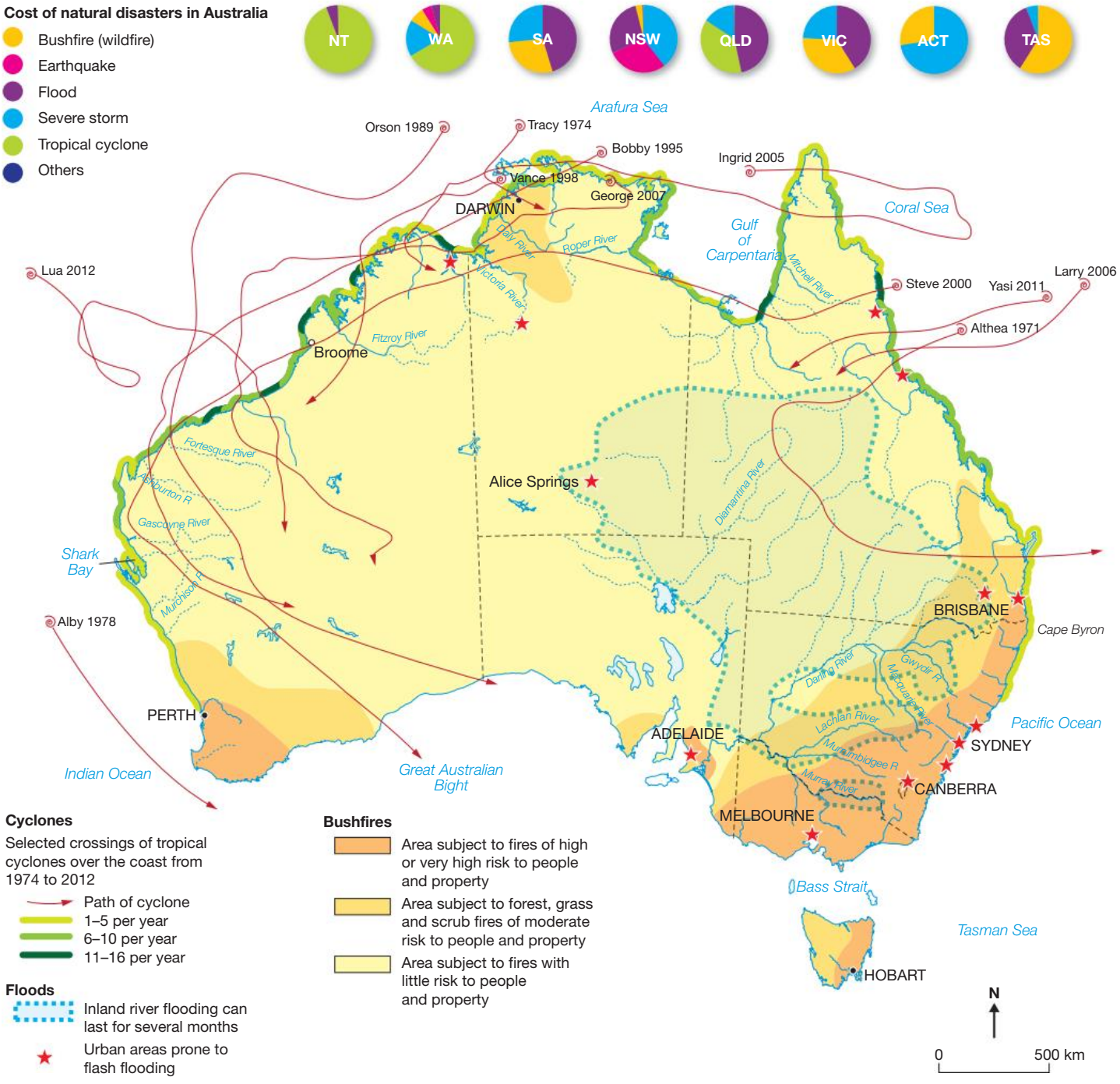


4.2 Weather-related hazards and disasters: (a) storm, (b) flood, (c) heatwave, (d) bushfire, (e) drought

Natural hazards and disasters in Australia

Since the European settlement of Australia, more people have died from heatwaves than any other natural hazard. The types of natural disasters and their distribution are shown on the map in Figure 4.3. The most costly natural hazards in economic terms have been drought and flood. The most costly single events, however, have been Darwin's Cyclone Tracy (1974), the Newcastle earthquake (1989), the Sydney hailstorm (1991), the Canberra bushfires (2003), Cyclone Larry (2006), the Newcastle storm (2007), the Gippsland floods (2007), Victoria's Black Saturday bushfires (2009), and the Queensland floods and Cyclone Yasi (2011). The graph in Figure 4.4 shows the frequency of natural disasters over the last 30 years.

4.3 Australia's most common natural hazards are storms, floods, droughts and bushfires.

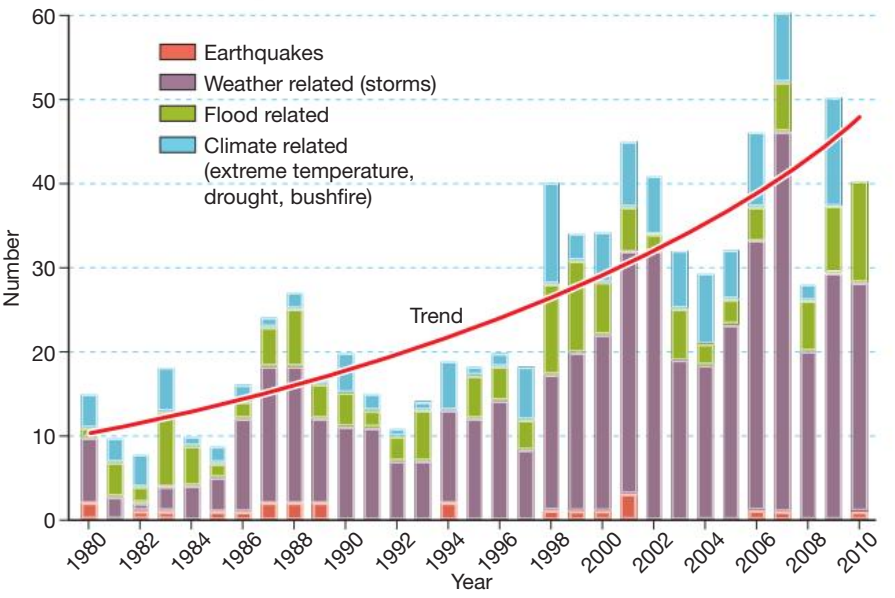


Impacts of natural hazards

Natural hazards have a range of environmental, economic and social impacts:

- ***environmental impacts***—destruction of natural and human environments; the death of wildlife either directly or indirectly (for example, due to starvation)
- ***economic impacts***—the destruction of property, crops and livestock, infrastructure, and plant and equipment; the loss of income for those affected
- ***social impacts***—loss of life and the stress placed on people, as well as the disruption to community life and the destruction of community-based infrastructure such as roads, bridges, schools, shops and power lines.

4.4 The incidence of natural disasters in Australia



Skillsbuilder

Pie graphs

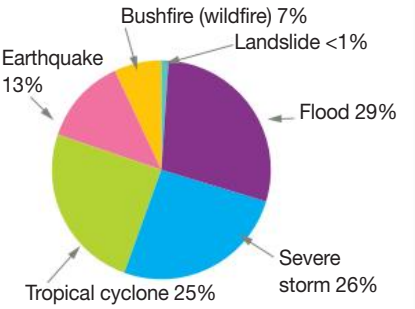
Pie graphs (see, for example, Figure 4.5) are circles divided into segments radiating out from the centre. The size of each segment of the graph is proportional to the value it represents.

A complete pie graph (360°) represents 100 per cent. Therefore, each percentage point is represented by 3.6°. Knowing this statistic will help you to construct and interpret pie graphs.

To construct a pie graph, follow these steps.

1. Draw a circle and then extend a line from its centre to the 12 o'clock position.
2. Convert the percentage value of each value or variable to degrees by multiplying it by 3.6.
3. List your converted values from the largest to the smallest. Place categories such as 'others' at the end of your list.
4. Starting at 12 o'clock, mark each segment on the graph using a protractor. Work in a clockwise direction, starting with the largest segment.
5. Shade and label each segment. It may be useful to provide a legend or key. If a legend is included it is not necessary to label the segments.
6. Add an appropriate title.

4.5 Average proportional cost of natural disasters in Australia, by type



Nature's deadly toll

Natural disasters killed 325 773 people worldwide in 2010–11 and cost US$510 billion. In total, 1282 natural disasters were recorded during the two-year period, making it one of the worst periods in recent history.

The earthquake in Haiti in January 2010 was the worst disaster in terms of human cost, killing 222 570 people.

In 2011, the earthquake and related tsunami in Japan killed more than 15 000; drought and famine in East Africa killed an estimated 30 000 people; floods in Thailand killed 800 people and caused damage costing US$45 billion; a typhoon in the Philippines killed 1200; and storms in the United States of America killed 700 and cost US$35 billion.

SPOTLIGHT

Impacts of climate change

Scientists predict that climate change will increase the frequency and severity of some natural disasters. The number of bushfires such as the one shown in Figure 4.6, for example, is likely to increase in many parts of the world as temperatures rise and rainfall becomes less reliable (see Figure 4.4). The frequency of severe storms and coastal flooding will increase and low-lying coastal communities will be at greater risk because of rising sea levels. Droughts will be more common and last longer.



4.6 A bushfire in Bunyip State Park in February 2009 threatened towns just east of Melbourne.

In late 2010 and early 2011, Australia experienced widespread flooding in Queensland, New South Wales and Victoria and the massive Tropical Cyclone Yasi slammed into northern Queensland. Christchurch, New Zealand, was devastated by a magnitude 6.3 earthquake, which killed more than 180 people.

On 11 March, a magnitude 9.0 earthquake, now known as the Great East Japan Earthquake, struck off the coast of Japan's largest island, Honshu. The accompanying tsunami killed more than 25 000 people. The economic cost of this disaster is expected to exceed $300 billion, making it the most expensive natural disaster in history.

ACTIVITIES

4.1

Knowledge and understanding

1 Explain the difference between a natural hazard and a natural disaster.
2 Identify the main natural hazards affecting Australia.
3 Outline the impacts of natural hazards and disasters.

Applying and analysing

4 Study Figure 4.3.
  a Identify the natural hazards that have the potential to impact where you live.
  b Discuss ways to reduce the impact of the hazards identified.

Geographical skills

5 Using Figure 4.3 and an atlas, describe the areas of Australia most seriously affected by the following natural hazards.
  a tropical cyclones
  b floods
  c bushfires
  d earthquakes
6 Study Figure 4.4. What trend is evident in the number of natural disasters in Australia? Think about the reasons for this trend. What are the most common types of natural disasters? Which are the least common?
7 Using the instructions in the Skills builder box 'Pie graphs', create two pie graphs to display the following data:

Natural disasters

Location	2010	2011
Africa	90	64
Asia	310	146
Europe	120	18
Americas	365	93
Australia and Oceania	65	11

4.2 Severe storms

Severe storms are the most common natural hazard. They are a local disturbance in the atmosphere and are accompanied by thunder, lightning, rain, hail and, in some cases, snow. They can occur anywhere and are responsible for more damage than any other natural hazard.

Effects of severe storms

Environmental

Storms usually only affect a small area compared with tropical cyclones and floods. Environmental damage caused by severe storms includes fallen trees and branches, and damage from hailstones and rain.

Social

In Australia severe storms on average kill between five and ten people a year, mostly due to lightning strikes (see Figure 4.7). More deaths occur when strong winds cause power lines and tree limbs to fall, and debris (such as roofing iron) to become airborne. People may be left homeless after a severe storm.

Economic

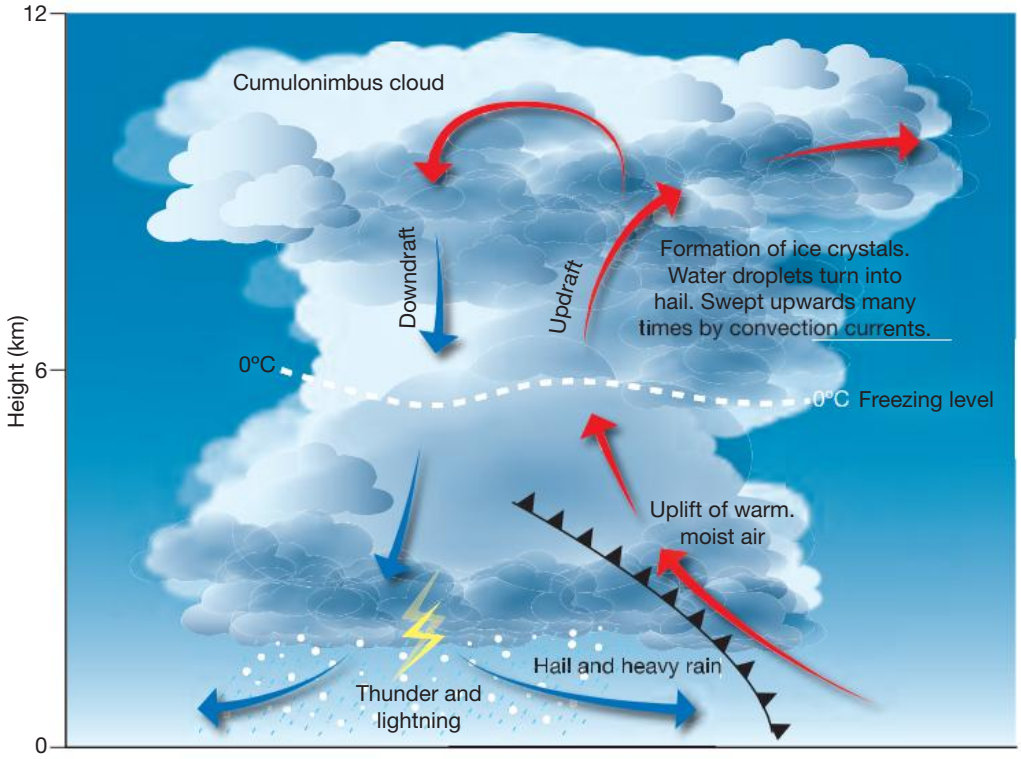
Severe storms can be very expensive. Infrastructure that is damaged or destroyed needs to be repaired or rebuilt. This can include power lines, homes and businesses. A major economic cost is the damage caused to cars by large hailstones smashing windows and denting panels.

How storms develop

Storms develop when warm, moist air rises rapidly in an unstable atmosphere. Sometimes this upward movement is caused by the passage of a cold front. On other occasions (often in summer), the heating of the earth's surface is enough to bring about the rapid upward movement of moist air (see Figure 4.8). Most of these storms do not reach the level of intensity needed to produce widespread damage, but they all produce lightning, which can cause death, injury and damage. Sometimes they are accompanied by hail, wind gusts and flash floods.

4.7 Storms are among nature's most spectacular and most dangerous natural hazards.





4.8 The development of a thunderstorm associated with the passage of a cold front

Skillsbuilder

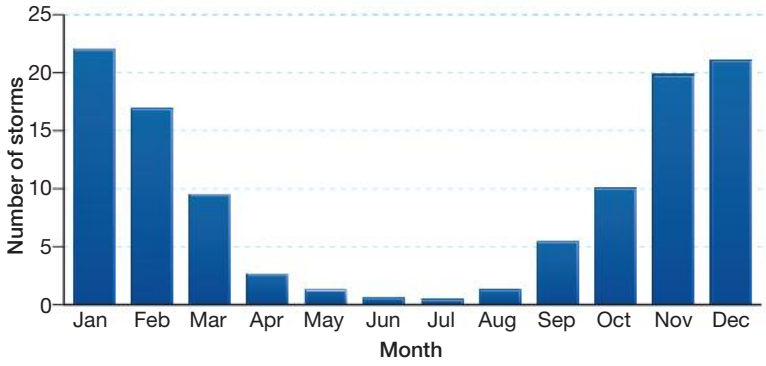
Reading a column graph

A column graph (see Figures 4.9–4.10) uses vertical columns to present information. The height of the column indicates the value of the data. The values on the horizontal axis represent different times or places at which the data was collected. This information can be compared. Note that bar graphs are similar to column graphs, but use horizontal bars.

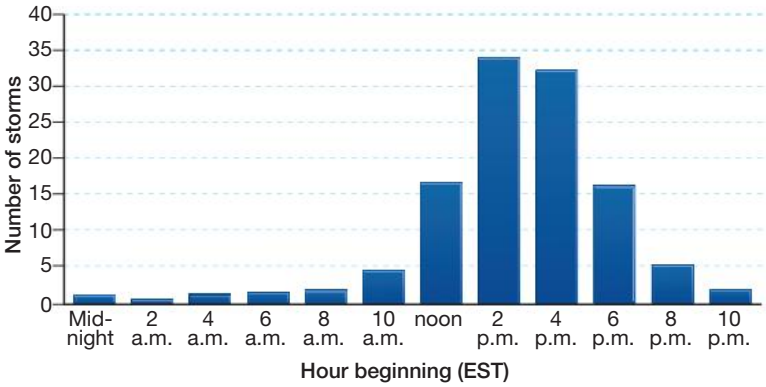
To interpret a column graph, follow steps 1–5.

1. Study the graph's title to see what the graph represents.
2. Read the vertical and horizontal axes.
3. Read the legend to see what extra information it contains.
4. Look at the data. Can you observe a pattern in the data? If so, describe the pattern and suggest reasons for it.
5. Discuss the implications of the trends or patterns identified in the graphed data.

4.9 Monthly distribution of severe thunderstorms in NSW and the ACT



4.10 Hourly distribution of severe thunderstorms in NSW and the ACT



Lightning and thunder

Lightning is caused by the discharge of electricity during thunderstorms. It is accompanied by thunder. The cause of lightning is not fully understood but ice inside a cumulonimbus cloud is thought to be a key element in lightning development.

The distance of lightning from an observer can be calculated using the time interval from when the lightning is seen to when the sound of thunder is heard. Lightning is approximately 1 kilometre distant for every 2.9 seconds that elapse between the visible flash and the first sound of thunder.

The 2007 Newcastle storm

On 8 June 2007, severe thunderstorms with very heavy rain (164.6 millimetres in six hours from 3.00 p.m. to 9.00 p.m.) and gale-force winds lashed the Newcastle area, resulting in severe flooding in the city's central business district and nearby suburbs. Hundreds of cars were stranded or swept away. Many shops and businesses were flooded. Winds averaged up to 105 kilometres per hour with gusts to 124 kilometres per hour. The 76 000-tonne bulk ore carrier *Pasha Bulker* was blown onto Nobbys Beach (see Figure 4.11) and was not refloated until 2 July. There were 20 000 calls for assistance to the State Emergency Service.

4.11 The bulk carrier *Pasha Bulker* stranded on Nobbys Beach after running aground during a severe storm



SPOTLIGHT

Storm survival guide

There are many precautions you can take to make sure you don't become a victim of a severe storm. Some of them are listed in Table 4.12.

4.12 Guide to surviving a storm

Indoors

1. Keep clear of windows, electrical appliances, pipes and other metal fixtures.
2. Avoid using telephones. If an emergency call is required, make it brief!
3. Disconnect external aerial and power leads to radio and television sets.
4. Disconnect computers at their power sources.

Outdoors

1. Seek shelter in a building or 'hard top' vehicle.
2. Avoid taking shelter under an isolated tree or small stand of trees.
3. If out in the open, crouch down, preferably in a hollow, with feet together, and remove metal objects from head and body. Do not lie down.
4. If your hair stands on end or you hear buzzing from nearby rocks, fences etc., move away to a new position immediately.
5. Don't fly kites or model aircraft with control wires.
6. Don't handle long or metallic objects such as umbrellas, golf clubs or fishing rods in the open.
7. Avoid standing close to, or touching, metal structures, wire fences or metal clothes lines.
8. Don't ride horses or bicycles or drive in open vehicles.
9. If driving, park your car away from trees, power lines etc. Stay inside but avoid touching or leaning on metal body parts.
10. Leave the water immediately and seek shelter if you are swimming or surfing.
11. If boating, go ashore as soon as possible or seek protection beneath a high structure such as a bridge or jetty.
12. Ensure that the mast and stays of sailing boats are adequately 'grounded' to the water.

DID YOU KNOW?

Thunderstorms have killed 1635 people and injured 2021 in Australia since 1824.

ACTIVITIES

4.2

Knowledge and understanding

1. Explain what is meant by the term 'severe storms' and identify what often accompanies them.
2. Outline the conditions under which severe storms develop.
3. Retell how people are killed during severe storms in Australia.

Applying and analysing

4. Study Figure 4.8. Write an explanation of how thunderstorms develop and explain why they are often associated with gusty winds, hail, lightning, thunder and flash flooding.

Geographical skills

5. Study Figures 4.9 and 4.10, then answer the following questions.
   - a In which months of the year are severe storms most likely to occur in New South Wales and the Australian Capital Territory?
   - b At what time of the day does severe storm activity peak in New South Wales and the Australian Capital Territory?
   - c You have been asked to plan an outdoor activity in New South Wales or the Australian Capital Territory that requires fine weather. In which month would you plan the event and what time of the day? Explain your response.

Investigating

6. Using the Bureau of Meteorology severe storm website and the media (newspapers, magazines, television etc.) investigate storms in Australia during the previous 12 months.
   - a Include a definition of a severe storm and the causes of a severe storm.
   - b On a blank outline map of Australia, locate and mark each storm. Annotate the map and include the following information.
     - the date the storm occurred
     - the impacts of the storm
     - the agencies involved in meeting the needs of the people affected
     - the types of assistance available to the victims of the disaster
     - precautions to take during a severe storm

4.3 Tropical cyclones

Tropical cyclones (known as hurricanes and typhoons in other parts of the world) are intense low-pressure systems that form over warm tropical waters. They are usually accompanied by gale-force winds and torrential rainfall.

Cyclones explained

Tropical cyclones begin as tropical depressions (strong low-pressure systems that form in the low latitudes near the Equator). They become cyclones when the systems intensify and wind speeds increase, especially towards the centre (or vortex) of the storm. In severe cyclones, wind speeds can exceed 200 kilometres per hour. In the Southern Hemisphere, winds circulate clockwise around the calm eye of the storm. Tropical cyclones can vary in diameter from about 150 kilometres to over 1000 kilometres.

Cyclones move at speeds of up to 25 kilometres per hour along a fairly unpredictable path. The life of an average cyclone is about seven days, but some last longer.

The life cycle of a cyclone

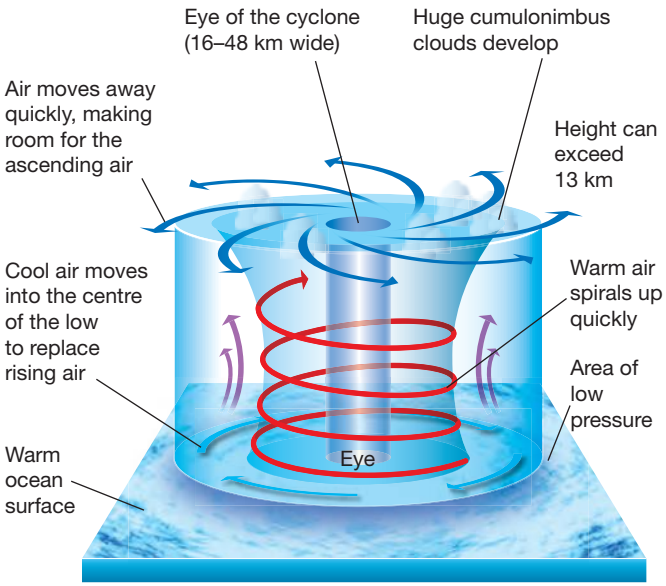
For tropical cyclones to develop, certain conditions need to be present. These include:

- a warm ocean surface (above 26°C) and very humid air—this means that they usually only occur between 5 degrees and 30 degrees latitude on both sides of the Equator
- low-pressure systems.

The process of cyclone formation is shown in Figure 4.13. It begins when an area of low pressure coincides with the vigorous upward movement of air and the formation of cumulonimbus cloud. This is the type of cloud normally associated with thunderstorms. Three phases follow.

Pre-maturity

As the rate of uplift (or convection) increases, winds begin to spiral in towards the system's centre. This is because air moves away from areas of high pressure towards areas of low pressure, which are formed when air is drawn upwards by convection currents. Eventually, the surface winds reach gale force and the distinctive spiral pattern of cloud begins to develop.



4.13 Structure of a tropical cyclone

Maturity

If the warm ocean surface and low atmospheric pressure remain, the cyclone will continue to increase in strength and power. As it does, the cloud system becomes more circular in shape and develops a distinct eye. This is the severe cyclone stage, at which the cyclone is most destructive (see Figure 4.14). Of all the cyclones that form, about half progress to this stage.

Decay

Tropical cyclones normally decay, or lose their intensity, when they move over land or over the cooler oceans in higher latitudes away from the Equator. A cyclone moving over land normally weakens rapidly due to loss of its energy source—namely, the warm ocean surface. In northern Australia, however, when cyclones move inland they often continue as rain depressions for a number of days, bringing widespread flooding rain, and may even redevelop if they move over the ocean once more.



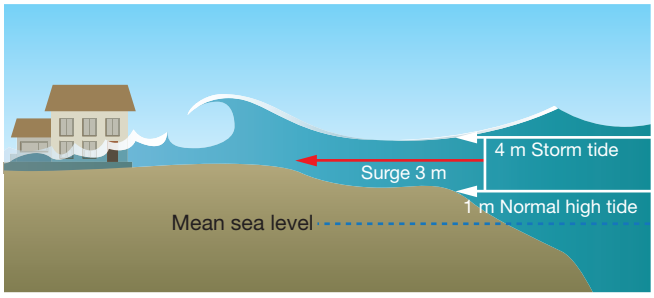
4.14 Damaged vegetation after Tropical Cyclone Yasi hit the area of Mission Beach, Queensland, in February 2011

Cyclone categories

Cyclones are categorised according to their strength. There are five categories: Category 1 is the weakest and Category 5 is the strongest (see Table 4.15).

Storm surges

A **storm surge** is a large mound of seawater that accompanies a tropical cyclone as it comes ashore, as shown in Figure 4.16. The intense winds of the cyclone pile up the ocean into a dome of water that is pushed onshore as the cyclone strikes the coast. The low **air pressure** of the cyclone adds to the height of the mound of water, though this is a secondary effect.



4.16 Storm surges can cause widespread damage in low-lying coastal areas.

4.15 Cyclone categories

Rating	Wind speed	Wave height	Damage
1	Up to 125 km/h Gales	1.2–1.6 m	Slight damage. Damage to some crops, trees and caravans. Craft may drag moorings.
2	126–169 km/h Destructive	1.7–2.5 m	Significant damage. Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small craft may break moorings.
3	170–224 km/h Very destructive	2.6–3.7 m	Structural damage. Some caravans destroyed. Power failures likely.
4	225–279 km/h Very destructive	3.8–5.4 m	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures.
5	Above 280 km/h Very destructive	More than 5.5 m	Almost total destruction and extreme danger. Houses flattened, cars overturned.

Cyclone warning systems

The Bureau of Meteorology identifies cyclones when they develop, and tracks their course. Each cyclone is given a name from an alphabetical list.

The Bureau also has a cyclone warning system. As soon as gales are expected within 24 hours, it issues a cyclone warning to areas that are in danger, predicting wind speeds and other weather conditions. The warnings are issued from three tropical cyclone warning centres (TCWCs) in Brisbane, Darwin and Perth. Information about a cyclone is sent to the TCWCs by computer-controlled instruments located at weather stations around the coast. Automatic weather stations on remote islands, as well as radio links with ships and aircraft, also provide information. Satellite images can be received every hour from a Japanese weather satellite.

Tropical Cyclone Yasi, 2011

Tropical Cyclone Yasi originated from a tropical low near Fiji in late January. It then increased in strength and moved towards Australia, as outlined below and shown in Figure 14.17a–c:

- *31 January*—intensifies to a Category 3 cyclone late in the afternoon
- *1 February*—intensifies to a Category 4 cyclone
- *2 February*—intensifies to a Category 5 cyclone
- *3 February*—makes landfall in Queensland early in the morning.

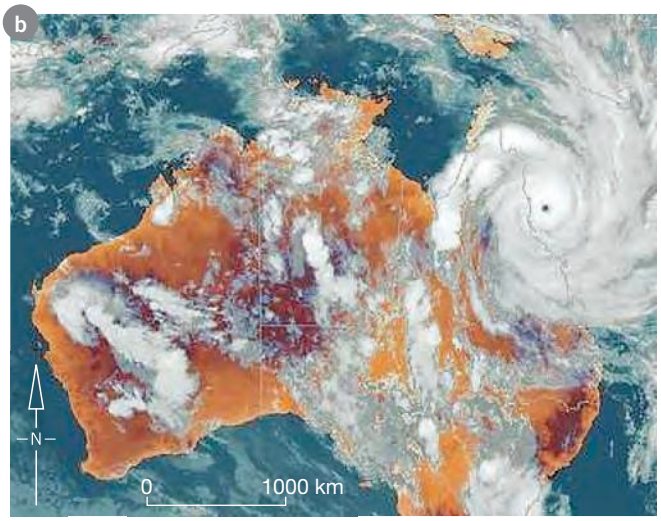
The destructive core of the cyclone crossed the Queensland coast between Cardwell and Innisfail. The maximum sustained wind speed reached 205 kilometres per hour, with wind gusts exceeding 285 kilometres per hour.

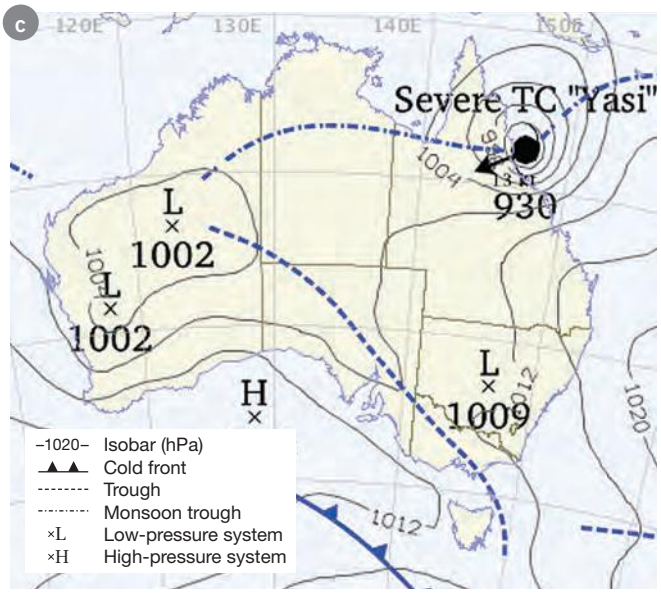
A storm surge estimated at 7 metres high **inundated** low-lying coastal areas, pushing as far as 300 metres inland in some places. The cyclone's destructive winds were accompanied by heavy rainfall and flooding. The highest 24-hour rainfall total recorded was 471 millimetres at South Mission Beach (see Figure 4.17a).

The worst affected communities were Tully, Innisfail, Ingham, Cardwell, Mission Beach, El Arish, Silkwood and Silky Oak. Dozens of homes, businesses and other property (such as the boats in Figure 4.18) were destroyed or severely damaged, vegetation was stripped of its leaves and crops were destroyed. The cost of the disaster exceeded $800 million.

4.17 (a) Radar image showing rainfall intensity as Yasi crossed the Queensland coast; (b) satellite image of Yasi's swirling cloud mass; (c) weather map showing Severe Tropical Cyclone Yasi









4.18 Damaged boats at Port Hinchinbrook, Queensland, after Cyclone Yasi

ACTIVITIES

4.3

Knowledge and understanding

1 Define what a tropical cyclone is. Explain how they form. Outline the type of weather associated with cyclones.
2 Describe how storm surges contribute to the damage caused by cyclones.
3 Identify the parts of Australia that are affected by cyclones.
4 Explain how the Bureau of Meteorology monitors the development of cyclones.

Geographical skills

5 Use Figure 4.17c to answer the following questions.
   a What is the air pressure (hectopascals) of Severe Tropical Cyclone Yasi?
   b Describe the pattern of the isobars around Tropical Cyclone Yasi. What type of winds does this indicate?
   c In what direction is the cyclone heading?
   d How do the low-pressure systems in Western Australia and New South Wales differ from Tropical Cyclone Yasi? What type of weather would these areas be experiencing?

Investigating

6 Create a timeline of what occurs and what to do before, during and after a tropical cyclone. Your timeline should mention all the following stages.
   - the build-up (including preparing your home)
   - during the cyclone (including the eye)
   - immediately after the cyclone
   - after the cyclone (including the damage caused by the cyclone)

   Note: Photographs, diagrams and or videos can be included with your timeline.

7 Access the BoM cyclone website. Using information found on this site and elsewhere, prepare an appropriate multimedia presentation. The following questions will help you to structure your presentation.
   a What are cyclones?
   b Where and how do they develop?
   c In what ways do cyclones pose a threat to life and property?
   d What precautions can be taken to protect life and property?

4.4 Tornadoes

A tornado (or 'twister', as it is sometimes called) is a violently rotating column of air extending from the base of a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction. Tornadoes come in many shapes and sizes, but are typically in the form of a visible funnel whose narrow end touches the earth and is often encircled by a cloud of swirling debris and dust. The funnel of the tornado is called the vortex.



4.19 Tornadoes are violently rotating columns of air extending from the base of a thunderstorm to the ground.

What causes tornadoes

For a **tornado** to form, two main factors are needed. The first of these is an unstable atmosphere with rapidly rising air. As warm, moist air rises, it cools and condenses, forming the cumulus and cumulonimbus clouds typically associated with thunderstorms.

The second important factor is wind shear. This is the difference between wind speed on the ground and that found higher up in the atmosphere. A thunderstorm cell can develop if there is a speed difference of 30–40 kilometres per hour between winds found at the surface and those found at about 3000 metres.

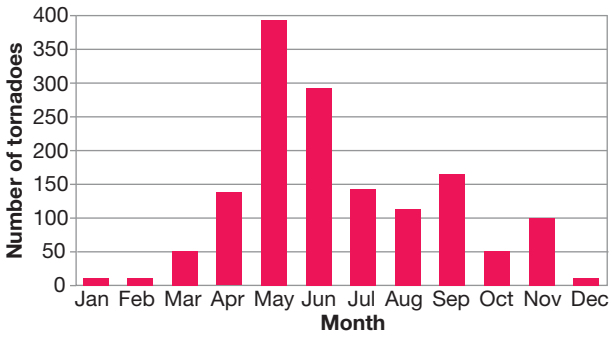
This wind shear causes air to spin in a tube-like fashion along a horizontal axis. The updraft of the thunderstorm then sucks this rolling air upwards so that the axis of its spin is vertical. This gives the tornado its funnel-like appearance (see Figure 4.19).

Where tornadoes occur

Although tornadoes can occur in many parts of the world, they occur most frequently in the United States of America, east of the Rocky Mountains, in a region known as 'Tornado Alley' (see Figure 4.21). During the spring and summer months, thunderstorms develop throughout the region as warm, moist air is forced to rise rapidly by eastward-moving cold fronts. As the updraft increases in velocity, a spinning vortex can develop. The low air pressure created at the centre of the funnel sucks in surrounding air. If the vortex touches the ground the updraft and difference in pressure can cause great damage.

The most deadly tornado on record occurred in 1925, and up to 747 people perished as twisters swept across Missouri, Illinois and Indiana. Since records began in 1875, more than 19 000 people have been killed by tornadoes in the USA. In an average year, more than 1200 tornadoes are reported across the USA (see Figure 4.20).

4.20 The number of tornadoes in the USA in one year



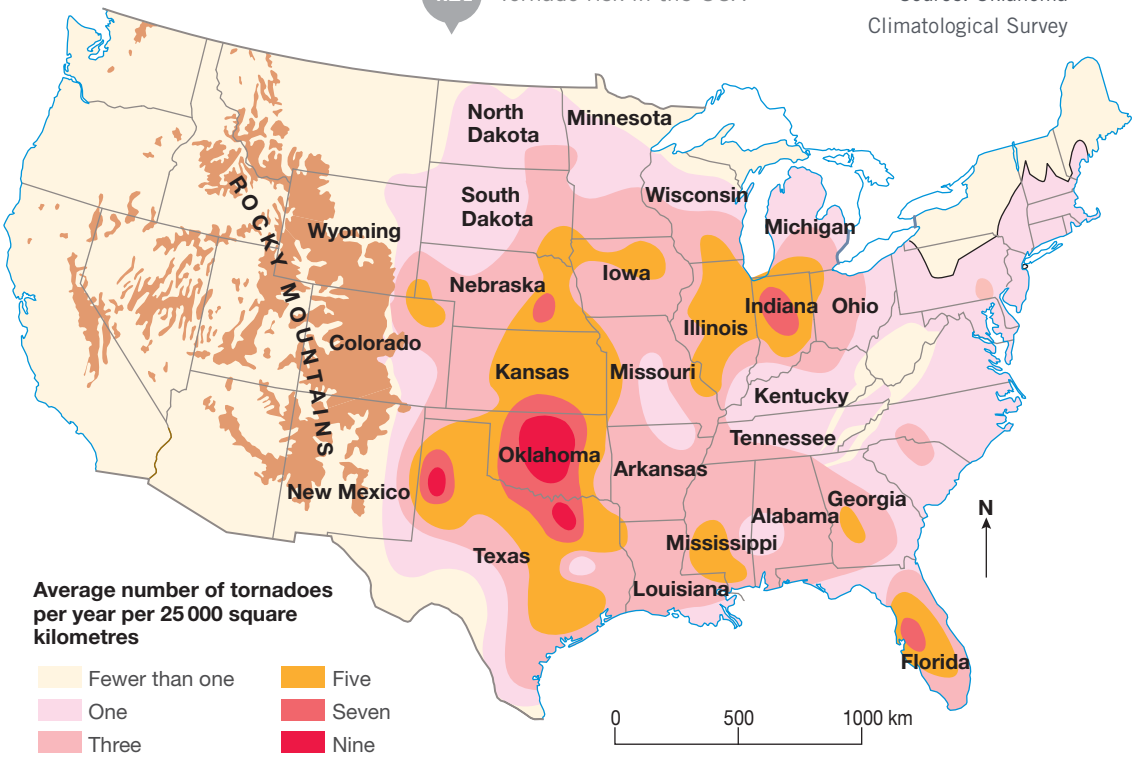
The power of a tornado

Most tornadoes have wind speeds of less than 180 kilometres per hour, measure about 80 metres across and travel several kilometres before subsiding. The most destructive tornadoes can have wind speeds of more than 480 kilometres per hour, develop a width of up to 3 kilometres, and stay in contact with the ground for more than 100 kilometres.

Some tornadoes are so powerful and destructive that they can tear buildings off their foundations and smash them into small pieces; they can flip large trucks and farm machinery and reduce them to mangled pieces of metal; they can pick up and dump cars kilometres away from where they were parked, snap trees off at their base and strip the asphalt from roads.

4.21 Tornado risk in the USA

Source: Oklahoma Climatological Survey

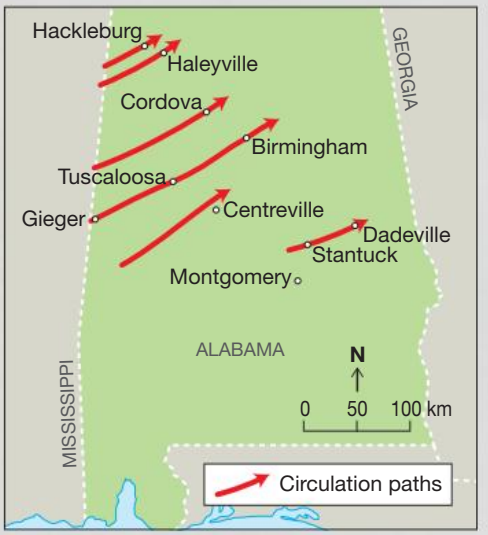


TORNADOES CARVE PATH OF DEATH

Destruction across America's South

A fierce tornado outbreak—the worst in 37 years—has killed at least 280 people across six states from Mississippi to Virginia. Among the worst affected communities was the city of Tuscaloosa, Alabama, which took a direct hit. Whole neighbourhoods were levelled.

The outbreak is the biggest in terms of impact since at least 1974. The 3 April 1974 outbreak sparked twisters across the eastern United States, claiming 310 lives. The damage may rival the 21 March 1932 outbreak, when 332 people were killed. It will not, fortunately, come close to the destruction of 18 March 1925, when 747 people died, most of them along the path of a single twister, after the so-called Tri-State Tornado tore up Missouri, Indiana and Illinois.



4.22 Several twisters slashed a path across Alabama from south-west to north-east on 27 April 2011.



4.23 After the tornado—Tuscaloosa, Alabama, April 2011



4.24 A tornado's path of destruction through the city of Tuscaloosa, Alabama, April 2011



4.25 A waterspout off Batemans Bay, New South Wales, in November 2012

Australian tornadoes

Australia has about sixteen tornadoes a year. They most commonly occur on the south-western coast of Western Australia; in south-eastern South Australia and the nearby border region of Victoria; in the area around south-eastern Queensland; and on the far north coast of New South Wales.

Waterspouts

Waterspouts develop when a rapidly rotating column of air links the base of a thunderstorm to a water body such as a lake or an ocean (see Figure 4.25). Waterspouts do not suck up water; the water seen in the main funnel cloud is actually water droplets formed when air condenses.

ACTIVITIES

4.4

Knowledge and understanding

1 State the name given to the funnel of a tornado.
2 Outline the two factors necessary for the formation of tornadoes.
3 Explain why the United States of America experiences so many destructive tornadoes.
4 Explain what a waterspout is.

Applying and analysing

5 Using Figure 4.21, describe the location of the US states that experience the greatest number of tornadoes per year.
6 Use Figure 4.20 to answer the following questions.
  a Which months have the highest number of tornadoes?
  b Explain why these months might have the highest number of tornadoes. (Hint: the seasons are opposite in the Northern Hemisphere.)
7 Study Figure 4.22, then describe the path of tornadoes in Alabama, USA.
8 Describe the damage observed in Figures 4.23 and 4.24.
9 Write a newspaper report outlining the impacts of a tornado on a small town in the USA's Tornado Alley.

Investigating

10 The Enhanced Fujita (EF) scale is used to rate tornado intensity. The EF scale is based on the damage tornadoes inflict on human-built structures and vegetation. Use the scale to classify the intensity of the tornado responsible for the damage shown in Figures 4.23 and 4.24.
11 Investigate the safety procedures people can put in place to minimise the impact of tornadoes. Structure your finding using the following subheadings: Before, During and After.

4.5 Flooding

Flooding occurs when a waterway overflows its natural banks onto normally dry land. Floods can result from prolonged heavy rain, rapid winter snowmelt or sudden, heavy downpours.

The costs of floods

Environmental costs

Floods can have both positive and negative effects on the environment. The movement of water can remove trees and vegetation and kill wildlife. Flood water can also deposit rich sediment, ideal for growing crops.

Economic costs

Floods are among Australia's most costly natural disasters. Each year, flooding costs the nation, on average, $300–400 million (see Figure 4.26) . Since 1790 there have been more than 2360 flood-related deaths. Today, the majority of deaths from flooding are the result of people trying to drive, walk or swim through floodwaters. Some people are killed by flash flooding while camping on dry riverbeds.

Social costs

Long-term social costs include people losing their homes and businesses and having to rebuild.

4.26 Householders struggle to stop floodwaters inundating their home, Brisbane, 2011.





4.27 Human impacts on flooding

Types of floods

There are three types of **floods**: slow-onset floods, rapid-onset floods and flash floods.

Slow-onset floods build up over time and may last for a week or more—even months. They are often the result of a long period of above-average rainfall. Slow-onset floods can lead to loss of stock, damage to crops and extensive damage to road and rail links. Rivers in central and western New South Wales and Queensland, as well as parts of Western Australia, can flood in this way.

Rapid-onset floods occur more quickly, and are more common in mountain areas of larger rivers and in rivers draining to the coast. These floods may only last one or two days. They are potentially more damaging, since there is often less time to move livestock and farm machinery and to prepare homes and properties.

Flash floods occur when intense storms drop large amounts of rain within a brief period of time. They can occur with little or no warning and can reach their peak within only a few minutes. Flash floods can be extremely dangerous. Sometimes they are caused by heavy rainfall many kilometres away. The resulting floodwaters surge down rivers or creeks, sweeping away all in their path: they can move boulders, tear out trees and destroy buildings and bridges.

Almost all parts of Australia can experience flash floods. These floods pose the greatest threat to life and result in significant damage to property. They are a serious problem in those urban areas where drainage systems are unable to cope.

Factors influencing floods

The main factors that influence whether flooding will occur are:

- the amount and distribution of rainfall
- the capacity of the watercourse or stream network to transport run-off
- water catchment and weather conditions leading up to a rainfall event
- the type of ground cover
- topography (the shape of the land)
- tidal influences.

Human impacts

Human activities in water catchment areas have contributed to the frequency and severity of flooding. People increase the likelihood of flooding by removing water-absorbing vegetation, especially on hillsides. Not only does this increase **run-off**, but it also exposes the soil to erosion, especially by running water. Valuable soil is washed into rivers, where it clogs the channels. The rivers are then less able to cope with the increased volumes of water.

Urban areas, with their hard surfaces, such as roads and buildings, do not absorb water. These areas often experience flash flooding. Heavy downpours can overwhelm stormwater drains and cause water to spill across roadways and footpaths. Figure 4.27 shows these human impacts.

DID YOU KNOW?

Just 15 centimetres of rapidly moving floodwater can knock a person down. A mere 60 centimetres of water can float a vehicle as large as a bus.

SPOTLIGHT

Victorian floods, 2011

Record-breaking rainfall between 12 and 14 January 2011 caused major flooding across much of the western and central parts of Victoria. The river systems affected by the floods included the Wimmera, Loddon, Campaspe and Avoca. The floodwaters inundated the city of Horsham and the towns of Charlton (see Figure 4.28), Rochester and Carisbrook. Other settlements seriously affected included the city of Shepparton and the towns of Beaufort, Bridgewater on Loddon, Clunes, Creswick, Echuca, Kerang, Skipton and Warracknabeal.

The floods devastated farms, with 51 700 hectares of pasture and 41 200 hectares of crops flooded and 6106 sheep killed. Victoria's Department of Primary Industries later calculated a damage bill of up to $2 billion.

4.28 A boat makes its way down a flooded street in Charlton, Victoria.



Flood warnings

With the exception of flash floods, there is usually a warning period before floods occur. Some river systems have quite sophisticated warning systems. They may, for example, have an electronic data collection system that automatically and continuously transmits rainfall and river heights from selected locations within the catchment. In Australia, warnings are issued through the Bureau of Meteorology.

Flood management

The construction of expensive levee banks provides some protection from flooding. The best way to protect property and reduce the risk of loss of life is to restrict the types of activities allowed on flood plains. Too many people still choose to live in flood-prone areas.

The risk of flooding increases as more clearing of vegetation takes place in upper catchment areas. Some ways of managing floods are shown in Table 4.29. These may help to reduce the impact of flooding.

4.29 Reducing the impacts of floods

Flood control
• Dams and reservoirs • Levees • River diversion • Barrages and locks • Whole catchment management
Reducing the risk of flood damage
• Flood plain land-use zoning • Relocation of flood-prone property • Flood-proofing of buildings • Flood forecasting • Being prepared
Minimising the effect of losses
• Flood insurance • Evacuation • Post-disaster relief • Public information and education

ACTIVITIES

4.5

Knowledge and understanding

1 Construct your own definition of the term 'flood'.
2 Outline the causes of flooding.
3 Describe the differences between slow-onset floods, rapid-onset floods and flash floods.
4 Identify the flood type that is potentially the most dangerous for human life. Give reasons for your answer.
5 Outline how the activities of people can increase the frequency and intensity of flooding.
6 Explain what is meant by the term 'flood mitigation'.

Applying and analysing

7 Complete the following tasks.
  a Study the list of factors that influence whether a flood will occur.
  b List how each of the factors alters the likelihood of flooding.
  c Discuss ways of managing or preventing the factors that increase the likelihood of flooding.
8 Study Table 4.29. Present the information in the table as a concept map.
  a Describe what you see, and the possible damage caused.
  b Identify ways in which flood damage could be reduced in the future.

Investigating

9 Investigate a flood that has occurred in your region, or a region of your choice, in recent years.
  a Identify the type of flood.
  b Outline the reasons for the flooding.
  c Describe how the flood developed over time.
  d Describe the damage the flood caused and how people responded.
10 You are a television reporter who has been assigned the task of reporting on the flooding shown in either Figure 4.26 or Figure 4.28. You are required to present a five-minute report for the evening news bulletin. In your report you should outline the possible causes of the flood, describe its impact on the community and outline how the community is coping with the disaster. Produce your television broadcast using iMovie or Windows® Movie Maker®.

4.6 Case study: Queensland floods, 2010–11

By late 2010, a severe drought, which had affected much of eastern Australia for more than a decade, ended with the arrival of record-breaking rains and widespread flooding across Victoria, New South Wales and Queensland. The worst of the flooding occurred in the Fitzroy, Burnett and Condamine river basins of central Queensland.

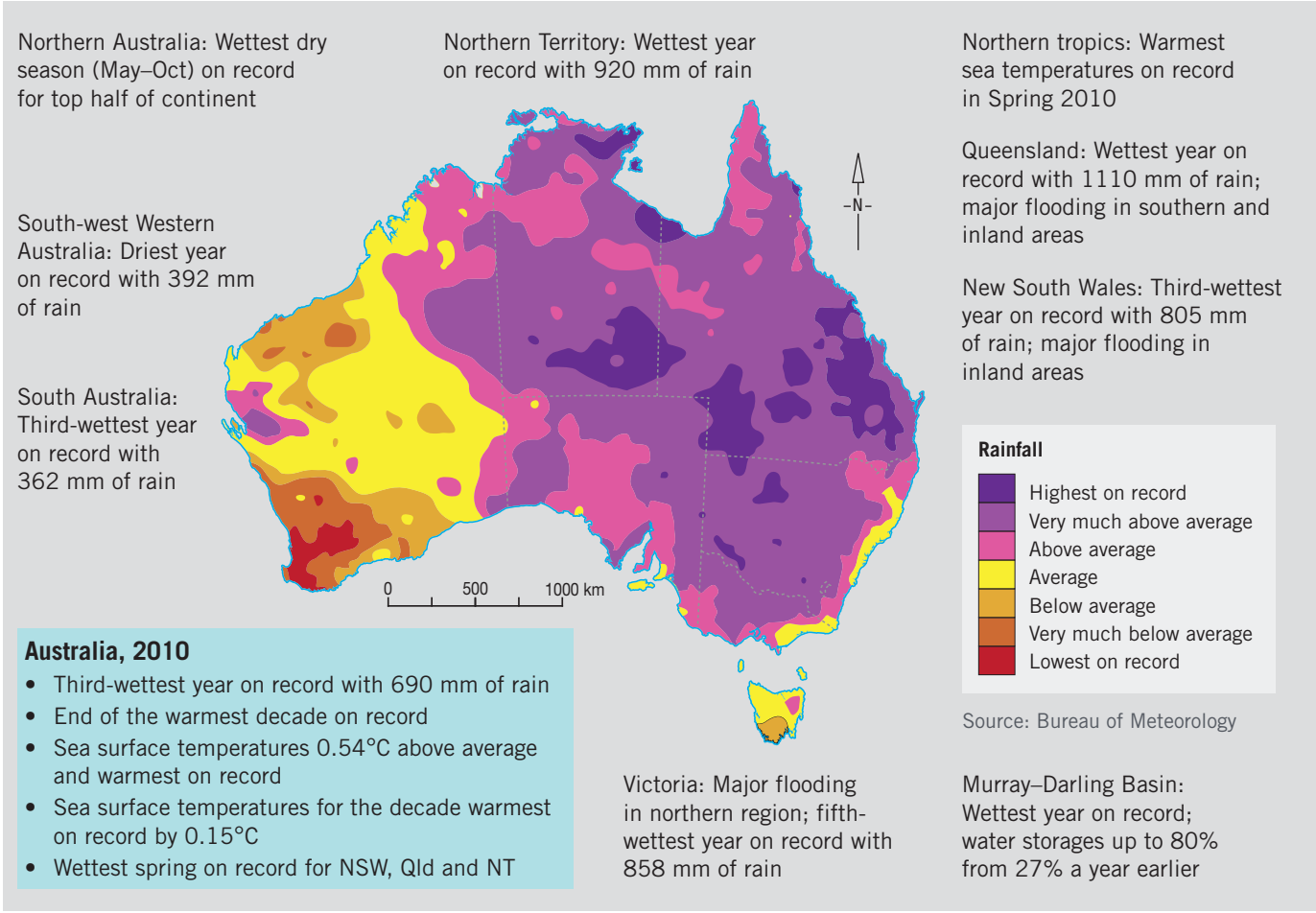
Australia's 'big wet'

In 2010, Australia experienced the third-wettest year on record, with the period from June to December the wettest ever experienced. The return of the rains ended a 14-year 'long dry'—one of the longest droughts in Australian history.

Data collected by the Bureau of Meteorology shows that the Australian mean rainfall total for 2010 was 690 millimetres, well above the long-term average of 465 millimetres (see Figure 4.30).

Sea surface temperatures in the Australian region during 2010 were 0.54°C above the long-term average. This is the warmest on record for the Australian region. Very warm sea surface temperatures contributed to the record rainfall and very high humidity across eastern Australia during the winter and spring of 2010.

4.30 Australia's 2010 annual rainfall compared with the long-term average

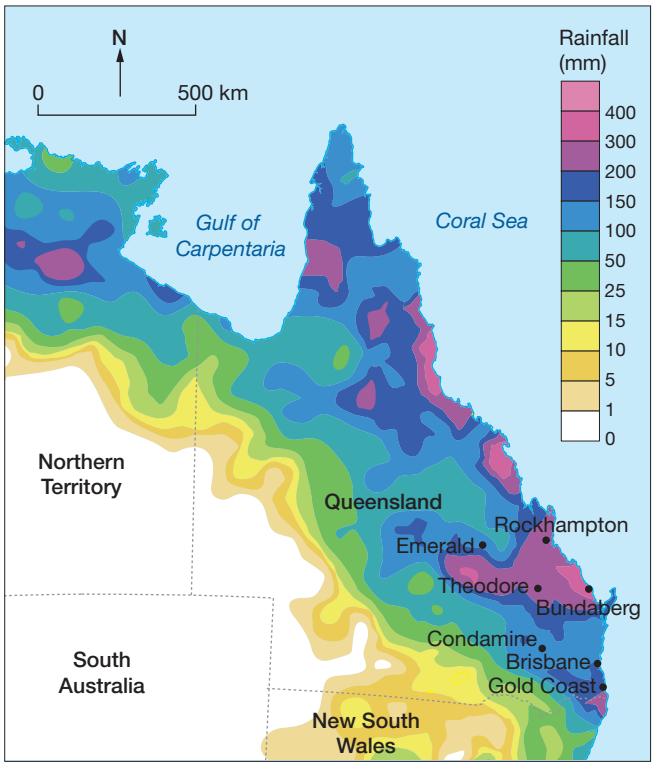


Causes of the Queensland floods

The Queensland floods were caused by the heavy rainfall that occurred when Tropical Cyclone Tasha combined with a monsoonal trough (a region of relatively low atmospheric pressure). On 24 December 2010, the weather system crossed the Queensland coast from the Coral Sea, bringing torrential rain that fell in a broad area from the Gulf of Carpentaria in the north of Queensland to the Gold Coast in the south-east, as shown in Figure 4.31. This area was already saturated from persistent above-average rainfall during the preceding months.

Thousands of properties were flooded in Brisbane, Emerald, Bundaberg, Rockhampton and many smaller centres, while the communities of Theodore and Condamine were evacuated. For some residents, the only way to travel was by boat, as shown in Figure 4.32. A number of rivers throughout the region reached record levels. Damage to property and infrastructure, as well as the economic cost from crop losses and disruptions to mining, was very significant.

4.31 The distribution and intensity of rainfall across Queensland in the week ending 28 December 2010



Source: Bureau of Meteorology

4.32 Flooding in suburban Brisbane



Source: Bureau of Meteorology

Effects of the flooding

By the end of the crisis at least seventy towns, and more than 200 000 people, had been affected by the flooding. Thirty-five people perished. The damage bill exceeded $1 billion. The economic losses were, however, much greater—perhaps as much as $30 billion.

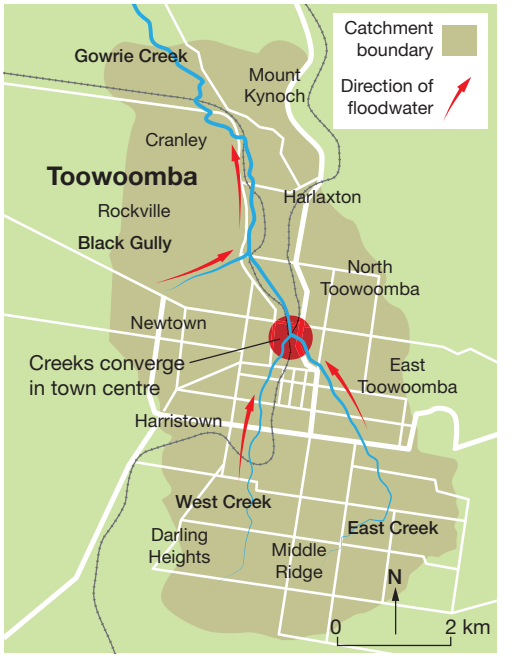
The 2011 Toowoomba and Lockyer Valley flash floods

The City of Toowoomba (population 128 600) sits just below the top of the Great Dividing Range, some 700 metres above sea level, and 125 kilometres west of Brisbane. The city's central business district (CBD) sits in a small valley where two small creeks—East Creek and West Creek—join to form Gowrie Creek (see Figure 4.33).

In the period leading up to the city's 2011 flash flood, the region had experienced a wet couple of months, with more than 300 millimetres of rain falling in December and a further 250 millimetres in the first week of January. An additional 160 millimetres fell in the 36 hours to 10 January, further saturating the region's soils. Just after noon on January 10, fierce storms hit the city. The torrential rain that accompanied the storms surged down East and West creeks. Unable to cope with the amount of water, the creeks burst their banks, pushing a wall of water through the city centre, shown in Figure 4.34, sending cars smashing into bridges and tearing facades off buildings.

The storm that devastated Toowoomba also dumped a massive amount of rain high in the Lockyer Creek water catchment, just to the east. Lockyer Creek rose to a record height of 18.92 metres, resulting in a wall of debris-laden water that surged down the valley. This smashed through several small towns before dumping a mountain of debris on the town of Grantham. The water did not follow existing river courses, which were already flowing swiftly after weeks of rain, but simply swept across paddocks, leaving a path of destruction. Eleven people died in the Lockyer Creek/Grantham flash flood. The water would eventually flow on to swamp Ipswich

4.33 The extent of flash flooding in Toowoomba



4.34 Flash flooding caused widespread damage in Toowoomba's CBD in January 2011.



and reach the overflowing Wivenhoe Dam. From there it flowed into the Brisbane River before flooding the low-lying riverside suburbs of Australia's third-largest city.

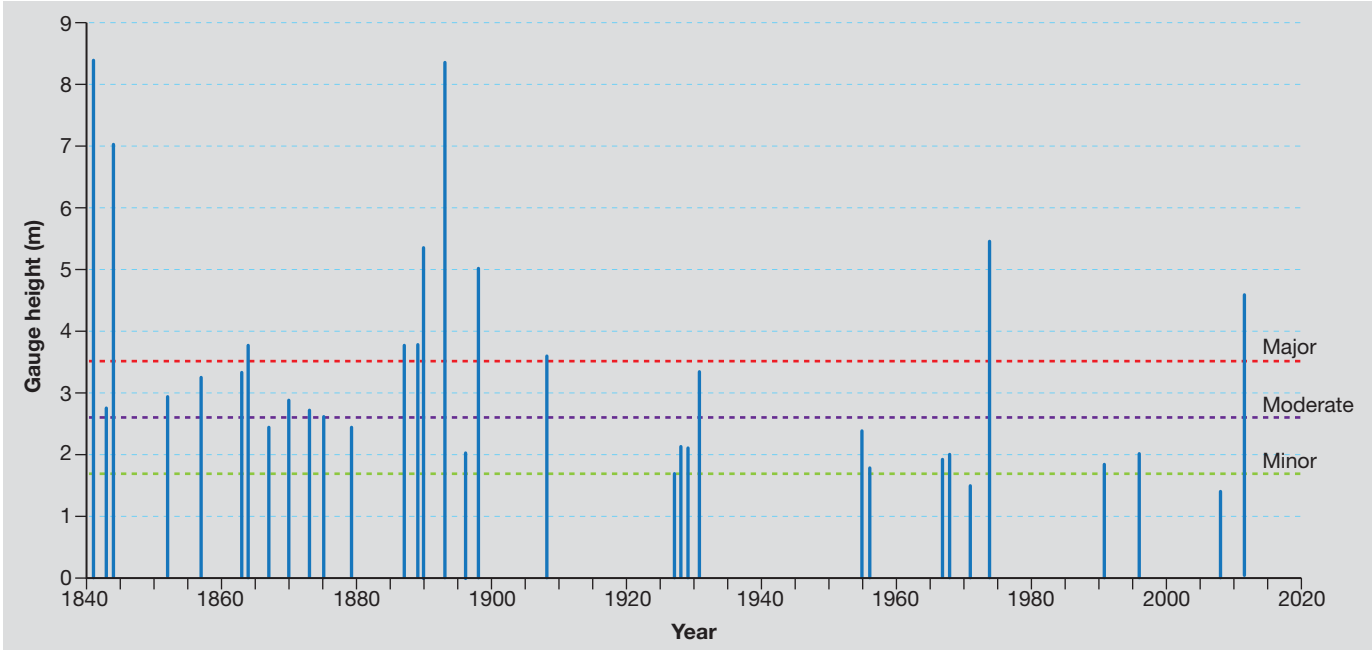
DID YOU KNOW?

It's estimated that up to 7.5 billion tonnes of water—equivalent to 15 Sydney Harbours—fell on south-east Queensland during the 'superstorm' of 10 January 2011.

Brisbane floods

Figure 4.35 shows that residents of Brisbane are not unfamiliar with floods. The city was again flooded when the Brisbane River broke its banks at about 2.30 p.m. on 11 January 2011. Luckily, the river's peak (4.46 metres) was lower than had been expected. It was, however, among the ten worst floods on record, and more than 20 000 homes were inundated. The worst-affected areas were the suburbs of St Lucia, West End, Rocklea and Graceville.

4.35 History of flooding on the Brisbane River, 1840–2011



Source: Bureau of Meteorology

ACTIVITIES

Knowledge and understanding

1 State why the 2010–11 Queensland floods were considered to be such a significant natural disaster.

2 Outline the reasons why there was such a sudden change to the weather patterns being experienced in Australia in late 2010 and early 2011.

Applying and analysing

3 Explain why the flash flooding in Toowoomba and the Lockyer Valley was more dangerous than the Brisbane floods.

Geographical skills

4 Look at Figure 4.30 and describe the pattern of rainfall in Australia for 2010.

Investigating

5 Create a timeline of the circumstances that led to the flash flooding experienced in Toowoomba and the Lockyer Valley in early 2011. Add to the timeline the following information.

- the amount of rainfall
- the clean-up process
- rebuilding damaged homes, building and infrastructure
- finalising insurance claims
- the findings of the Queensland Floods Commission of Inquiry
- suggested ideas to prevent future flooding (and damage)

4.7 Heatwaves

A heatwave is a prolonged period of very hot weather. Severe heatwaves can cause widespread crop failures and thousands of deaths from hyperthermia (heat stroke).

Causes of heatwaves

Heatwaves occur during summer in warm climates. They develop in one of two ways. Firstly, in areas dominated by high pressure with little or no rain or clouds, the air and ground can heat up to excess. A stationary, or very slow-moving, high-pressure system can result in a persistent heatwave. Secondly, winds can direct hot, dry air from arid regions towards areas that are normally cooler.

Heatwaves in Australia

Recent heatwaves in Australia have included the following:

- ***March 2008***—Adelaide experiences fifteen days in a row above 35°C (previous record: seven days)
- ***January 2009***—Adelaide experiences seven days in a row above 40°C
- ***March 2011***—Perth experiences twenty-six days in a row above 30°C
- ***January 2013***—Perth experiences seven days in a row above 39°C
- ***March 2013***—Melbourne experiences nine days in a row above 30°C.

Impacts of heatwaves

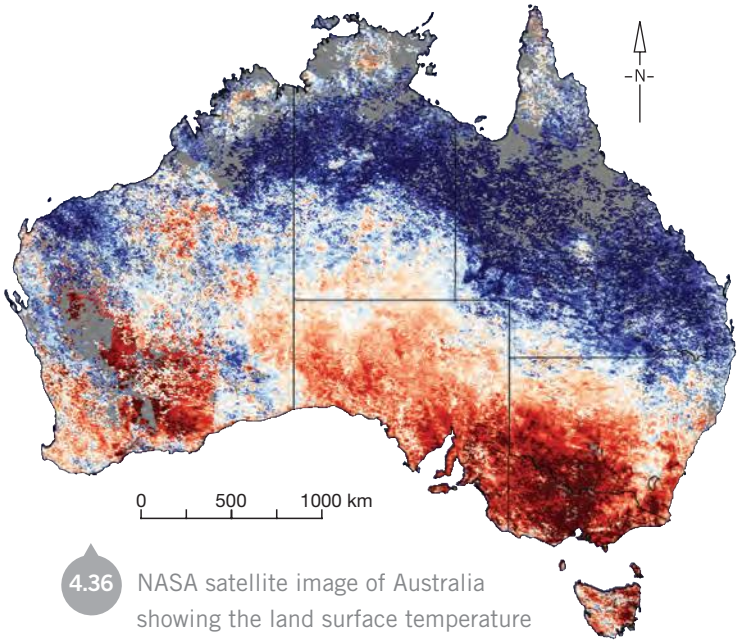
Health and wellbeing

Hyperthermia becomes an important health issue in times of sustained high temperatures, especially when heat is combined with high humidity. Perspiration (the means by which the body seeks to regulate its temperature) is absent from 84 to 100% of those affected. Those most affected by heat-related illness include older adults, very young children, and those who are sick or overweight.

During the 2003 European heatwave, up to 35 000 people died from heat-related illnesses. Much of the heat was concentrated in France, where nearly 15 000 people died. In Portugal, the temperature reached as high as 48°C. In addition to physical impacts, excessive heat can cause psychological stress.

Bushfires

Heatwaves, combined with drought, can increase the likelihood of bushfires. In 2009, for example, the south-eastern Australia heatwave that commenced in late January led to record-breaking prolonged high temperatures across Victoria (see Figure 4.36). During the heatwave Melbourne recorded its highest ever temperature, 46.4°C. The heatwave produced extreme fire conditions. On 7 February, now known as Black Saturday, raging bushfires claimed 173 lives and destroyed 2500 homes.



4.36 NASA satellite image of Australia showing the land surface temperature from 25 January to 1 February 2009, compared with average midsummer temperatures. Places where temperatures were warmer than average are red, places experiencing near-normal temperatures are white, and places with cooler than average temperatures are blue.

SPOTLIGHT

Cold waves

A cold wave occurs when there is a rapid and sustained drop in temperatures to very low levels within a 24-hour period. Such cold snaps can have a devastating effect on crops and livestock. They can also damage infrastructure and disrupt economic activity and social activities.

The European Cold Wave of 2009–10 brought record low temperatures and heavy snowfalls across Europe (see Figure 4.37). Ninety people died. Temperatures as low as –47°C were recorded in the Italian Alps.



4.37 A child plays in front of an ice-covered car in Versoix, Switzerland, after a cold snap in February 2012.

Infrastructure failures

Heatwaves can be very disruptive to the economy and the day-to-day activities of people. Increased use of air-conditioning can create power outages. Rail lines can buckle, disrupting public transport, and breakdowns can cause traffic chaos.

Wildlife

A long heatwave can have a serious impact on wildlife. For example, in 2008, after a long heatwave, more than 2 tonnes of dead fish were discovered in the Agly River, in France (see Figure 4.38).



4.38 Fish killed by a heatwave

ACTIVITIES

4.6

Knowledge and understanding

1 State where and when heatwaves develop.
2 Outline the causes of heatwaves.
3 State what a cold wave is.
4 Copy and complete the following table.

	Impact upon people's health and wellbeing	Other impacts
Heatwave		
Cold wave		

Applying and analysing

5 Study Figure 4.36 and locate the regions in Australia that experienced higher than average midsummer temperatures in 2009.
6 Working in groups, discuss and list the ways in which heatwaves can increase the risk of bushfires. Share your findings with the rest of the class.

Investigating

7 Investigate the effects of heat stress on:
  a people
  b plants
  c animals.
  Prepare a digital presentation of your findings and present it to the class.
8 Explore the ways in which people can avoid heat stress during heatwaves. Present your findings as a mind map.
9 Investigate a recent example of a cold wave, and prepare a short report. Include where the cold wave occurred, the temperatures that were experienced and the damage and destruction it caused.

4.8 Drought

Drought occurs when there is a prolonged period of below-average rainfall in an area. It can also be said to exist when the supply of water is insufficient to meet the needs of people.

Defining drought

Meteorological drought

A meteorological drought occurs following an extended period of below-average precipitation (rainfall, snow, hail, sleet). Official declarations of drought vary between regions. For example, in the United Kingdom, where rainfall is higher and more regular than in Australia, a drought is a period of fifteen days without rain.

In Australia, there are two definitions of **drought**.

- A serious rainfall deficiency occurs when for three or more months, rainfall in an area is between the lowest 5 and 10 per cent recorded in that area over the long term.
- A severe rainfall deficiency occurs when for three or more months the rainfall is less than the lowest 5 per cent of recorded rainfall in that area over the long term.

In arid regions, a drought might be said to occur when there is a succession of unusually dry years.

Hydrological drought

Hydrological drought occurs when water storages such as reservoirs, rivers and groundwater reach critically low levels.

Agricultural drought

Agricultural drought occurs when there is not enough soil moisture for crop production—plant growth is affected.

Socio-economic drought

Socio-economic drought occurs when the supply of a good declines because of a shortage of water. The supply of hydro-electric power and water-demanding crops such as cotton depend on the availability of water.

Impacts of drought

During a drought, rivers and dams dry up, plants wither and die, and the soil is dry and dusty. Droughts are a normal part of weather in most parts of the world. The problem for farmers, and other water users, is not knowing when they will occur and for how long they will last (see Figure 4.39).

Environmental impacts

During drought, native grasses die off, leaving topsoil bare and vulnerable to wind erosion. The topsoil is blown away in dust storms and the land may become infertile. This process is called **desertification**. Drought and people's overuse of land contribute to **land degradation**.

Water quality in river systems is also affected. As flows decrease, rivers become stagnant and may suffer outbreaks of toxic algae. Floods, by contrast, reduce pollutants by flushing out river systems.

Other environmental impacts include the loss of biodiversity, increased risk of extinction for endangered plants and animals, increased chance of weed invasion and an increase in the frequency and intensity of bushfires.

Economic impacts

The worst effects of drought are crop failures and the death of livestock due to lack of water and feed. Farmers are sometimes forced to sell their livestock at a vastly reduced price. They suffer loss of earnings and may face crippling debt. In extreme cases, they are forced to sell their farms. The rural economy (especially those businesses selling goods and services to farmers) and export earnings are also affected. This can, in turn, impact on a country's rate of economic growth.



4.39 Drought takes a heavy toll on those who depend on the land for a living.

Social impacts

Droughts can have a terrible social impact on rural communities. The loss of a farmer's crops and livestock can be the cause of anxiety and stress. Financial stress can contribute to difficulties in marriages and an increase in the suicide rate. Inequalities between rural and urban sectors of society are often increased by prolonged droughts. Droughts can also increase the farmer's workload. Livestock, for example, need to be handfed.

Long-lasting droughts have contributed to the decline of the rural population and the demise of some smaller rural towns. Dam-based recreational activities are often banned as water levels fall.

People in urban centres suffer indirectly through increased food prices and (sometimes) a reduction in quality.

Famine

When crops fail and livestock die, food availability is severely reduced. This can lead to famine, and the effects can be catastrophic. People suffer malnutrition as their dietary intake is reduced, and the outcome for many, especially the old and young, is death. Figure 4.40 shows two young children who are experiencing malnutrition from famine. These two children may suffer other long-term health effects. These include stunted growth, leading to shorter stature as adults, and poor school performance.

Responses to drought

Preventing droughts is not possible, but people can reduce their impact. Responses to drought are outlined in Table 4.41.

4.41 Responses to drought

Farmers
• Develop a drought management plan • Stock/crop the property at a sustainable rate • Install water-saving forms of irrigation • Store grain and/or feed for use in times of drought • Move stock to areas with feed (this is called agistment) • Sell all non-breeding stock • Increase water storage capacity (bores, tanks and dams)
Urban dwellers
• Reduce the amount of water used in the home and business • Mulch gardens • Install rainwater tanks • Obey any restrictions imposed by state government



4.40 Famine causes great human suffering.

SPOTLIGHT

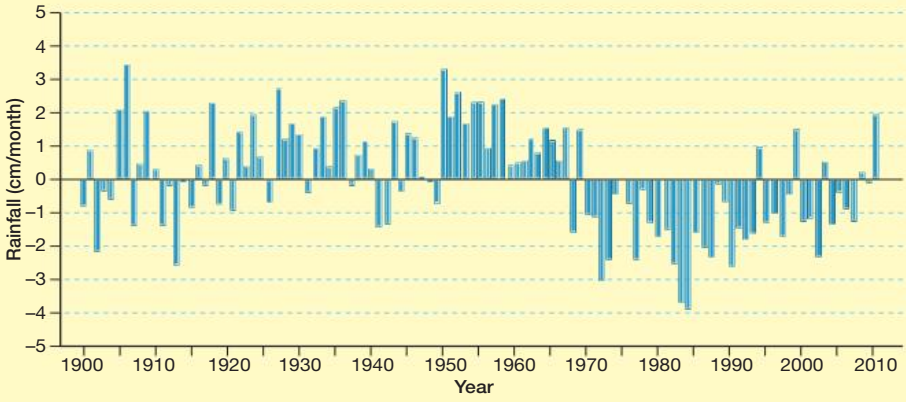
Drought and famine in the Sahel

In 2010, Africa's Sahel region (see Figure 4.42) suffered one of its worst famines in recent times. The famine was caused by a heatwave that followed nearly four decades of below-average rainfall. The extreme temperatures devastated the region's crops. More than 350 000 people faced starvation and 1.2 million were at risk of famine.

For a long time it was thought that drought in the Sahel was caused by humans' overuse of the region's natural resources, overgrazing, deforestation and poor land management. In the late 1990s, however, climate studies suggested that large-scale climate changes were also triggering drought. Figure 4.43 shows rainfall anomalies (departure from regular rainfall) for the Sahel since 1900. Population growth and the loss of land to the production of cash crops such as cotton are also adding to the shortage of food in the region. These crops are produced for export to developed countries.



4.42 The Sahel is a zone of transition between the Sahara Desert in the north of Africa and the savanna grasslands in the south.



4.43 Rainfall anomalies in the Sahel, 1900–2010

ACTIVITIES

4.7

Knowledge and understanding

1 Define drought.
2 Explain why official declarations of drought vary between the United Kingdom and Australia.
3 Outline the differences between meteorological, hydrological, agricultural and socio-economic droughts.
4 Summarise the environmental, social and economic impacts of drought.

Applying and analysing

5 Study Table 4.41. Explain the ways in which farmers can respond to droughts.
6 Is the drought in the Sahel a meteorological, hydrological, agricultural or socio-economic drought, or a combination of two or more? Explain.
7 a Study Table 4.41 and rank the responses according to which will be the most effective in reducing water demand in both the short and long terms.
b Explain your ranking and identify those responses you think will reduce water demand.

Geographical skills

8 Study Figure 4.42 and, with the aid of an atlas, investigate the climate, vegetation and land uses of the Sahel. Summarise your findings in a written report.
9 Study Figure 4.43 and describe the trends in Sahel rainfall since 1950.

Investigating

10 Use the internet to investigate a recent drought outside Australia. Find out about the drought's duration, the type of drought it was (meteorological, hydrological, agricultural or socio-economic), the areas over which it extended and the impact it had on the communities affected. Present this report as an annotated visual display and include a map of the area.

4.9 Case study: Drought in Australia

Drought has been a part of life in Australia since the Dreaming. While Indigenous Australians developed sophisticated ways of coping with Australia's irregular rainfall, early European settlers struggled. European-based systems of agriculture relied on rainfall and fertile soils; Australia had neither.

Causes of drought

Australia has one of the most variable rainfall climates in the world. As a result, it tends to experience severe droughts every 10–15 years on average. Droughts may last for extended periods—in some cases, a decade or more.

Droughts over eastern and northern Australia are usually associated with the weather phenomenon known as El Niño. El Niño is a reversal of the weather phenomenon known as La Niña. La Niña brings rainfall to eastern and northern Australia.

Figure 4.45a outlines an El Niño period. The main changes that occur in an El Niño period and result in low rainfall for Australia are:

- weaker easterly trade winds from South America
- cool water off the east coast of Australia
- higher air pressure over eastern and northern Australia.

Figure 4.45b outlines a La Niña period. The main changes that occur in a La Niña period and result in high rainfall for Australia are:

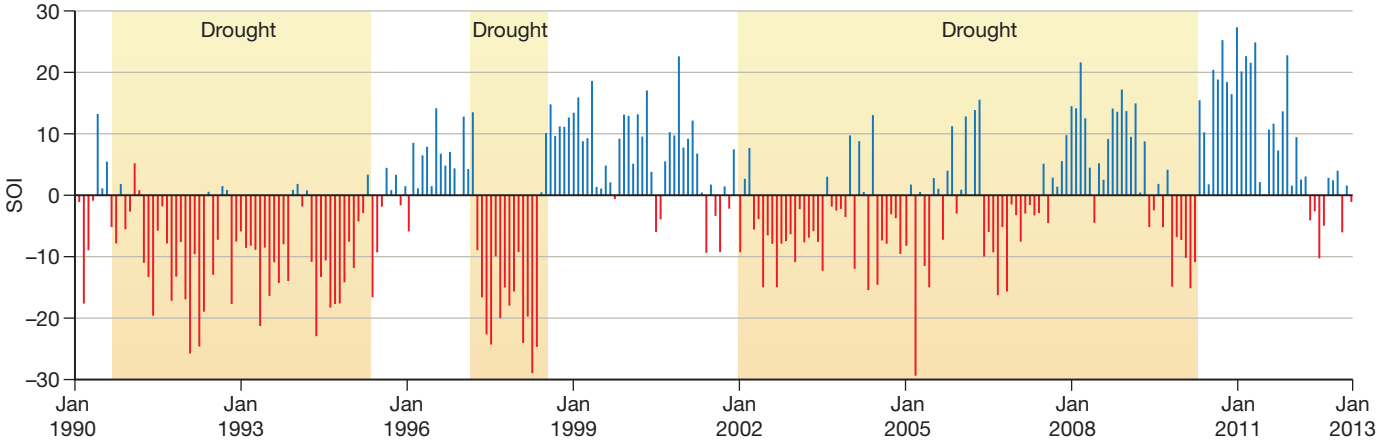
- stronger easterly trade winds from South America
- warm water off the east coast of Australia
- low air pressure over eastern and northern Australia.

The Southern Oscillation

The Southern Oscillation Index (SOI) is a measure of the monthly or seasonal variations in the air pressure difference between Tahiti and Darwin (see Figure 4.44). Long-term measurements show that:

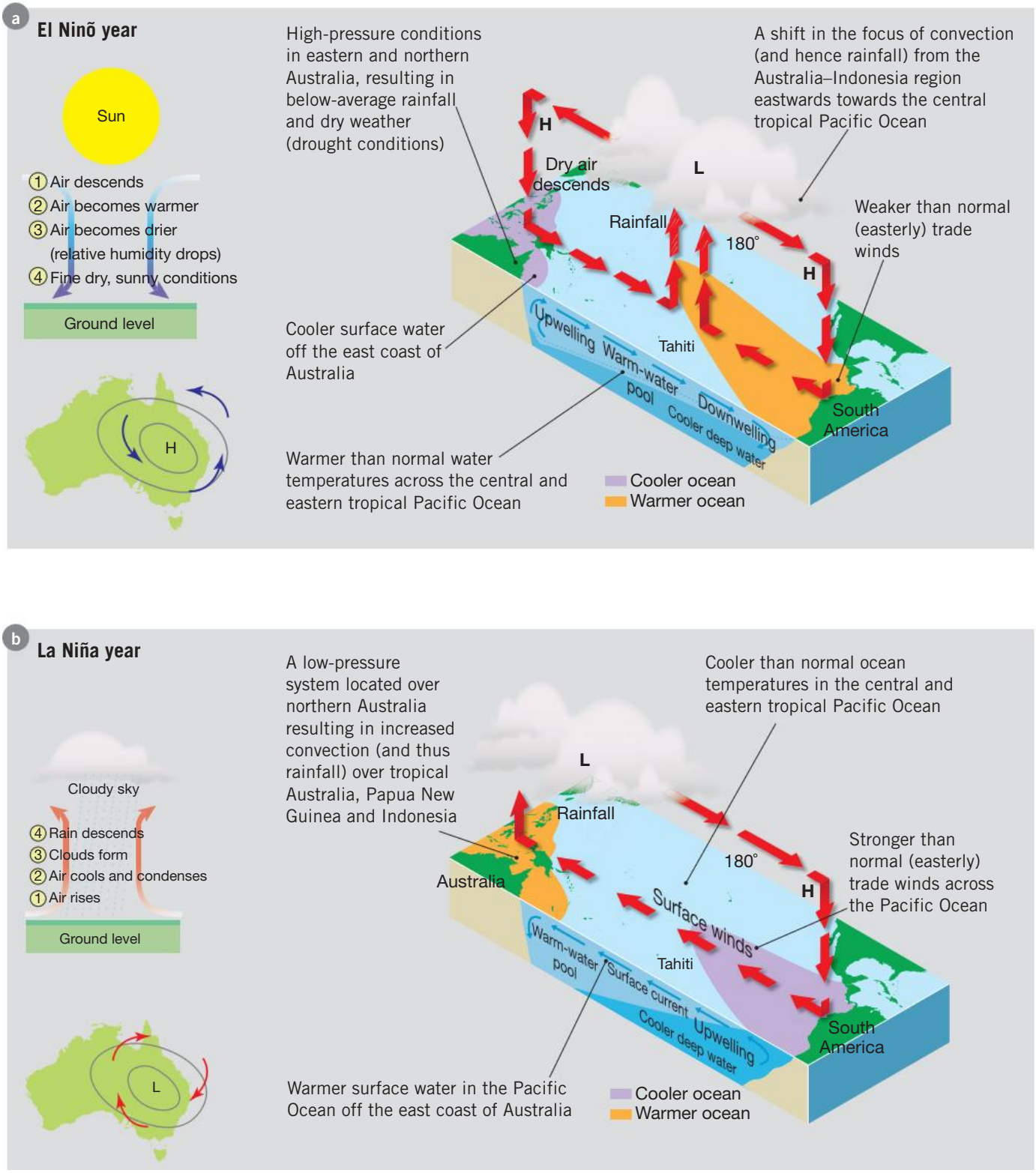
- negative SOI values are linked to El Niño periods and droughts
- positive SOI values are linked to La Niña periods and high rainfall.

4.44 The Southern Oscillation Index, 1990–2013



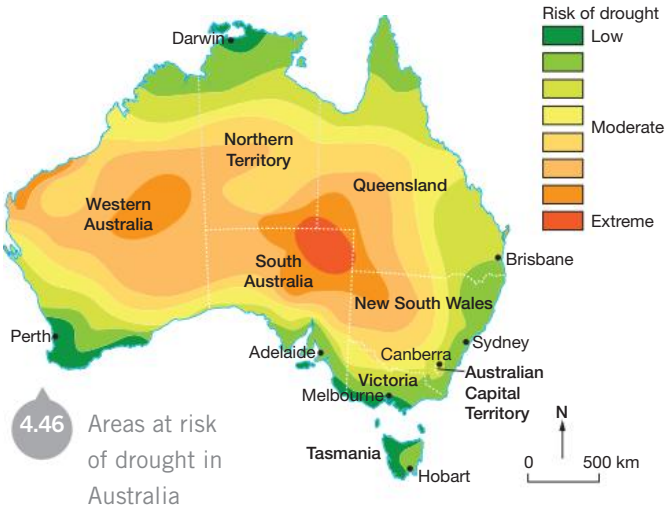
Source: Bureau of Meteorology

4.45 Impact of (a) El Niño and (b) La Niña

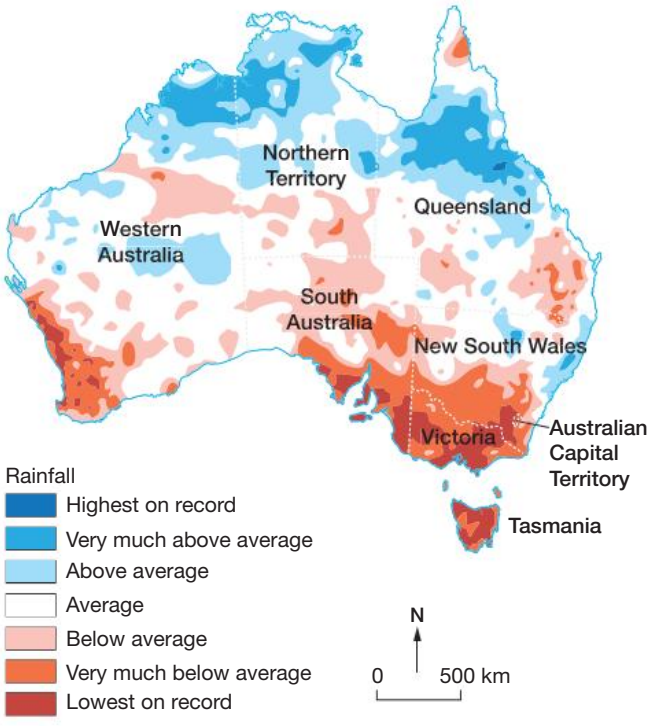


Predicting droughts

Figure 4.46 identifies those areas that are at risk of drought in Australia. Because of the widespread risk of drought, scientists monitor changes in the surface temperature of the Pacific Ocean. Changes in ocean surface temperature can provide advance warning of an El Niño or a La Niña period. With advance warning, farmers can reduce their stock numbers to conserve feed. They may also be able to adjust their crop-planting program to avoid crop losses and soil erosion.



4.46 Areas at risk of drought in Australia



4.47 Areas of rainfall deficiency show up clearly in this map of rainfall distribution in 2006–09.

History of droughts

Major Australian droughts have included the 'Federation Drought' (1895–1902); the 1914–15 drought; the Second World War droughts (1937–45); the 1965–68 drought; the drought of 1982–83; and the long El Niño drought of 1991–95.

Recent Australian droughts

Between 2002 and 2003, and again in 2006–09, Australia experienced some of the worst drought conditions on record. Figure 4.47 shows the extent and severity of the 2006–09 drought. Much of southern Australia experienced either a serious or a severe water deficiency, and parts of Western Australia, South Australia, New South Wales, the Australian Capital Territory, Victoria and Tasmania received the lowest rainfall on record. Figures 4.48 and 4.49 show the impacts of the drought. Australia's farmers experienced great economic hardship as crops failed and livestock either were sold or died. Those living in major urban centres (including Sydney, Melbourne and Canberra) were forced to reduce their use of water. The drought conditions contributed to huge dust storms such as the one seen in Figure 4.48, and some of the worst bushfires ever experienced in eastern and southern Australia. These included the Black Saturday bushfires of 7 February 2009 in Victoria. The drought broke when La Niña rains drenched the region in late 2010.



4.48 During drought, millions of tonnes of topsoil are blown in blinding dust storms such as this one in Sydney, 2010.



4.49 Coping with the impacts of drought is one of the greatest challenges facing Australia's farmers.

ACTIVITIES

Knowledge and understanding

1 Outline the effects of drought.

2 Copy and complete the following table.

	El Niño	La Niña
Type of air pressure on the east coast of Australia		
Water temperature off the east coast of Australia		
Influence on Australia's weather		

Applying and analysing

3 Identify the data used to predict droughts. Explain the ways in which farmers can respond to these predictions.

Geographical skills

4 Study Figures 4.46 and 4.47. Were all areas that experienced rainfall deficiency between 2006 and 2009 located in areas of high drought risk? Explain.

Investigating

5 Investigate a recent drought in Australia. Present your findings as an annotated visual display. Include in your response the following information.

- **a** a map of the area investigated with information about natural features, climate type, average temperatures and annual rainfall
- **b** the drought's duration, the areas over which it extended and the impact it had on the communities affected
- **c** suggestions for droughtproofing the region and/or reducing the impacts of drought in Australia

4.10 Responding to hazards

There is little, if anything, people can do to prevent weather-related natural disasters. There are, however, a range of ways in which people can manage the impacts of such events.

Early warning systems

Developments in the science of meteorology have greatly increased the accuracy of weather forecasting. Meteorologists are now better able to predict extreme weather events. Warnings can be issued via a range of technologies, such as television, radio and mobile phones. Having warning about such events enables people to undertake necessary preparations to minimise loss of life and damage to property. They can secure their homes and businesses and take shelter in a secure, safe place.

Cyclones and tornadoes

Early cyclone or tornado warning systems allow people to secure their property and act to reduce the threat to their physical wellbeing.

Floods

Early flood warning systems enable people to sandbag premises and build temporary levee banks. Early warning systems also provide people with time to remove valuables from their homes and businesses and move themselves and their livestock and vehicles to higher and safer ground.

Drought

The onset of drought occurs more slowly. In urban areas, water use can be reduced through water restrictions and education campaigns. Farmers can adapt to the drier conditions by reducing stock levels and by using feed grown and stored in better times.

Building laws

Local governments can regulate the activities and the types of buildings that are permitted on flood plains and in areas affected by storm surges. For example, by banning the construction of new homes and commercial buildings in such areas, authorities can minimise property damage and the disruption that flooding and storm surges cause to people's lives.

Where communities are already well established on a flood plain, engineering measures can be used to minimise the impacts of flooding and storm surges. Homes can also be designed in ways that reduce the effects of flooding (see Figure 4.50).

In built-up areas, authorities can take a range of measures to minimise flash flooding. These include:

- using porous paving, or replacing sealed surfaces with grass and gardens to allow more water to soak into the ground
- keeping street drains clear of blockages
- constructing on-site stormwater retention systems
- controlling erosion from building sites.

Building codes and standards can also minimise damage to property. In Australia's cyclone-prone areas, new buildings must be built to a standard that:

- enables them to remain stable and not collapse
- prevents progressive collapse
- minimises local damage and loss of amenity
- avoids causing damage to other properties.



4.50 Following the 2011 Brisbane floods, architect Michael Rayner designed a home that can withstand floods. Rayner based his design on the original Queenslander-style home.

Engineering responses

In the case of flooding, responses that involve engineering can reduce peak flood levels and potential damage. Such responses include:

- using dams and water retention basins to capture floodwaters
- building pipelines to move captured water from place to place
- building levee banks and floodgates to divert water (see Figure 4.51)
- erecting barriers such as sea walls to deflect storm surges from coastal communities
- widening and deepening channels of rivers and creeks.

Emergency responses

It is the role of governments to help people in emergencies. This assistance can be supplied through various government departments and agencies. Governments also provide emergency funding to help communities recover from disasters.

Volunteer-based emergency services are quick to respond when disasters occur, as are organisations such as the Red Cross. Community-based groups also play an important role in emergencies.

4.51 Do-it-yourself flood mitigation in Mississippi, USA



ACTIVITIES

4.8

Knowledge and understanding

1. Explain how developments in meteorological science have helped people manage and adapt to extreme weather events.
2. Give one example of how planning measures implemented by local government can help reduce the impact of floods and storm surges.
3. Outline how engineering responses have been used to manage the impacts of extreme weather events.
4. How can governments and volunteer organisations provide help and support in the period following an extreme weather event?
5. Construct a mind map summarising the ways in which communities manage and adapt to extreme weather events.

Investigating

6. Using the internet, investigate the early warning systems of the Australian Bureau of Meteorology. Write a short report summarising your findings.
7. Research *one* of the volunteer-based organisations that assist in response to an extreme weather event. Find out:
   - **a** what the organisation's role is
   - **b** who its members are
   - **c** what the source of its funds is
   - **d** what types of assistance it provides.
8. As a class, discuss how you might assist in response to a weather-related natural disaster affecting:
   - **a** a local community
   - **b** a community in another part of the world.

CHAPTER

5

WATER: A RENEWABLE RESOURCE



Water is our most precious natural resource; we can't live without it. Under the right conditions it is a renewable resource, with rain and snowfall regularly topping up storages. However, water is a very unevenly distributed resource. Water use around the world has increased due to demands from agriculture and a growing population. Water sources around the world are becoming more polluted, with the result that one-sixth of the earth's people do not have access to safe drinking water.

Shortages of clean water can impact negatively on human wellbeing and slow the rate of economic development. As countries struggle to access declining water supplies, the potential for outbreaks of armed conflict grows.

In this chapter we focus on the importance of water, the water cycle, the global distribution of water resources and the various ways in which people use water. We also examine global inequalities in access to clean water, and water as a source of conflict.

KEY IDEAS

- To describe how water takes different forms (solid, liquid, gas; fresh water, salt water) at different stages of its passage through the water cycle
- To recognise that most of the world's water cannot be used by people, and that global stocks of available fresh water are limited
- To investigate and compare the direct, indirect and competing uses for water
- To explore the availability of surface water and groundwater as a resource for people

GLOSSARY

aquifer	a layer of rock that is capable of storing significant quantities of water
blue water	fresh surface water and groundwater, i.e. lakes, rivers and aquifers
catchment	the area drained by a river and its tributaries; an alternative term for river basin or drainage basin
contaminated water	water that is unsafe to drink because it is not clean
drainage basin	the area drained by a river and its tributaries; an alternative term for catchment or river basin
green water	the precipitation on land that does not run off or become groundwater, but is stored in the soil or temporarily stays on top of the soil or in vegetation
grey water	water generated from domestic activities such as laundry, dishwashing and bathing
irrigation	the watering of crops by artificial means
metabolic processes	processes by which the body transforms food into energy
photosynthesis	the process by which green plants make glucose (sugar), using water, carbon dioxide and sunlight
run-off	the movement of surface water down slopes
sanitation	the infrastructure related to the collection and disposal of sewage (human waste)
tributary	a smaller river or stream that flows into a larger one
virtual water	the volume of fresh water that is consumed (or polluted) when a product is created
water cycle	the processes by which water circulates between the earth's oceans, atmosphere and land
water footprint	the total volume of fresh water used by an individual, a household, a business, a community or a country
water table	the level at which under-rock strata are saturated by water
watershed	the boundary between catchments

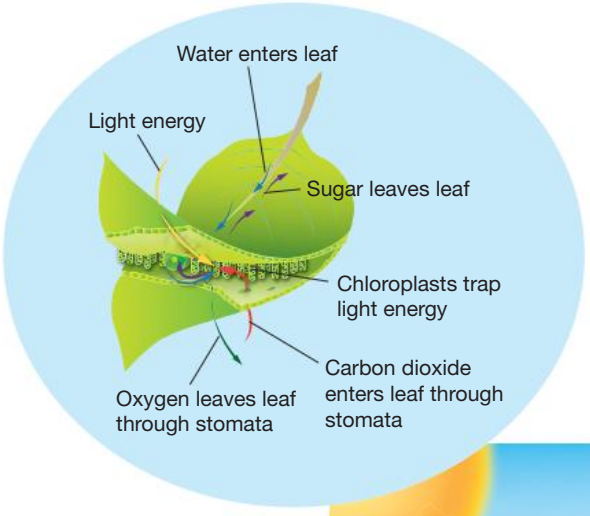
5.0 A woman carries water in Africa.

5.1 Water

Water is essential to all known forms of life on earth. Plants and animals depend on water, and access to clean, fresh water is essential to the wellbeing of humans. Without water, the earth would be a barren, dusty, lifeless planet.

Water and life

Plants use water in the processes of **photosynthesis** and respiration. Water is also critical to the **metabolic processes** of animals. For example, water is the solvent in which the body's waste products dissolve and are then expelled.



Light energy and carbon dioxide are freely available from the air surrounding the plant

The water within the plant is directly necessary for photosynthesis, and also for preserving water in the plant by periodically closing the stomata (the tiny openings on the surface of leaves that allow gas to pass in and out)

Water is absorbed through the roots and may be scarce during dry seasons and droughts

Once the roots have absorbed water, it is transported up the plant into the leaves by structures called xylem

The roots of plants extend into the soil in order to access moisture under the surface

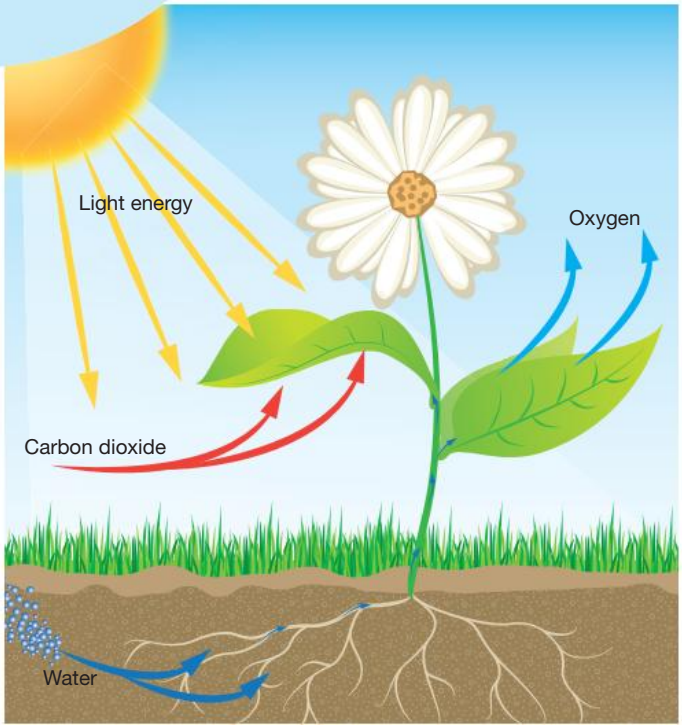
Photosynthesis

Photosynthesis (from the Greek words *photo*, meaning 'light', and *synthesis*, meaning 'putting together') is the production of sugar from light, carbon dioxide (CO_2) and water, with oxygen as a waste product. It is the most important biochemical process known, as nearly all life depends on it. It can be represented by the following word equation:

carbon dioxide + water + light energy → glucose (sugar) + oxygen

Photosynthesis can be defined simply as the conversion of light energy into chemical energy by plants.

5.1 The process of photosynthesis turns carbon dioxide, water and the energy of the sun into glucose (sugar) and oxygen. It is essential for life on earth.



The stomata enable photosynthesis to take place by letting carbon dioxide in and letting oxygen out. While they are open, however, water vapour can also escape. The stomata can be closed by guard cells, which surround them. In order for the guard cells to be closed, they must swell with water. Without enough water, the stomata cannot be closed, which results in more severe dehydration for the plant and an inability to carry out photosynthesis.

Transpiration is the name given to the process by which water vapour is emitted from the leaves of plants



5.2 Water is essential for the human body.

Water and wellbeing

The human body is largely made of water—between 55 and 78 per cent, depending on a person's body size. To function properly, the body needs between 1 and 7 litres of water a day. The actual amount depends on a person's level of physical activity and the temperature and humidity. Most water is taken in via food and drink. Water also helps the body to regulate its temperature through perspiration. During exercise, as in Figure 5.2, people need to drink more water.

Life in water

The earth's waters (its rivers, lakes, seas and oceans) are full of life. The earliest forms of life appeared in water. There are many types of marine mammals, such as dolphins, whales, otters and seals. Some animals, known as amphibians, spend a part of their life in water and a part of it on land. Aquatic plants, such as kelp and algae, grow in the water and support underwater ecosystems. Plankton (microscopic organisms) form the foundation of most ocean food chains.

Animals that live in water have found different ways to obtain oxygen. Fish have gills instead of lungs—though some species, such as the lungfish, have both. Marine mammals come to the surface to breathe air.

ACTIVITIES

Knowledge and understanding

1. Explain why water is so important to life on earth.
2. Briefly explain the process of photosynthesis. Why is it important?

Applying and analysing

3. Demonstrate why access to clean, fresh water is important to human wellbeing.
4. List all the different ways in which you have used water in the past week; for example, cleaning your teeth, using the dishwasher.
5. Calculate how much water or fluid you consume each day.
6. Contrast the life in water of marine mammals and amphibians.

5.2 The water cycle

The water cycle is often referred to as a 'closed system' because the same water has been circulating since the earliest days of the planet. No water is added and none is taken away. Humans interact with the water cycle in many ways, some of which pollute the water and disrupt the cycle.

Movement and change

Water is always moving and changing: it changes its form (ice and snow, liquid water or water vapour) and its location. Water can be used by humans, animals and plants during its journey through the cycle, but it always goes back to nature.

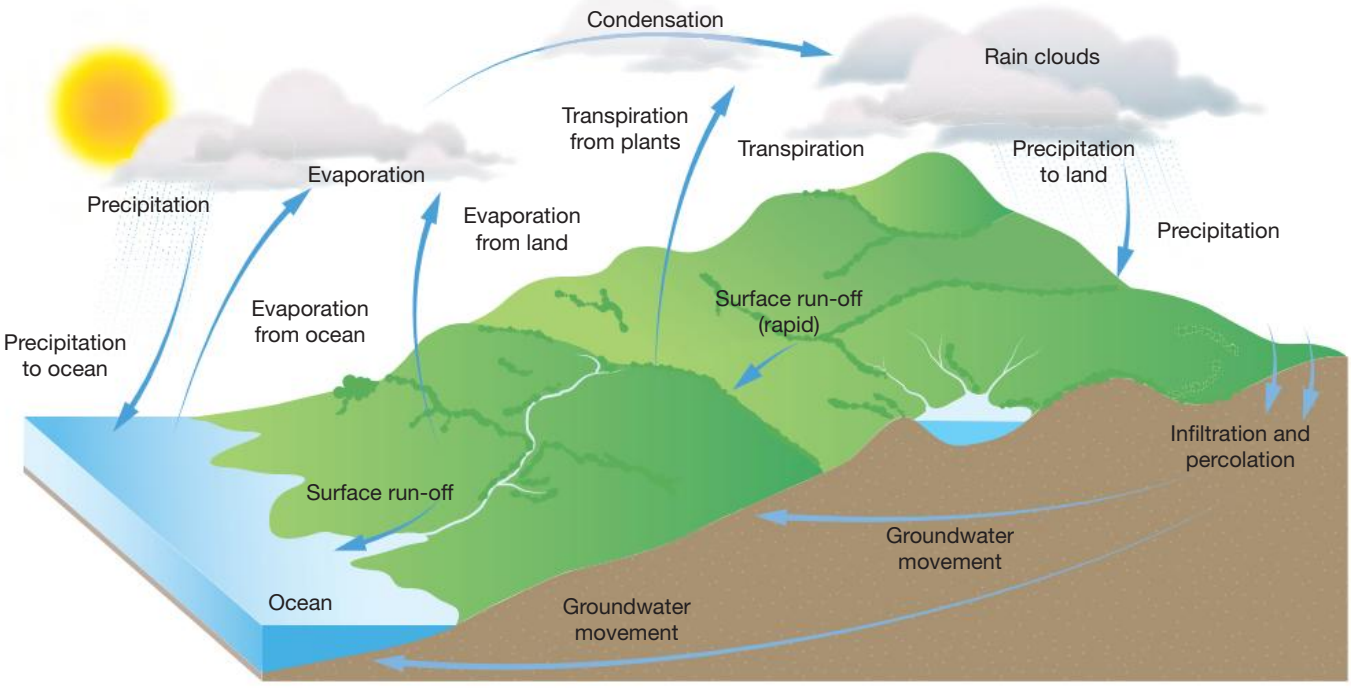
Since the beginning of industrial civilisation, the uses people make of water have multiplied. The **water cycle** (or hydrological cycle) is shown in Figure 5.3.

Evaporation
The process by which water is changed into water vapour. Water can evaporate from any moist surface, but about 84 per cent of the water vapour in the atmosphere comes from the oceans.

Transpiration
The process by which the water absorbed by plants passes into the atmosphere from the plant surface, mainly from the leaves

Condensation
The changing of water vapour into droplets of liquid water in the form of dew, fog or clouds

Precipitation
Any or all of the forms of water, whether liquid (e.g. rain) or solid (e.g. hail, snow), that fall from clouds and reach the ground



Infiltration
The movement of water from the land surface into the soil

Groundwater
Water beneath the earth's surface that fills pores between materials such as sand, soil and gravel

Groundwater movement
The slow underground movement of water. Subsurface water may eventually return to the surface (e.g. as a spring) or seep into the oceans, lakes or river channels.

Run-off
The movement of surface water down slopes

5.3 The water cycle



5.4 A snow-making machine, or 'snow gun', Thredbo, New South Wales

Human impacts

Humans interact with the water cycle in a variety of ways, by:

- building structures, such as levee banks, to protect farmland and settlements from flooding
- storing water in dams in areas where rainfall is unreliable
- using canals and pipelines to transport water from one area to another
- sinking wells and bores to extract groundwater
- using water and gravity to generate hydro-electricity
- using large bodies of water such as oceans or lakes to dump sewage and pollutants
- clearing land for agriculture, mining and urban development
- creating artificial precipitation; for example, snow making (see Figure 5.4).

ACTIVITIES

5.1

Knowledge and understanding

1 Explain why the water cycle is referred to as a 'closed system'.
2 Describe the difference between evaporation and transpiration.

Applying and analysing

3 Select four dot points from the section 'Human impacts'. Describe how each action affects the water cycle; for example, 'Storing water reduces run-off'.
4 Imagine you are a molecule of water. Write a short story about your movement through the water cycle.
5 Using computer software such as SmartArt, construct a diagrammatic representation of the water cycle. On your illustration, label the main processes involved in the water cycle. Use colour coding to identify those processes that involve a change in state and those that involve a change in the physical location of water.

5.3 Distribution of water

The earth's oceans hold 97 per cent of the world's surface water. The other 3 per cent of the earth's water is fresh water. The amount of fresh water is more than enough to meet people's needs, but it is not evenly distributed around the world.

Location of fresh water

Of the world's store of fresh water, 79 per cent is stored in glaciers and the polar ice caps. A further 20 per cent is stored as groundwater, soil moisture, swamp water and permafrost. Just 1 per cent is easily accessible fresh water. Figure 5.5 shows the distribution of the earth's water.

While the amount of available fresh water may seem small, the total amount is far greater than the earth's population requires. Unfortunately, it is not evenly distributed across the earth's surface. Some areas are critically short of water while others have plenty.

Water storage

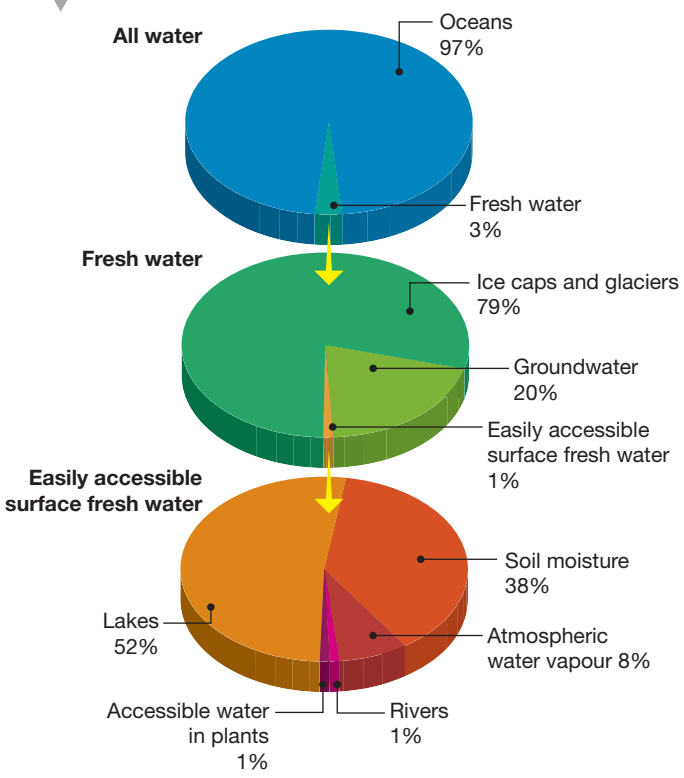
The length of time that water is stored varies. Table 5.6 shows the estimated time that water spends in storage in the world's water resources.

Water loss

Figure 5.7 shows the amount of precipitation (in cubic kilometres) for each continent, and the percentage of that water that is lost to evaporation or becomes **run-off** and flows into streams, creeks and rivers, or underground, to become groundwater. Factors that influence the type of water loss are:

- ***climate***—warm or hot climates will have greater evaporation than cooler climates
- ***vegetation***—types of plants and plant cover; for example, there will be more evaporation in the grassy paddocks of on a sheep farm than in denser vegetation that holds moisture
- ***soil type***—some soils are more permeable than others (they allow water to soak in)
- ***topography*** (shape of the land)—steep areas will have more run-off than flatter areas
- ***location***—hard surfaces such as roads and pavements lead to greater evaporation than unpaved surfaces, so there is greater evaporation in cities and towns than in rural locations.

5.5 The global distribution of the earth's water resources

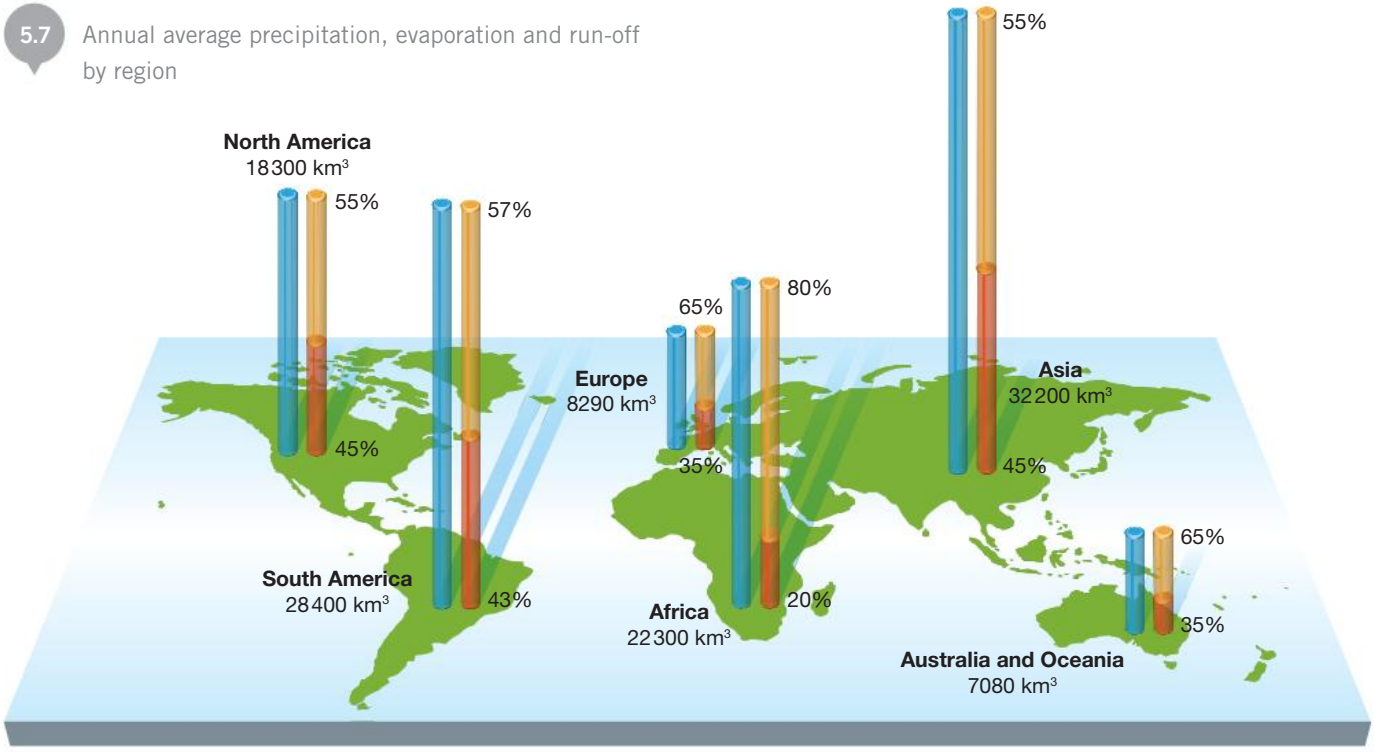


5.6 Estimated time in storage of the world's water resources

Water resource	Time held in storage
Biospheric water*	1 week
Atmospheric water	1.5 weeks
River channels	2 weeks
Soil moisture	2 weeks to 1 year
Swamps	1 to 10 years
Lakes and reservoirs	10 years
Ice caps and glaciers	1000 years
Oceans and seas	4000 years
Groundwater	2 weeks to 10 000 years

* Water held in animals and plants

5.7 Annual average precipitation, evaporation and run-off by region



Source: UNEP/GRID-Arendal

ACTIVITIES

Knowledge and understanding

1 What percentage of the earth's fresh water is stored on the surface in storages such as rivers, wetlands and lakes?

Geographical skills

2 Study Figure 5.5 and then answer the following questions.
   - a State the proportion of the earth's water that is fresh (i.e. not salty).
   - b State the proportion of the earth's fresh water that is easily accessible. Of this, how much is stored as soil moisture?
   - c State the amount of the world's fresh water that is stored as groundwater.

3 Study Table 5.6 and present the information in the table in a graphic form.

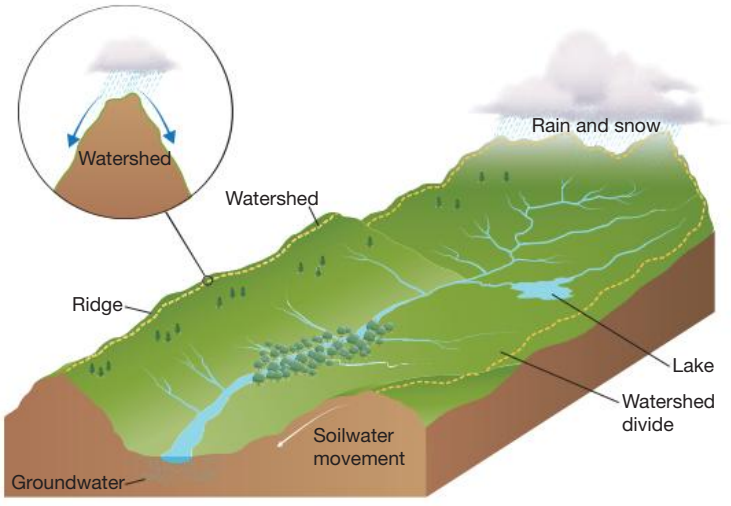
4 Study Figure 5.7, then answer the following questions.
   - a Which continental landmass has the largest annual average volume of run-off?
   - b What is the average annual volume of run-off on the driest of the continental landmasses shown on the map?
   - c By how much does the average annual volume of run-off in South America exceed that in North America?
   - d Which region receives the greatest precipitation?
   - e Which region has the least precipitation?
   - f Which region has the greatest rate (percentage) of evaporation?
   - g What are the implications of this data for agriculture in Africa?

5.4 Catchments

A catchment is an area of land from which water drains into a river. Every part of the earth's land surface is part of a catchment. Neighbouring catchments are divided by watersheds, and rivers are arranged within catchments in drainage patterns.

A river catchment

When precipitation falls to the ground, water moves over the land and finds its way into streams or down into the ground. While some of this water evaporates into the atmosphere, and some is stored as groundwater, the rest is slowly discharged into rivers. This is why rivers continue to flow even when there is no rainfall or precipitation. Figure 5.8 shows a catchment in a mountainous area. The figure also shows a **watershed** (also known as a drainage divide) separating neighbouring catchments. In flat areas, the watershed may be difficult to identify.



5.8 A catchment and dividing watershed. A watershed is the point at which precipitation falls and flows into either one of two neighbouring water catchments.

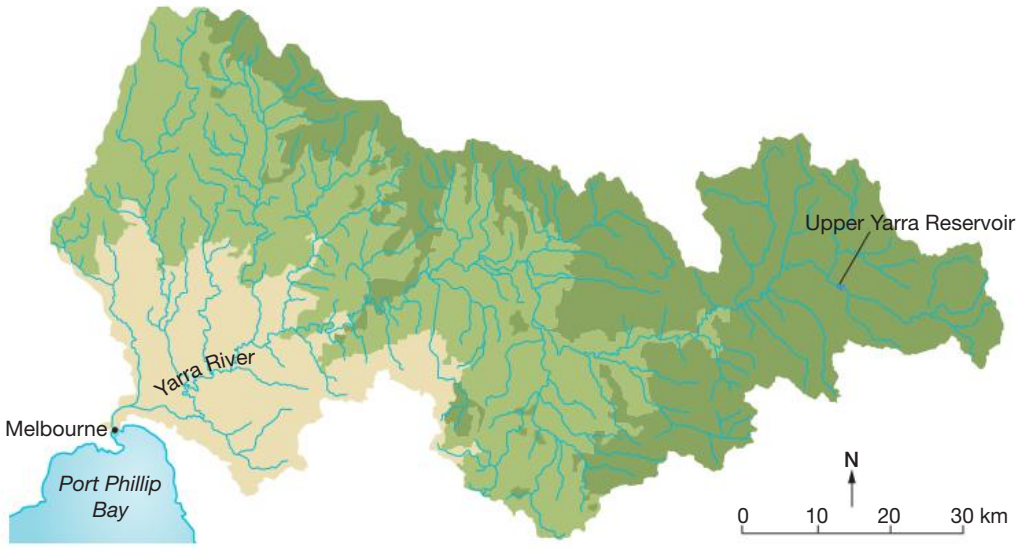
Catchment sizes

Catchments vary greatly in the area they cover. They range from small urban or coastal catchments to catchments covering thousands of square kilometres. The Amazon River Basin in South America covers approximately 7 050 000 square kilometres, as shown in Figure 5.9. Melbourne's Yarra River catchment, for example, covers 4078 square kilometres (see Figure 5.10), while the Murray–Darling catchment covers parts of three states and an area of 1 061 469 square kilometres, or approximately one-seventh (14 per cent) of the total area of the Australian continent.

Not all rivers flow into the sea. Some rivers flow inland, into inland seas, lakes or wetlands. For example, the Diamantina River, which has its source in central Queensland, flows into Lake Eyre, South Australia. Because all rivers and streams have their own catchment, it is not unusual to find catchments within catchments. Each **tributary**, for example, will have its own catchment area.



5.9 The Amazon River Basin



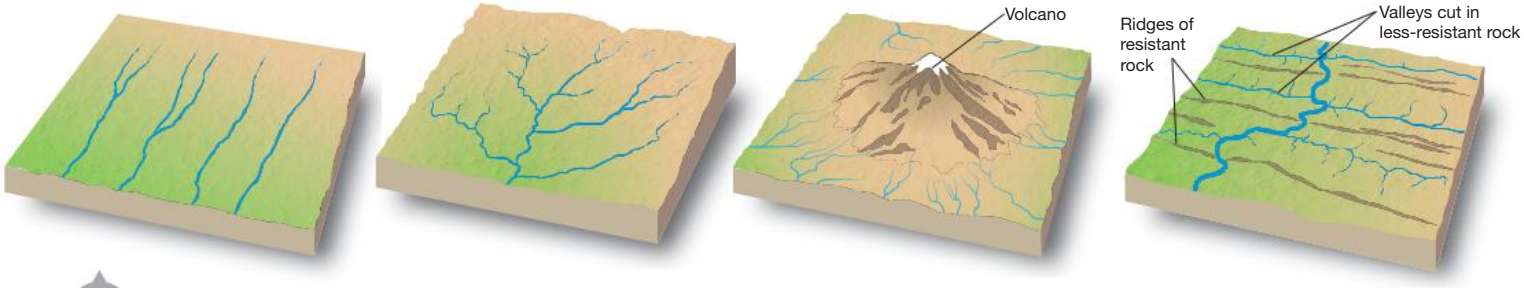
5.10 The Yarra River catchment

Parallel
A drainage pattern commonly found on newly uplifted land and where rivers and tributaries flow downhill more or less parallel to each other

Dendritic
A tree-like drainage pattern with tributaries converging on the main river channel. Common in areas dominated by one rock type.

Radial
Commonly found in areas dominated by dome-shaped mountains or volcanic cones. Rivers flow outwards from a central point like the spokes in a wheel.

Trellis (or irregular)
A drainage pattern that develops in areas dominated by areas or harder, more resistant, rocks and softer, less resistant, rock



5.11 Common drainage patterns found in catchments

Drainage patterns

The arrangement of rivers within a catchment is known as the drainage pattern. Most drainage patterns develop over a long period of time and their development is heavily influenced by the geology and landforms of the catchment. The most common patterns are shown in Figure 5.11.

The importance of catchments

In a river **catchment** (or **drainage basin**), soil, plants, animals and water all function together. Any change affecting one of these elements will have an impact on the others. The protection and management of catchments is important because they are where all our food is grown and where our drinking water comes from. Catchments are therefore part of our life support systems.

ACTIVITIES

5.2

Knowledge and understanding

1 Explain the difference between a catchment and a watershed.
2 Discuss why catchments are important.
3 Why do rivers continue to flow even when it has stopped raining?

Geographical skills

4 Study Figures 5.9–5.11, then answer the following questions.
   a What is the name of the drainage pattern in the Amazon River Basin and the Yarra River catchment?
   b In which direction does the Amazon River flow?

5.5 Groundwater

When precipitation reaches the earth's surface, some of it flows into streams or lakes, some of it is used by plants, some evaporates and returns to the atmosphere, and some soaks into the ground and becomes groundwater.

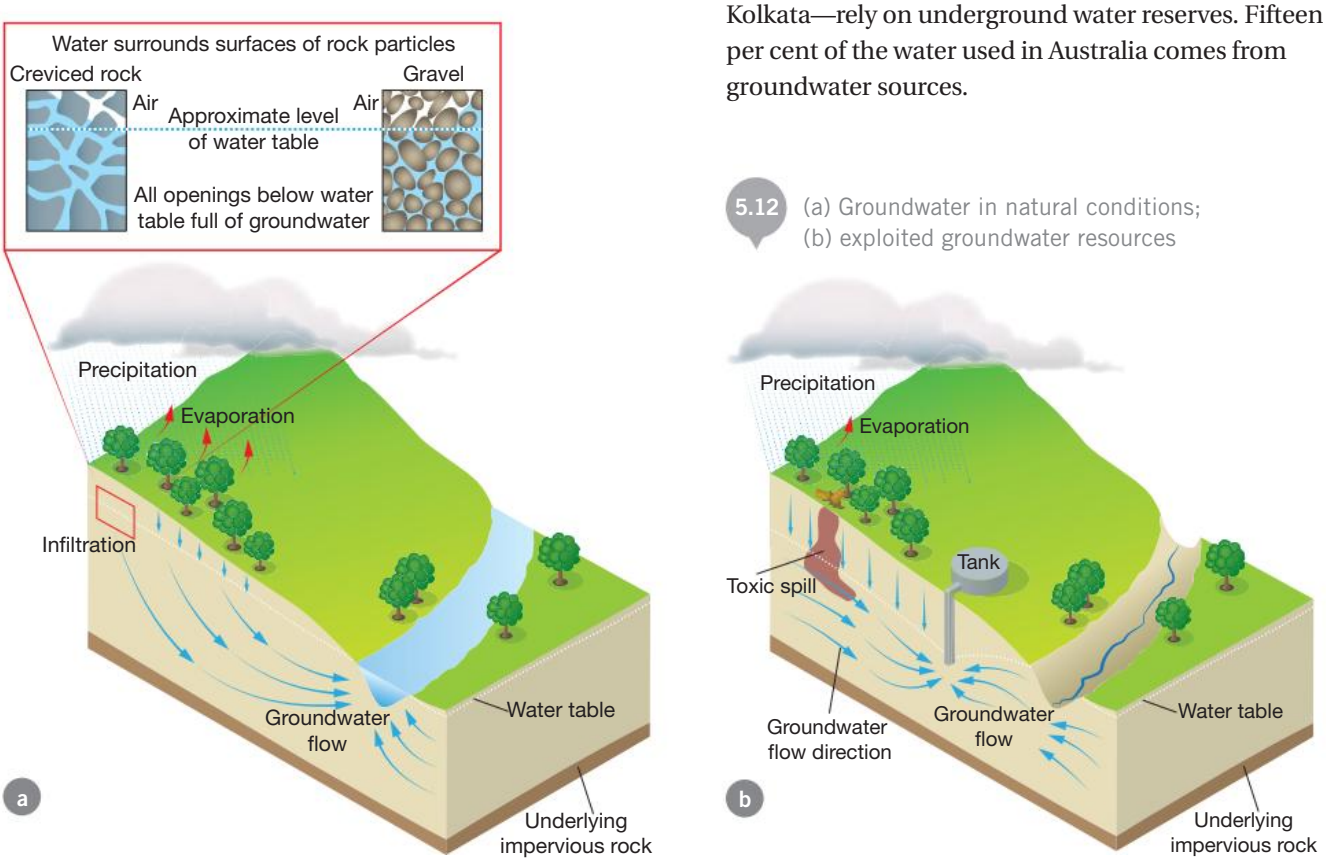
Using groundwater

Groundwater is water found below the earth's surface in soil pore spaces and cracks in rock structure. The layer of soil and rock in which the water is found is called an **aquifer**. The depth at which soil becomes completely saturated with water is called the **water table**, as shown in Figure 5.12.

Throughout the world, groundwater is pumped or drawn from wells drilled or dug down into aquifers. This water is used for agricultural, domestic and industrial purposes. If it is used at a rate that is slower than the rate at which the aquifer can be replenished (or recharged), groundwater can sustain communities indefinitely.

If groundwater is used at a rate faster than the rate of recharge, the water table falls and collecting water becomes more difficult.

Today, an estimated 2.2 billion people, or one-third of the world's population, rely on groundwater as their main source of water. In rural India, 50 per cent of **irrigation** water and 80 per cent of drinking water come from underground (see Figure 5.13), through three million hand-pumped wells. In Europe, 75 per cent of the water used comes from aquifers. The next biggest users are the United States of America (51 per cent) and Asia (32 per cent). Twelve cities of more than 10 million people—including Bangkok, Shanghai, London and Kolkata—rely on underground water reserves. Fifteen per cent of the water used in Australia comes from groundwater sources.



5.12 (a) Groundwater in natural conditions; (b) exploited groundwater resources



5.13 Villagers in India draw groundwater from a communal well.

SPOTLIGHT

The Great Artesian Basin

The Great Artesian Basin is the largest and deepest confined aquifer in the world. It covers an area of 1.7 million square kilometres, or 23 per cent of the Australian continent (see Figure 5.14). The basin is 3000 metres deep in places and is estimated to contain 64 900 cubic kilometres of groundwater.

Water infiltrates the exposed sandstone aquifers along the western slopes of the Great Dividing Range, and is confined within the aquifers by impermeable layers of rock (layers that water cannot penetrate). For the most part the trapped water flows towards the south-west. In the northern section of the basin, however, some water flows towards the north-west and north (see Figure 5.14).

Natural discharge from the Basin occurs at springs—the points at which groundwater flows at the surface. These springs helped to sustain groups of Aboriginal people for tens of thousands of years and are a valuable resource for wildlife.

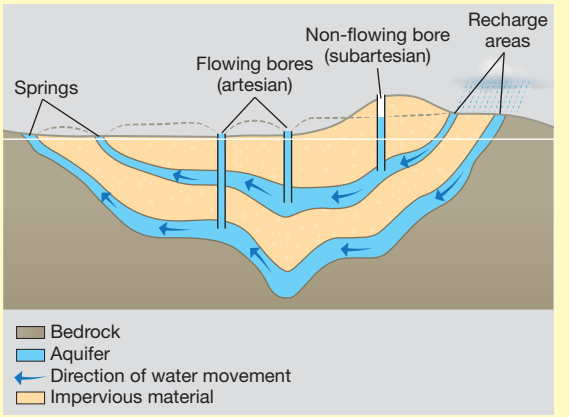
Because the aquifer is confined between impermeable layers of rock, it is held under pressure. When a bore is drilled into an aquifer, the pressurised water rises to the surface. When water flows from the bore without assistance, the bore is described as an 'artesian' bore. If the water has to be pumped to the surface, the bore is described as 'subartesian' (see Figure 5.15).

Other large aquifers include the Ogallala Aquifer in the United States of America; the Guarani Aquifer underlying parts of Argentina, Brazil, Paraguay and Uruguay; the Yarkon–Taninim Aquifer (Israel–Palestine); and the Bas Saharan Basin in Africa.

5.14 Location of Australia's Great Artesian Basin



5.15 Cross-section of the Great Artesian Basin





5.16 A bore taps water from the Great Artesian Basin.

Groundwater as a renewable resource

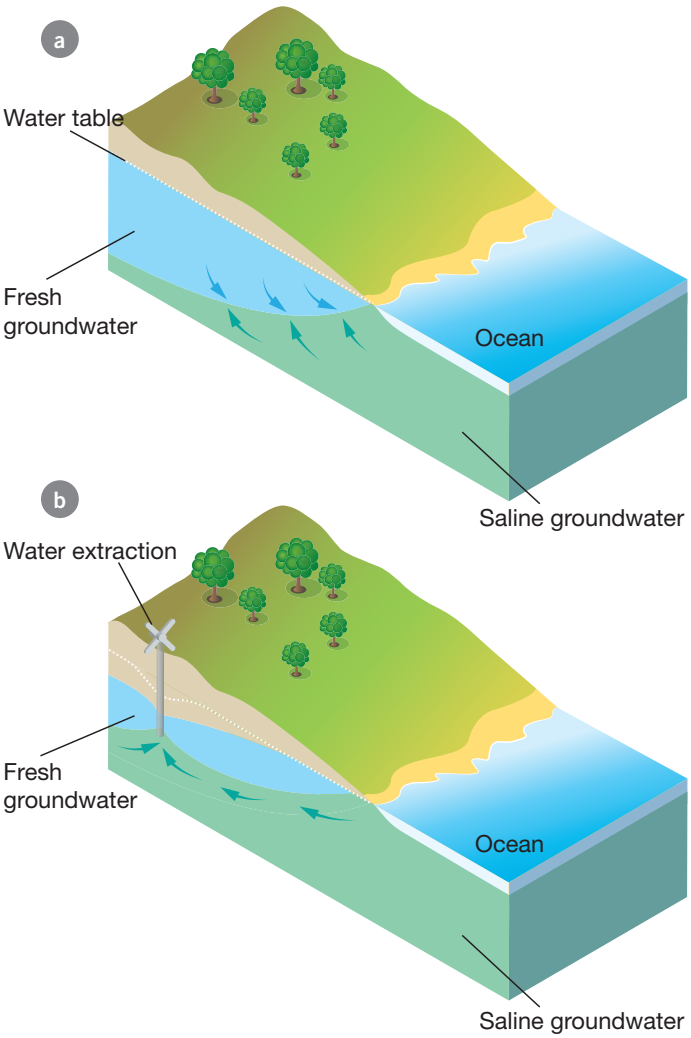
If the rate of groundwater extraction is equal to, or less than, the rate at which it is replenished, groundwater can be classified as a renewable resource.

Advantages of groundwater

Groundwater is a popular source of water in many parts of the world. It has the following advantages.

- It is a reliable source of water because it is not affected by drought (at least in the short to medium term).
- It can be accessed in the place where it is needed. There is no need for expensive infrastructure such as pipes to transport water.
- Because the quality of groundwater is usually high, the expense of treating water to a standard fit for human consumption is minimised.

5.17 Saltwater intrusion



Threats to groundwater supplies

There are a number of threats to the quantity and quality of groundwater. These include the following:

- Excessive pumping from an aquifer can allow salt water to seep in and pollute the groundwater. This is called saltwater intrusion. See Figure 5.17b.
- Overuse can cause the water table to drop below the base of a well. The well then needs to be dug deeper or the settlement that relies on the well may have to be abandoned.
- Excessive withdrawals of groundwater can cause the ground above the aquifer to subside (drop).
- The aquifer can become polluted by toxic chemicals, including pesticides and fertilisers. These can enter the food chain, where they can cause birth defects and other serious medical conditions.

ACTIVITIES

Knowledge and understanding

1 Explain how groundwater is stored below the earth's surface and used around the world.
2 Describe the threats to groundwater resources.

Geographical skills

3 Study Figure 5.12. Outline the impact that water extraction can have on groundwater. Explain how a toxic spill in one part of the catchment can affect people's drinking water in another.
4 Study Figure 5.14.
  a Describe the flow of water within the Basin and identify the area where aquifer recharge takes place.
  b Estimate the greatest distance the water travels from the intake area.
  c *The Great Artesian Basin is more important to South Australia than New South Wales, Queensland and the Northern Territory.* Discuss.
5 Study Figure 5.17. Explain how salt water can penetrate and pollute a freshwater aquifer.

Investigating

6 Select one of the other aquifers listed in the Spotlight box 'The Great Artesian Basin'. Undertake internet research. Write a report similar in structure to 'The Great Artesian Basin'. Remember to include a map.

5.6 Water use

The amount of water people use increased sixfold during the twentieth century. This is more than twice the rate of population growth.

Types of water

Blue water is a term commonly used to describe the earth's fresh surface water and groundwater—that is, the water in freshwater lakes, rivers and aquifers.

The term **green water** is used to describe water stored in the soil or present in vegetation.

Grey water is wastewater. It comes from domestic activities such as washing clothes, washing dishes and bathing. Grey water can be recycled and used to water gardens and sporting fields.

DID YOU KNOW?

A chicken is made up of 75 per cent water. For an elephant, the figure is 70 per cent.

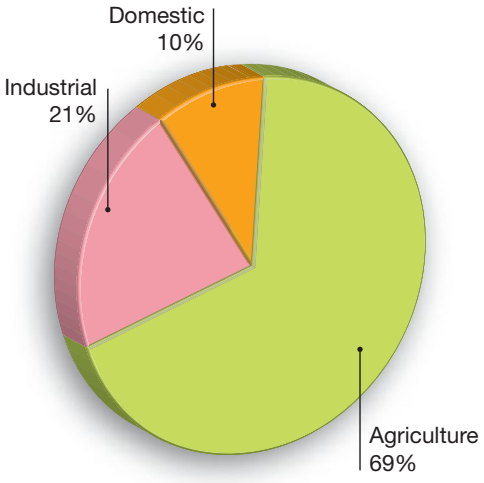
Where water is used

About 69 per cent of all available fresh water is used for agriculture (see Figure 5.18). A further 21 per cent is used in industry. Major industrial users are power plants, which use water for cooling, or as a source of energy for hydro-electricity; refineries, which use water for cooling; and manufacturing plants, which use water as a solvent. It is estimated that just 10 per cent of worldwide water use is for household purposes. These include drinking, bathing, cooking, **sanitation** and watering of gardens.

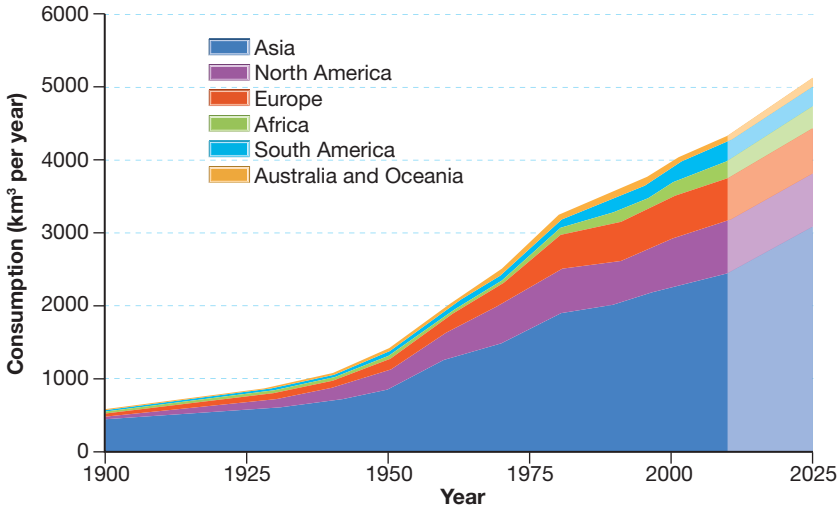
Per capita water use

Water consumption can be very high. The amount used per person per day is 575 litres in the United States of America, and 193 litres in Germany. Compare this with the 20–30 litres per person per day that is considered enough to meet basic human needs in developing countries. Figure 5.19 shows past, current and predicted water consumption by continent.

5.18 Global water use by sector: agriculture, industry and domestic uses



5.19 Global water consumption, 1900–2025

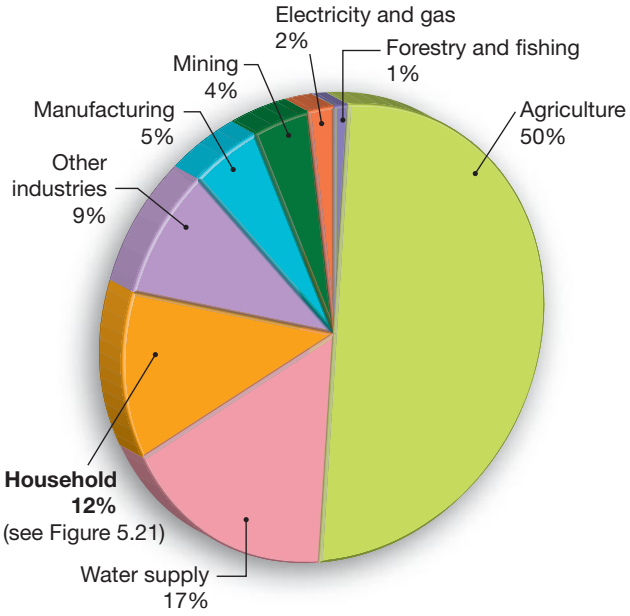


Water use in Australia

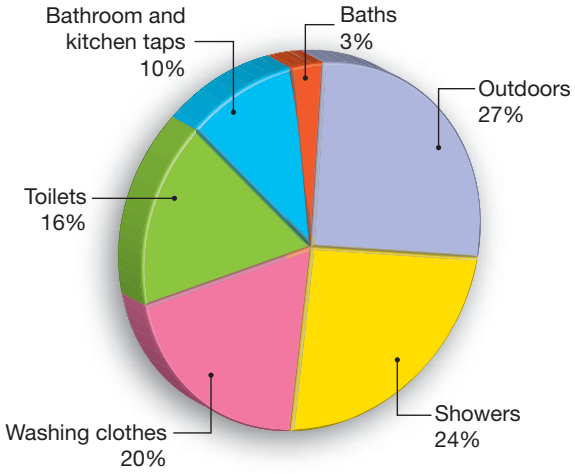
Australia has one of the highest per capita (or per person) rates of water use in the world. The largest consumer of water in Australia is the agriculture sector. While two-thirds of all the people on earth use less than 60 litres each of water a day, the average Australian uses more than twice that amount during a single shower, and about 493 litres a day in total.

Figure 5.20 shows water use in Australia by different sectors of the economy, and Figure 5.21 further analyses water use in Australian households.

5.20 Water use in Australia by different sectors of the economy, 2008–09



5.21 Typical household water use in Australia



SPOTLIGHT

Bottled water

Global sales of bottled water in 2011 amounted to about 175 billion litres. The value of bottled water sales was in excess of $60 billion. At about $3.00 per litre, bottled spring water is more expensive than petrol, which sells for approximately $1.40 per litre.

Apart from being more expensive than petrol, bottled water is an environmental problem in Australia and worldwide.

- Plastic bottles are made out of oil, and the production of these bottles emits hundreds of times more greenhouse gases than the equivalent amount of tap water.
- Australia's annual bottled water use creates more than 60 000 tonnes of greenhouse gas emissions, or about the same amount that 13 000 cars generate over the same time.
- Relatively few bottles are recycled (approximately 36 per cent), and hundreds of millions of bottles each year end up in landfill or as rubbish on our streets.

Increasingly, people are being encouraged to drink tap water.

ACTIVITIES

Knowledge and understanding

1 State the estimated basic water need of people. How does this compare with the average Australian household water use?
2 Distinguish between 'blue', 'green' and 'grey' water.

Applying and analysing

3 Develop a plan to reduce bottled water use in Australia. Your plan should include reasons for your decisions and an explanation of how the plan should work.

Geographical skills

4 Study Figure 5.19. Describe the change in global water consumption since 1900. Suggest reasons for this.
5 Study Figure 5.21. Identify the three largest areas of household water use in Australia. Do you think these would be the three largest areas of water use in your household? Explain.

5.7 Water footprint

A water footprint is the total volume of fresh water used by an individual, a household, a business, a community or a country. For an individual, it includes water used directly (for example, for drinking, bathing, cooking and washing clothes) and water used indirectly (for example, in producing things such as food, paper, electricity, steel and cotton clothes).

Water use and footprint

The water footprint of countries can be used to determine and compare global water use. National water use consists of two parts:

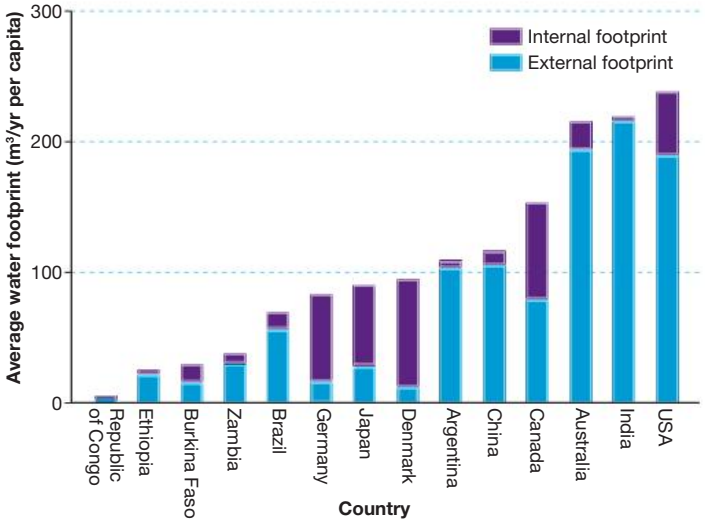
- the internal **water footprint**, which is the water used inside the country
- the external water footprint, which is the water used to produce goods and services that are imported from other countries.

Figure 5.22 shows internal and external water use for selected countries.

Water use includes **virtual water**. The virtual water content of a product is the amount of fresh water that is used when the product is created. An example of virtual water is the water used in coal power stations (see Figure 5.23). Countries can both import and export virtual water.

If, for example, your family buys an imported car (which uses approximately 150 000 litres of water during the production process), you are using another nation's water. As a general rule, the more economically advanced a country, the greater both its internal and its external water footprint.

5.22 Average water footprint and proportion of water use sourced externally, for selected countries





5.23 Steam rising from power station cooling towers in the Latrobe Valley, Victoria. Water used in manufacturing processes is commonly referred to as unseen virtual water.

Australia's water footprint

In 2008–09, Australia's total domestic water use was 14 101 gigalitres (1 gigalitre is approximately the amount of water in 500 Olympic swimming pools). This is a decrease of 25 per cent from 2004–05, when 18 767 gigalitres of water was used. Water use in Australia has decreased because of drought and the introduction of water restrictions.

Average household water use in Australia equals 80 500 litres per person per year.

A family's water footprint

Water supply authorities want to reduce the amount of water that households use. They do this in various ways:

- through public education campaigns
- through the price they charge for water
- by installing water-efficient appliances
- in some cases, by imposing water restrictions.

An Australian 'water wise' household's water use is shown in Table 5.24. Individual figures will, of course, vary. The amount your household uses depends on such things as how much time you spend at home, how often you have visitors, the size of your garden and whether you have a pool.

To encourage people to use less water, there are a number of online water footprint calculators. There are also apps you can download onto your mobile phone that calculate your water footprint, tell you how much water is used in the production of selected goods and track your use of water, gas and electricity.

5.24 Water consumption of a 'water wise' Australian household

People per household	Water consumption
1	239 litres/day
2	360 litres/day
3	458 litres/day
4	542 litres/day
5	619 litres/day
6	689 litres/day

Source: Sydney Water

DID YOU KNOW?

The total global water footprint is 7450 billion cubic metres per year. This is an average of 1240 cubic metres per year for every person on earth.

Reducing water use

There are many ways in which households can reduce their direct water footprint (that is, their home water use).

Examples include:

- installing dual-flush toilets and water-saving showerheads, dishwashers and clothes washers
- turning off the tap when brushing your teeth
- using less water in the garden (for example, by planting drought-resistant plants, mulching garden beds and using drip irrigation)
- collecting rainwater and using grey water for irrigation.

ACTIVITIES

5.3

Knowledge and understanding

1 State what is meant by the term 'water footprint'.
2 Distinguish between a country's 'internal' and 'external' water footprint.
3 State what the term 'virtual water' refers to.
4 Discuss why Australia's water footprint has been decreasing.

Analysing and applying

5 Develop your own example of the trade in 'virtual water'.

Geographical skills

6 Study Figure 5.23, then answer the following questions.
  a List the five countries with the highest water footprint per capita.
  b Compare the internal footprint of each of those five countries with its external footprint.
  c Identify the countries that have a larger external water footprint than internal water footprint. Provide reasons why this might be so.
  d The United States of America has the third-largest population of all the world's countries but the highest water footprint per capita. Discuss why this is so.

Investigating

7 Access one of the many online water footprint calculators. Calculate your water footprint.

5.8 Virtual water

Virtual water is the water used in the production of goods and services we use. For example, to produce a McDonald's Big Mac takes about 2400 litres of water, most of which is used to grow the grain that feeds the cattle.

Water in food production

If we know how much virtual water is needed to produce a product, then we can use that knowledge to help us to use water more wisely.

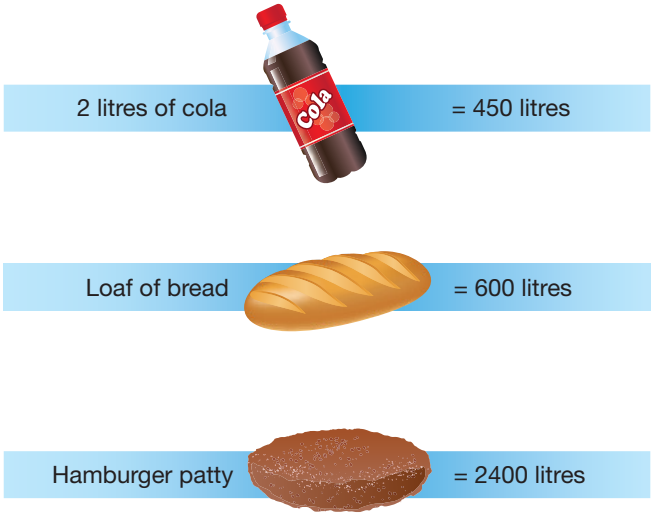
The majority of the virtual water that we use goes into the production of food, as shown in Figure 5.25. A typical breakfast can consume up to 1100 litres of water—140 litres for a cup of coffee, 120 litres for eggs 240 litres for milk and 80 litres for each piece of toast (not including butter or jam).

Large amounts of water are also used to produce many of the manufactured goods we use each day, as shown in Figure 5.26.

DID YOU KNOW?

The annual global trade in virtual water exceeds 800 billion tonnes, or the equivalent of ten Nile Rivers.

5.25 The amount of water used to produce selected foods



Trade in virtual water

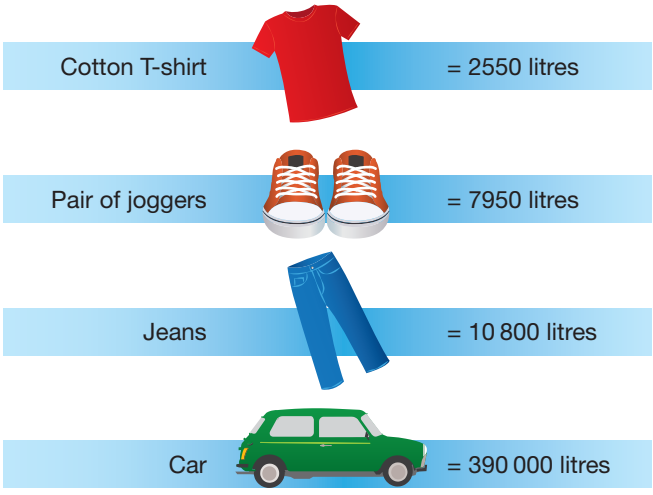
The concept of a trade in virtual water refers to the idea that when goods and services are exchanged, so is the water that was used to produce them.

How the trade works

When a country imports 1 tonne of wheat, that country saves about 1300 cubic metres of its own water. If water is scarce in that country, the water that it saves can be used for other purposes. If, however, water is scarce in the exporting country, it has exported 1300 cubic metres of water that is no longer available for other purposes.

For some countries it makes sense to save real water by importing the virtual water embedded in grain or meat. The Netherlands, Jordan, the United Kingdom, Japan and South Korea depend on virtual water imports for more than 62 per cent of their water needs. Large exporters of virtual water—mostly in the form of wheat, corn, soybeans and other food crops—are the European nations, the United States of America, Australia and Brazil.

5.26 The amount of water used to produce selected consumer products



SPOTLIGHT

Coffee's big thirst

Coffee is one of the most important agricultural products traded in the world. Producing coffee, however, requires a lot of water. It takes about 21 000 litres of water to produce 1 kilogram of roasted coffee. A standard cup of coffee needs 7 grams of roasted coffee, so each cup of coffee 'costs' 140 litres of water. Assuming that a standard cup holds 125 millilitres of coffee, we need more than 1100 drops of water to produce one drop of coffee.

International trade in coffee products is responsible for 80 billion cubic metres of virtual water exports. Among all the crop and livestock products, coffee is at the top of the list of global virtual water flows.

In total, the world's population needs 120 billion cubic metres of water per year in order to enjoy coffee. This is about 6 per cent of the world's total international virtual water flows.



5.27 Australians bought 23 million kilograms of coffee products in 2012. That is 1.26 billion cups, costing consumers about $3 billion.

ACTIVITIES

Knowledge and understanding

1. State how much water is used in creating a McDonald's Big Mac.
2. State why it is important to know the amount of virtual water involved in producing goods and services.
3. Explain the concept of 'trade in virtual water'. What are the implications of this concept for countries with scarce water resources?

Applying and analysing

4. Study Figure 5.25 and the information under 'Water in food production', and calculate the amount of virtual water required to produce:
   a. breakfast: 2 slices of toast and 1 cup of coffee
   b. lunch: a hamburger in bread and a 500 mL bottle of cola.
5. Study Figure 5.26. Think about how many pairs of jeans you own. How much water was required to produce them?

Investigating

6. Study the Spotlight box 'Coffee's big thirst'. Use this as a guide to investigate the amount of water required to develop, produce and run one of the following products:
   - mobile phone
   - television
   - portable media player such as an iPod
   - tablet computer such as an iPad
   - desktop or laptop computer
   - other technological device.

   Develop an oral report, supported by a multimedia presentation, outlining the findings of your research.

5.9 Access to clean water

Access to water is a global health issue. According to the World Health Organization (WHO), one in six people don't have access to reliable, safe drinking water, and 2.6 billion people (40 per cent of the world's total population) lack access to basic sanitation.

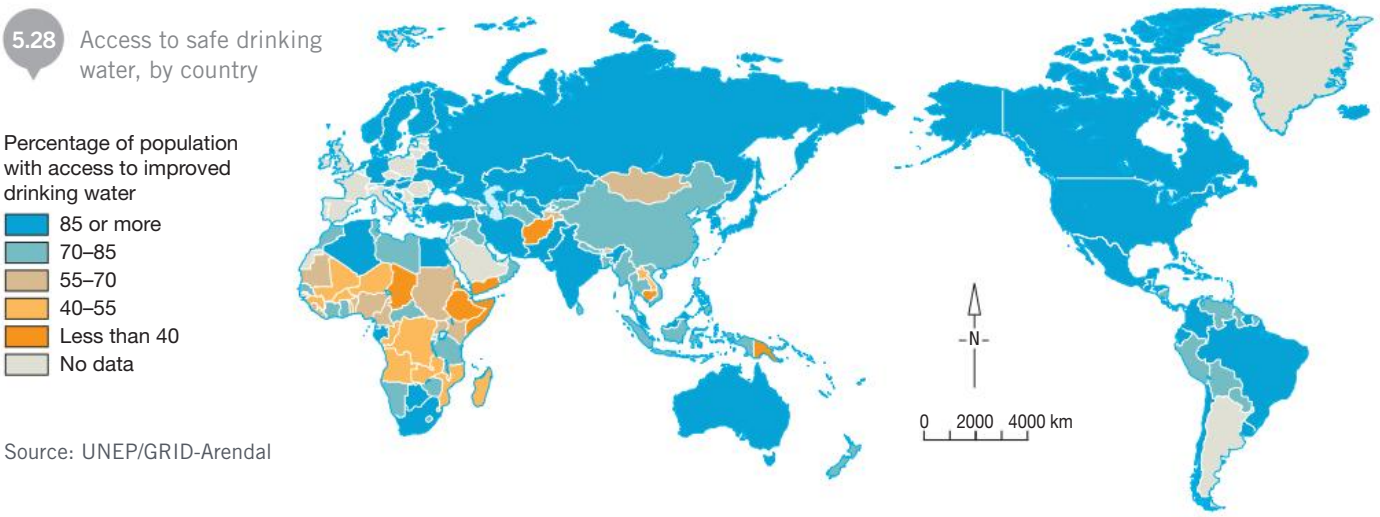
Water access issues

Access to safe water and access to sanitation are important. The contamination of water sources by human waste, and the waterborne diseases that result from this contamination, are a source of great human suffering.

Figures 5.28 and 5.29 show global access to safe or improved water, and places with little or no access to sanitation.

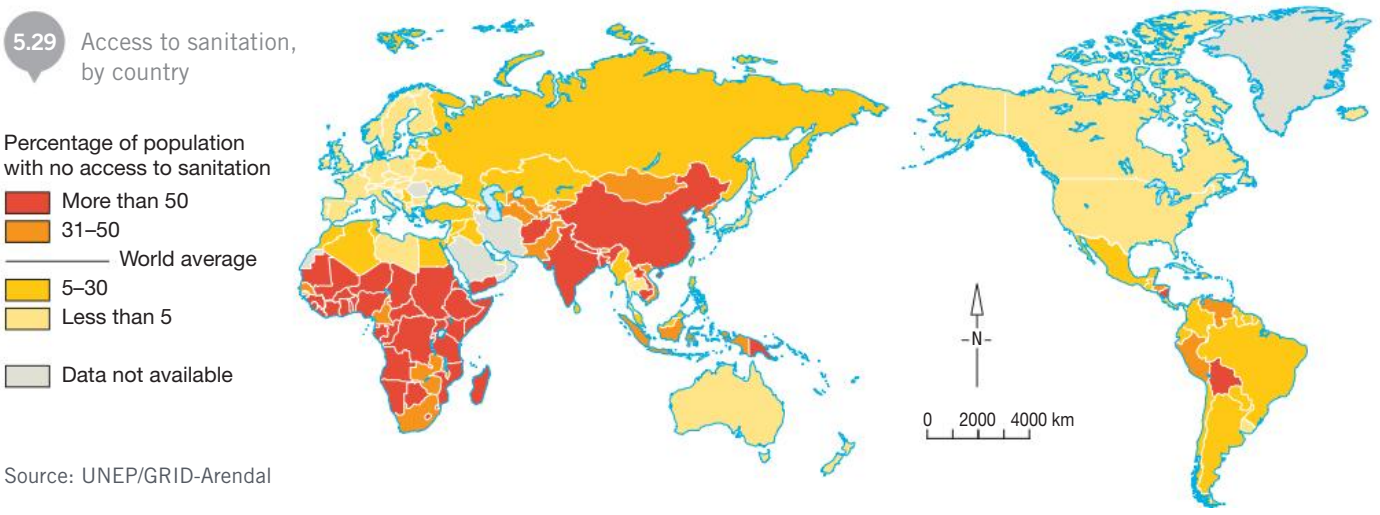
Access to water is also an economic issue because it is vital for reducing poverty and producing food and energy. It is especially an issue for women and children in developing countries. In many developing countries, women and children are responsible for finding and carrying the household's daily supply of water from distant wells, as shown in Figure 5.30.

5.28 Access to safe drinking water, by country



Source: UNEP/GRID-Arendal

5.29 Access to sanitation, by country



Source: UNEP/GRID-Arendal



5.30 Collecting enough water for drinking, cooking and basic hygiene for a family of six can mean carrying heavy water containers from a distant source for an average of 3 hours a day.

Waterborne diseases

Waterborne diseases occur when people drink **contaminated** drinking water. When the same contaminated water is used in the preparation of food, people can get a range of foodborne diseases. Diseases transmitted through contaminated water include diarrhoea, cholera, dysentery, typhoid and hepatitis A.

Sanitation

Sanitation is a basic need and a way to safeguard people's health. It prevents the spread of disease.

For many countries it is a challenge to provide the infrastructure (toilets, storage facilities, pumping stations, sewerage, water pipelines and treatment works) needed to prevent contamination. Infrastructure is expensive, and rapid rates of urbanisation often make it difficult for authorities to keep pace with population growth and provide proper sanitation. The solutions do not need to be expensive or high-tech. The construction of communal toilets is an example of a low-cost response.

Lack of toilets forces people to use public spaces. This increases the risk of transmitting disease. The Ganges River in India, for example, has approximately 1 billion litres of raw sewage dumped into it every day. This is frightening when you consider that just 1 gram of human waste in untreated water may contain 10 million viruses, 1 million bacteria and 100 worm eggs.

In India, it is estimated that 80 per cent of all health problems and one-third of all deaths are due to contaminated water. Building toilets can have an immediate impact on public health, and can reduce death rates from diarrhoea by up to a third.

Providing toilets has a number of other benefits. Toilets in schools encourage children, and particularly girls, to attend school. For example, if a school has no toilets, girls generally do not attend school during menstruation, and their education is disrupted. Hygiene education campaigns and the promotion of hand washing (when included in the school curriculum) can reduce diarrhoea cases by up to 45 per cent.

The United Nations Millennium Development Goals have a target of 75 per cent sanitation coverage worldwide by 2015. It is estimated that it would cost US$14 billion per year to meet that target. The economic benefits of sanitation are impressive. Every US$1 invested in improved sanitation provides a US$9 return in value. Those who benefit most are children living in disadvantaged communities.

Growing cities

People living in the world's rapidly growing slums have very limited access to safe water for household use. A slum dweller may only have access to between 5 and 10 litres per day, while a person in the same city on a middle income may use 50 to 150 litres per day.

In some cities with poor infrastructure, nearly 30 per cent of fresh water supplies are lost because of leaking pipes. In some large cities, pipes that leak can lose up to 70 per cent of their water.



5.31 Children play in a polluted drain in Manila, in the Philippines. Rapid urbanisation has overwhelmed efforts by the authorities to meet people's needs for clean water and sanitation.

SPOTLIGHT

World Vision making a difference

Australians take clean water for granted, but in many countries it is still considered a luxury. In Indonesia, four out of five mothers have no option but to give their families bacteria-infected water because of polluted wells. In one Indonesian community World Vision is addressing these water concerns.

Indonesia has some of the world's worst sanitation. UNICEF has found that 53.4 per cent of Indonesian families use a water source located within 10 metres of an open toilet.

This falls short of the universal standard for water safety. Water this close to a toilet is the ideal breeding ground for bacteria that cause diarrhoea, typhoid and other waterborne diseases.

In 2005, the isolated East Nusa Tenggara province in Indonesia faced particularly large challenges. Piping was limited, so some families sourced their water from wells more than an hour's walk away—and these wells were often polluted. More than 38 per cent of children under five in the province suffered from diarrhoea.

In the same year, World Vision began a project with the community to provide information about the importance of good hygiene and sanitation. School classes emphasised the importance of basic hygiene so children would bring this knowledge home to their families. A media campaign and prizes for best sanitation practices also helped get word out.

As well as providing advice on safe water sources, World Vision worked with the community to improve their water supply. World Vision assisted in building 25 kilometres of gravitational piping, a water reservoir, five water tanks and toilets in more than 800 households.

Today, 75 per cent of households have toilets. This has greatly helped to separate waste and clean water. Surveys show that knowledge about basic hygiene has improved throughout the area. Most importantly, diarrhoea in children under five years of age has decreased dramatically. By 2008, there were only 11.7 per cent of children infected.

Source: World Vision Australia website, 2012

ACTIVITIES

5.4

Knowledge and understanding

1 How many people in the world do not have access to clean water?
2 List the effects of poor sanitation on the health and wellbeing of people.
3 What are the benefits of improved sanitation and clean water?

Applying and analysing

4 Outline the strategies being used to meet the sanitation needs of people. Why has this approach been adopted?
5 'Improving sanitation is essential to ensure a clean water supply.' Is this statement correct or incorrect? Explain.
6 What impacts can a lack of access to a clean supply of water have on human wellbeing? Present your key points as a mind map.

Geographical skills

7 Study Figure 5.28. With the aid of an atlas, identify the parts of the world where less than 60 per cent of the population have access to safe drinking water.
8 Study Figure 5.29. With the aid of an atlas, identify the regions of the world that experience the lowest levels of per capita access to sanitation.
9 Study Figure 5.31. Explain why people living in such conditions are exposed to the threat of waterborne diseases. Undertake research to find out why such living conditions are common in many of the developing world's large cities.

Investigating

10 Waterborne diseases often become a problem in the period following major natural disasters.
   a Explain why they become an issue.
   b Select one of the waterborne diseases, and identify the source, symptoms, treatments and long-term effects of the disease.
   c Describe programs put in place after natural disasters to reduce the impacts of waterborne diseases. (Refer to the Spotlight box 'World Vision making a difference' as a guide.)

5.10 World water hotspots

Water is a national and global security issue because of increasing tensions both within and between nations over access to limited water resources that they share. Figure 5.32 shows the location of some recent water-based encounters between two or more competing interests.

Israel
In 2007, there were restrictions on fuel, spare parts and maintenance equipment sent to Gaza. Limited access to these materials threatened the functioning of Gaza's already limited water and sanitation system.

Iraq
An extensive network of canals has been used to divert water from the wetlands found between the Tigris and Euphrates rivers. As a result, the wetlands have shrunk by up to 95 per cent. Dams upstream in Turkey make the situation worse. Following the 2003 invasion of Iraq, diversion and drainage works were broken to allow water to again flood the marshes. Regeneration, however, has been very slow.

River Nile
The Nile is a source of water for millions of people who live in the ten countries that border its basin. It is also a source of conflict between nations. Uganda, Sudan, Ethiopia and Kenya have complained about Egypt's domination of the river's water resources. Plans by Ethiopia, Sudan and Eritrea to build dams are the most recent cause of conflict.

Sudan
Angry villagers in Sudan staged protests against Kajbar Dam; four villagers were killed by the government-controlled militia.

Spain
Spain's shortage of water has prompted authorities to build desalination plants.

5.32 The world's water hotspots



Burkina Faso
Declining rainfall has led to violence between animal herders and farmers with competing water needs.

Kenya
In Africa's Rift Valley, in the north-west of Kenya, water shortages have historically caused conflict between cattle-herding Turkana and Pokot tribes. Now, guns have replaced bows and arrows and the death toll is rising.

Okavango Delta
The Namibian government has presented plans to build a dam and a hydro-electric power station that would regulate the flow of water into Africa's Okavango Delta. While the government argues that the effect would be minimal, environmentalists claim that the project could destroy most of the Delta's animal and plant life.

Pakistan
A 2010 conflict over irrigation water resulted in more than 100 deaths. Two weeks of tribal fighting began when the Shalozan Tangi tribe cut off the supply of water to the Shalozan tribe. Elsewhere, the Mangal tribe cut off the supply of irrigation water to lands used by the neighbouring Tori tribe.

Northern India
In the 1970s, poor farmers from across northern India were encouraged to relocate to the once barren Thar Desert in Rajasthan, where a huge irrigation project had made the land fertile. But droughts and desertification have brought this productivity and prosperity to an end, plunging the region into crisis.

China
With drought common in the north and flooding common in the south, China began two major construction projects. The first is the now complete Three Gorges Dam on the Chang Jiang (Yangzi) River, which was designed to control flooding and provide renewable hydro-electricity. The second is a project to divert water from the Chang Jiang into the Huang He (Yellow) River, which often runs dry for up to half the year.

Mekong River and Delta
The Mekong River rises on the Tibetan Plateau and flows through China, Burma, Laos, Thailand, Cambodia and Vietnam, where it enters the sea. China has been building dams on the upper Mekong and this has affected the amount of water flowing downstream.

DID YOU KNOW?

Since 1950, there have been approximately 2000 disputes between countries related to catchments that cross international borders.

Concerns about the creation of dams, the health of the river and the six countries that the river supplies led to the establishment of the Mekong River Commission.

Queensland and New South Wales
Conservationists and farmers have joined forces to fight the expansion of the coal seam gas industry. Protesters fear that the extraction of the gas will destroy groundwater aquifers and pollute local waterways.

United States of America
In the USA, 95 per cent of water is found under the ground. Ogallala Aquifer is being used faster than the water is being replaced and in some areas the groundwater has been contaminated. Meanwhile, the Colorado River, which supplies Nevada and California with most of their drinking water and water for irrigation, is being depleted. States that rely on water from the Colorado River are facing severe water restrictions.

Mexico City
Water supply authorities pump 80 per cent of the city's fresh water from aquifers below the city. So much water has been removed that the city has sunk by approximately 9 metres.

ACTIVITIES

5.5

Knowledge and understanding
1 Explain why access to water is likely to be a source of conflict in the future.

Investigating
2 Undertake internet research to investigate one of the water-related conflicts featured in this unit. Present an oral report to communicate your results. Include in your report:
- a map of the region
- issues and concerns surrounding your chosen conflict
- the different parties involved in the issue
- solutions that have been undertaken in the past
- what your solutions would do to minimise or end the conflict.

5.11 A water-based conflict

As global warming accelerates, scientists predict that rainfall in many parts of the world will become increasingly unreliable. As a result, water scarcity will grow and the number of water-related conflicts is likely to increase.

SOURCE OF LIFE BECOMES THE THREAT

Water could be the focal point of South Asia's next great conflict, writes *Ben Doherty*

South Asia lives on its rivers. Its three great basins—the Indus, the Ganges and the Brahmaputra—are the most densely populated in the world. The Ganges alone supports half a billion people.

Seventy per cent of South Asia's 1.5 billion people live in farming families, and depend on the water of those basins for their survival (see Figure 5.33). That number grows by 25 million every year.

For generations the rivers have watered the breadbasket of the Punjab, the cotton plants and fruit trees of the Sindh, and the rice paddies of Bangladesh,



5.33 The catchments of the Indus, Ganges and Brahmaputra rivers

and grown this region faster than anywhere else.

But South Asia's water supply is unpredictable, and increasingly unmanageable. Lashed annually by monsoons, and regularly by devastating floods, in between, there are severe and prolonged droughts across the region. Even when the rain falls in moderation, there is often little infrastructure to manage or preserve it for leaner times.

Across every part of all three basins, there is less water and ever more people who rely on it. The issue of water in this part of the world is back in the spotlight this week with a case before the Permanent Court of Arbitration in The Hague between Pakistan and India.

Pakistan claims a new hydro-electric plant India is building on the Kishanganga River (known as the Neelum River in Pakistan) in Kashmir will rob it of water that rightfully belongs to it.

This is the political reality of this water-short century: rivers are (even more) powerful. Water is becoming a powerful weapon of diplomacy …

A security report from the US [claims] that over the next decade, 'many countries … will experience water problems—shortages, poor water quality, or floods—that will risk instability and state failure' …

Disputes are likely to emerge between countries, between states within countries, and even between cities and communities, over the right to an increasingly scarce resource … [and] extremists will 'almost certainly' target vulnerable water infrastructure …

[The] Lashkar-e-Taiba … terror group, [for example,] regularly threatens to blow up India's dams …

Last year, Pakistani newspaper *Nawa-i-Waqt* urged the government: 'Pakistan should convey to India that a war is possible on the issue of water and this time war will be a nuclear one' …

Scarce water will [also] drive up food prices, destabilise governments, and spark mass migrations within and across state borders.

For South Asia, climate change will see less water in rivers … by the middle of this century, shrinking glaciers will reduce the flow of water to the Indus by 8 per cent while … climate change could cause weaker monsoons, which start later, and have longer breaks in between periods of rain.

Demographics are changing too. As a country like India, especially, develops economically, a wealthier population will eat more meat, requiring more water-intensive agriculture …

The current Pakistan–India water dispute is a test of a decades-old water-sharing agreement …

Essentially, the Indus Waters Treaty, signed in 1960, gives Pakistan rights over the Indus Valley's three western rivers, India control over the three rivers to the east. The treaty is hugely important, in particular to Pakistan, which is downstream from India, and reliant on its larger neighbour's adherence to it for survival.

The Indus irrigates more than 80 per cent of the country's 22 million hectares of farmland, in turn providing 21 per cent of the country's gross domestic product.

But the treaty is beginning to crack under new pressures, and Pakistan's increasing anxiety about its neighbour's activities on its watercourses.

India has no fewer than 45 dams or power stations completed, planned or proposed on 'Pakistan's' western rivers, which Islamabad believes will give Delhi control over how much water flows over the border, and the ability, if it so chooses, to choke off Pakistan's agriculture, starve its people and ruin its economy.

India dismisses Pakistan's fears as … without scientific basis. It says it has adhered to the treaty and its … dams don't affect its neighbour.

Source: *Sydney Morning Herald*, 19 May 2012

ACTIVITIES

Knowledge and understanding

1 Discuss the impact that global warming will have on water scarcity.
2 Explain why the number of water-based conflicts is expected to increase.

Applying and analysing

3 Study the newspaper extract 'Source of life becomes the threat', then complete the following tasks.
   a Outline the importance of water to the peoples of South Asia.
   b Explain why water scarcity and water management are an issue in South Asia.
   c List the likely impacts of climate change on water availability in South Asia.
   d Briefly describe the water conflict between India and Pakistan.
   e Is there a link between water and terrorism? Explain.
   f Why is the 1960 Indus Water Treaty important for Pakistan?
   g Outline Pakistan's concerns. What is India's response?

5.12 Irrigation

Irrigation is the watering of crops by artificial means. Humans have been irrigating crops for thousands of years. Early examples of irrigation societies include those of Mesopotamia and Ancient Egypt. In Mesopotamia (in what is now Iraq and part of Iran), irrigation has been used for at least 6000 years.

Ancient Egypt

In Egypt, the floodwaters of the Nile were trapped on plots of land surrounded by dykes or walls of earth. The water was held within the dykes until the fertile sediment (with its rich store of plant nutrients) had settled. Any water that was not required was then returned to the Nile.

Irrigation allowed people to produce more food than they could use. This extra food was sold in markets. Irrigation enabled people to specialise in non-agricultural activities.

Today

Today, irrigation is used around the world. About 68 per cent of the land used for irrigation is found in Asia, 17 per cent in North America, 9 per cent in Europe, 5 per cent in Africa and 1 per cent in Oceania. The most intensively irrigated land is found:

- in North India and Pakistan, along the Ganges and Indus rivers
- in the Hai He, Huang He (Yellow) and Chang Jiang (Yangzi) basins in China
- along the Nile River in Egypt and Sudan
- in the Mississippi–Missouri river basin and parts of California, in the United States of America.

Smaller irrigation areas are spread across almost all populated parts of the world.

Developing countries

Many of the world's poor farmers use small-scale and low-cost traditional forms of irrigation. For example, millions of farmers in low-lying Bangladesh, where the water table is close to the surface, use human-powered treadle pumps (see Figure 5.34) to bring groundwater up to the earth's surface and into irrigation ditches. These simple devices are cheap, easy to build and operate on muscle power.

Other irrigation and water-saving strategies include capturing and storing rainwater, planting deep-rooted crops, controlling weeds and using mulch to reduce evaporation.

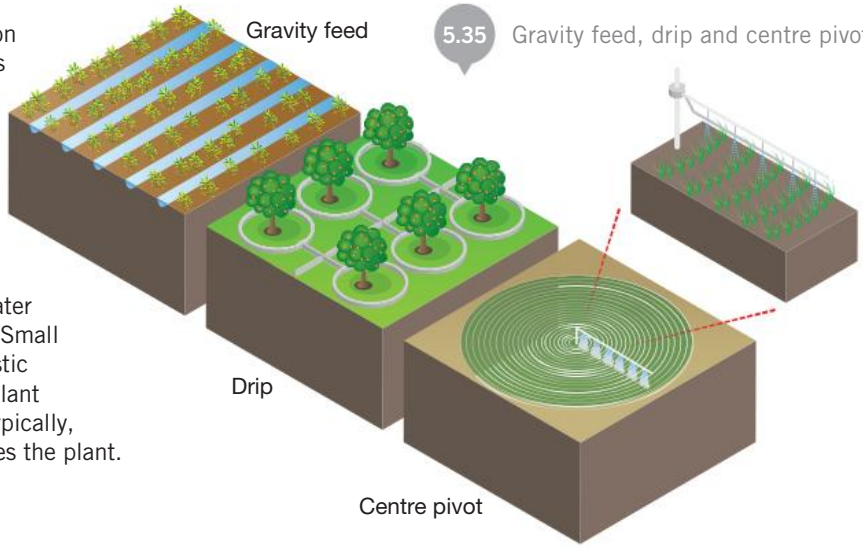
With the help of affordable irrigation and access to markets, farmers in the developing world can grow more food and climb out of poverty.

5.34 Treadle pumps are a small-scale, low-cost traditional form of irrigation.



Gravity feed or flood irrigation delivers more water to crops than is needed. Typically, 40% of the water is lost through evaporation, seepage and run-off.

Drip or trickle irrigation is the most efficient way to deliver small amounts of water to crops, but is also costly. Small drip fittings attached to plastic tubing deliver water to the plant at a slow and steady rate. Typically, 90–95% of the water reaches the plant.



5.35 Gravity feed, drip and centre pivot irrigation systems

Centre pivot irrigators use pumps and sprinkler heads to spray water onto crops. This is a relatively efficient form of irrigation: 90–95% of the water is delivered to where it is needed.

Reducing waste

Sixty per cent of the irrigation used throughout the world fails to reach the crops it is intended for, mainly because of inadequate technology and mismanagement. There are a number of ways wastage can be reduced. These include:

- lining or covering the canals that bring water to the irrigation ditches, which reduces infiltration
- irrigating at night to reduce evaporation
- monitoring soil moisture to manage the application of water efficiently
- avoiding growing water-thirsty crops in dry areas
- irrigating with treated grey water.

5.36 Pivot-irrigated fields in Arizona, United States of America



Types of irrigation

The main types of large-scale irrigation used in the world today are gravity feed, drip and centre pivot irrigation (see Figures 5.35 and 5.36). While drip and centre pivot irrigation systems are expensive, they are the most efficient methods—that is, they result in the least loss of water through evaporation. Gravity feed irrigation remains the most common irrigation method used.

ACTIVITIES

7.4

Knowledge and understanding

1 Define irrigation.
2 Outline the role irrigation played in the development of the market economy in ancient times.
3 State the regions of the world where irrigation is used most intensively.

Applying and analysing

4 Study Figure 5.35, then complete the following table in your workbook to compare different methods of irrigation.

	How it works	Advantages	Disadvantages
Gravity feed			
Drip or trickle			
Centre pivot			

5 Write a report outlining the ways in which irrigation waste can be reduced.

5.13 Case study: Irrigation in Bali

Bali is an island province of Indonesia located to the east of Java. The island is home to Indonesia's small Hindu minority, who make up more than 90 per cent of Bali's population of 3.9 million. Agriculture is Bali's biggest employer.

Bali's economy

Until the 1980s, the Balinese economy was largely agriculture-based. Today, 80 per cent of the island's economic activity is generated by tourism. Despite this, agriculture, in particular the growing of rice, is still the island's biggest employer. Fruit, vegetables and coffee are also grown. Fishing is also an important economic activity.

Paddy rice

The term 'paddy rice' is the name given to rice grown in semi-aquatic environments such as the flooded paddy fields seen in Figure 5.37. Paddy fields dominate the landscape of rice-farming areas throughout East, South and South-East Asia. The paddies can be built on river flood plains or carved into steep hillsides as terraces.

5.37 Bali's terraced paddy fields—an example of a managed environment

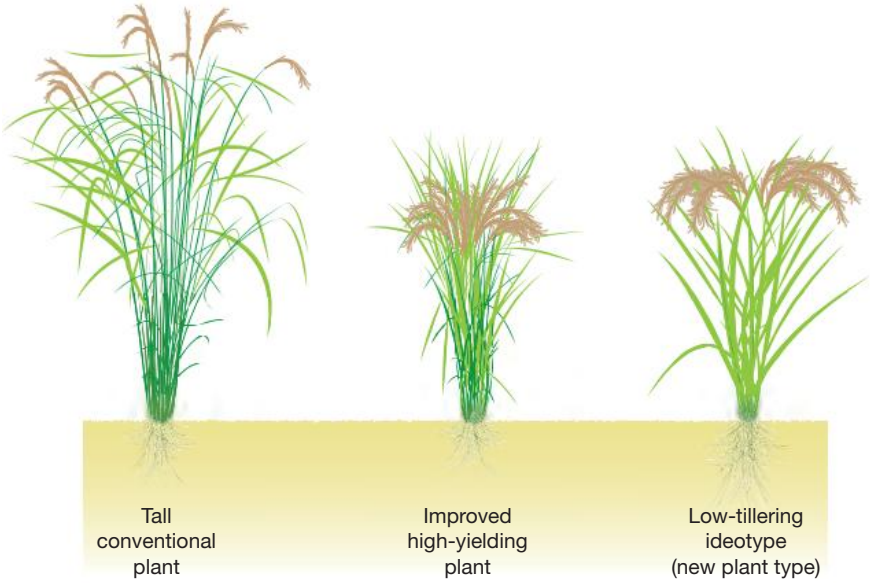
Their construction and maintenance requires a great deal of labour, and the crops need large quantities of water for irrigation. Getting the water to the paddy often involves complex water transfer systems, many of which have been in place for hundreds of years.

Flooded paddies provide an ideal environment for rice growing and prevent the growth of weeds that would compete with the rice plants for nutrients.

Rice varieties

Balinese rice farmers plant high-yielding varieties of rice that allow three growing seasons each year (see Figure 5.38). Because fertilisers and pesticides are expensive, farmers plant seeds in a small nursery plot before replanting the seedlings in accurately spaced rows in flooded paddy fields. This is a very labour-intensive process, but it increases the amount of rice grown.





5.38 New varieties of rice have relatively thick stems and are less likely to bend and fall over under the weight of the grain they carry.

Irrigated paddy rice in Bali

Rice is Bali's most important agricultural crop. Because of the island's mountains, the Balinese have terraced much of the land to create small plots of arable land. Many of these terraces are more than 2000 years old. Farmers, working with hand tools, carved the stepped terraces out of steep hillsides. Generation after generation of farmers have extended the terraces and kept them in order. They have done this out of necessity: rice is the islanders' main food.

The water needed to grow the rice comes from the rugged, mountainous interior of the island. To transport it to where it is needed involves a complex system of canals, tunnels, pipes, dams and dykes. The farmers use this system to flood or drain the rice fields at the right time.

The *subak*

Supplying these small terraced plots with water dominates communal life in Bali. Just as their ancestors were, today's rice farmers are members of a community cooperative called a *subak*.

The *subak* system involves much more than just managing water storage and supply, and draining rice terraces. It is a complex part of an artificial ecosystem developed over thousands of years. It is also part of Balinese culture. Every Balinese village has a *subak*, and all rice farmers must join and participate in its activities. This helps to ensure that the limited irrigation water is given out fairly and that a limited number of farmers tap into the flowing water at the same time. Importantly, it ensures that a farmer does not block the water from flowing downwards to rice terraces below. The *subak* is a major reason why a farmer is able to get up to three crops per year from the one paddy.

The *subak* also plays an important role in the spiritual life of rice-growing communities. Every month, the *subak* members will come together in the village temple to discuss matters concerning the *subak*: water supply, the harvest and the celebration of the anniversary day of the *subak* water temple. They worship Dewi Sri, the rice goddess.

ACTIVITIES

Knowledge and understanding

1. Describe the ways in which Bali is different from the rest of the Indonesian provinces.
2. Explain how Bali's farmers have adapted the rice-growing agricultural system to the province's topography.
3. Outline the role and responsibilities of the *subak*.

Applying and analysing

4. Create a PMI on the benefits of taking a collaborative approach to the management of water resources. Consider how the relationship between people's spiritual beliefs and the management of an environmental resource such as water can contribute to the long-term stability of a managed environment.

Investigating

5. Select one of the following rice-growing countries and investigate the way in which the irrigation and growing of rice is managed in that society. What are the similarities and differences between it and Bali?
   - Australia
   - India
   - Madagascar
   - Malaysia
   - Thailand
   - Vietnam

5.14 Case study: The Ganges

The Ganges River is very important to the livelihood and the spiritual wellbeing of the people of India and Bangladesh. In terms of spiritual and religious significance, it has no equal in the world. Hindus consider it a sacred river that will cleanse them of their sins, yet the Ganges is one of the most polluted rivers in the world.

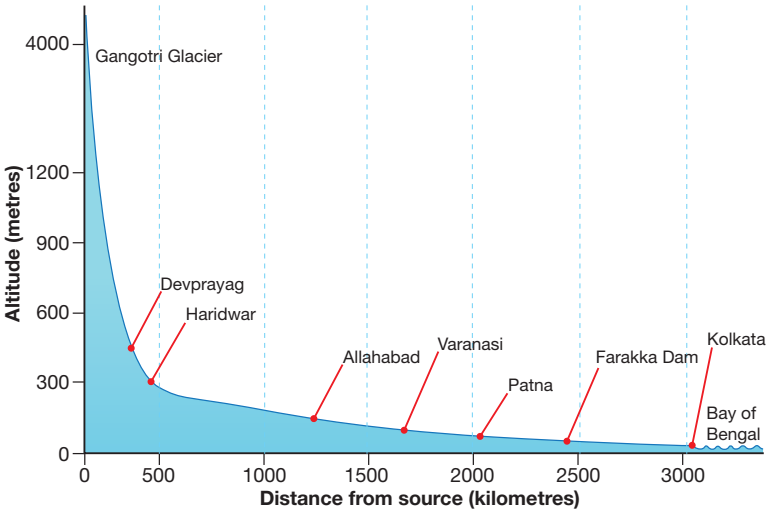
The Ganges catchment

The Ganges River starts in the meltwater (water from melting snow and ice) of the Gangotri Glacier. The river then plunges nearly 3800 metres until it empties onto the plains of northern India at Hardwar, as shown in Figure 5.39. From here, the Ganges River flows eastwards and descends to sea level at a slower pace. It winds across a huge flood plain that is over 300 kilometres wide, and then flows into Bangladesh, joining the Brahmaputra and Meghna rivers. Together, they drain into the Bay of Bengal through a maze of channels to form the largest delta in the world.

The Ganges catchment covers an area of 1 million square kilometres, an area larger than New South Wales (see Figure 5.40). The river is fed by the melting snow and glacial ice of the Himalayas. Adding to this flow are the heavy monsoon rains that arrive in June each year and sweep across India (see Figure 5.41).



5.40 The location of the Ganges catchment



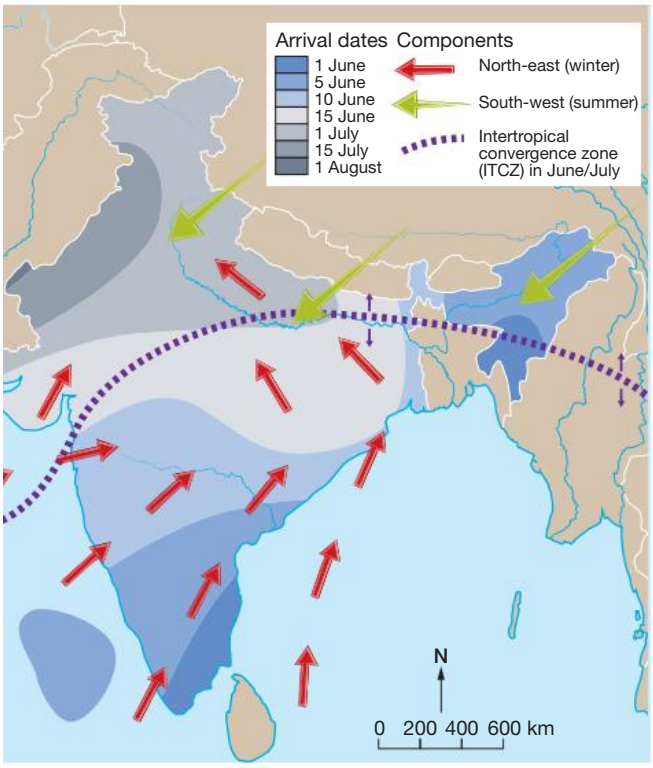
5.39 Cross-section along the length of the Ganges

A productive catchment

The flood plain of the Ganges supports one of the highest population densities in the world. One-third of India's 1.2 billion people live near the river, and many of them depend on its water for washing, drinking and cooking. The fertile soils and the use of irrigation produce two or three crops a year in both India and Bangladesh. The main crops cultivated are rice, sugar cane, lentils, oilseeds and potatoes.

Dams and canals have been built to store and carry the water to where it is needed. While irrigation has increased the production of crops, it has robbed the river of much of its water, especially in the upper Ganges.

Deforestation in the highlands has exposed the soil to erosion. This erosion then causes the river to fill with silt. Two hundred years ago, large paddle steamers operated between Kolkata and Allahabad, but now the river is too shallow for ships.



5.41 The onset of the Indian monsoon

The river flows through twenty-nine cities with a population of over 100 000 and twenty-three cities with a population between 50 000 and 100 000. With rapid economic growth, people are moving into these urban areas.

A sacred river

The spiritual role that the Ganges plays is more important than its economic role. To India's 830 million Hindus, the Ganges is a sacred river that they must bathe in at least once in their lifetime. They believe its holy waters have the power to purify and wash away the sins of a lifetime.

From all over India, people make the journey to the Ganges. At the river they go into the water and collect some water to take home (see Figure 5.42). In the holy cities of Varanasi and Allahabad, temples line the riverbank and stairways (called ghats) lead down to the water. Every day, more than 60 000 people come to bathe and pray in the river. Some come in the hope that the waters will cure their illnesses. Hindus also believe that if a person's ashes are placed in the Ganges after cremation, they will go to Heaven.

5.42 The Ganges River is of great spiritual significance to Hindus.



A polluted river

While the Ganges is holy, it suffers with the load of human and chemical waste, ashes and bloated bodies once it reaches urban areas. Many devout Hindus drink the water of the river. Communities along the Ganges suffer from waterborne illnesses such as dysentery, typhoid and cholera.

Sewage

The volume of waste is overwhelming the river. An estimated 1 billion litres of raw sewage flow into it each day. With the rapid growth of cities, toilets and sewage treatment systems have become inadequate.

Less than a third of municipal sewage in India undergoes treatment, and municipal sewage is now responsible for over 80 per cent of the Ganges's pollution. The World Health Organization's standard for drinking water requires human waste levels to be below 10 per 100 millilitres of water. Tests conducted at Varanasi show levels as high as 100 000 per 100 millilitres.

Industrial wastes

With rapid economic growth in India, industry has boomed along the Ganges. Many factories are environmentally unsound, and wastewater containing chemicals has been discharged into the river as shown in Figure 5.43. Environmental laws that exist to regulate such pollution are often ignored and rarely enforced. Petrochemical and fertiliser plants, textile mills, sari-dying and brass-making factories, tanneries and distilleries are among the worst offenders.

5.43 To improve the health of the Ganges River, the water entering the river through drainpipes such as this one needs to be treated.

A major polluting industry is tanning and leather-making near Kanpur, where chromium and other chemicals leak into the river (see Figure 5.44). Industrial wastes only make up about 12 per cent of the total volume of pollutants reaching the Ganges, but they are of major concern because they are so toxic.

Human remains

Along the banks of the Ganges, the bodies of the dead are cremated on wooden pyres. At Varanasi, more than 42 000 corpses are cremated each year, with the ashes, charcoal and any unburned remains cast into the river. Poor families who cannot afford cremation often place bodies directly in the river.

Cleaning up the Ganges

In 1985, the Indian government set up the Ganga Action Plan (GAP). This aimed to clean up the river by building a number of waste treatment facilities, but testing shows no significant improvement in water quality. Unpaid electricity bills meant that sewage treatment plants lay idle, and many pumps broke down after being choked with plastic bags.

SPOTLIGHT

Special qualities of Ganges water

People have used the water of the Ganges for thousands of years without seriously affecting its quality. This is partly due to the river's ability to purify itself. The water has a unique and extraordinary capacity to retain oxygen and it is thought to contain high levels of radioactive radon, an element that kills disease-causing bacteria. This explains why its water remains fresh over long periods of storage.





5.44 Factories such as this tannery discharge pollutants directly into the Ganges.

In 2010, the Indian government began a new $4 billion campaign to treat the heavily polluted water of the Ganges. This new project replaced the GAP and it has received $1.5 billion in funding from the World Bank. The 2020 goal of this project is to stop the discharge of untreated wastewater into the river by building more treatment plants. Many argue that more focus should be placed on funding the infrastructure needed to connect urban areas to a sewer. This would ensure that the waste actually gets to a water treatment plant.

An uncertain future

As both population numbers and economic activity continue to surge along the Ganges, the river will become increasingly polluted. There is also the added concern that global warming may reduce the river's flow. Climate change is expected to cause glaciers around the world to decrease in size. This means there will be less meltwater entering rivers around the world, including the Ganges.

ACTIVITIES

5.6

Knowledge and understanding

1 Describe how people use the Ganges catchment.
2 Explain why India's Hindus consider the Ganges to be sacred.

Applying and analysing

3 Outline the sources of pollution that affect water quality in the Ganges catchment.
4 Assess the strategies that have been used to clean up the Ganges.
5 Discuss the impact that global warming will have on the Ganges and the people who rely on the river.

CHAPTER

6

WATER RESOURCE MANAGEMENT



Rapid world population growth, unsustainable use of water and changes to patterns of precipitation resulting from climate change are placing increasing demands on water resources all over the world. In many parts of the world, ecosystems are under stress as the water on which they rely is being used for agriculture and other purposes. Such concerns highlight how important it is to manage the world's water resources wisely.

In this chapter we focus on water resource management. In particular, we look at water resources and water management in Africa. We also focus on strategies to increase the supply of water and conserve existing sources. Case studies are used to highlight key issues in the management of our water resources.

KEY IDEAS

- To appreciate that water is a shared resource that is difficult to manage
- To know the various ways in which the supply of water can be increased and existing resources conserved
- To know how water resources are managed in Africa
- To develop skills in communicating geographical information and thinking critically

GLOSSARY

aqueduct	an artificial channel built to transport water
brine	a very salty solution
dam	a structure built across a river to control the river's flow and create a reservoir
deep aquifer	a deep underground layer of water stored in rock; this water is difficult to access except with expensive drilling
desalination	the removal of salts from seawater or other saline (salty) solutions
desertification	the expansion of deserts due to overgrazing, soil erosion, climate change or prolonged drought
green energy	energy (electricity) produced using renewable resources, such as wind or sunlight, and without creating greenhouse gases
groundwater	water beneath the earth's surface that fills pores or tiny spaces in materials such as sand, soil or gravel
hydro-electricity	electricity generated by using the energy of falling water
malnutrition	poor nutrition from a lack of food
Millennium Development Goals	ten goals of the United Nations General Assembly; the goals include eradicating extreme poverty and hunger, improving maternal health and ensuring environmental sustainability
reservoir	a large natural or artificial lake used as a source of water supply
reverse osmosis	a process used to remove contaminants and salts from salty water
subsistence agriculture	a system in which farmers only grow enough crops or raise enough animals to feed themselves and their family
water scarcity	a situation in which the demand for water is greater than the amount available
water stress	the negative effect that water scarcity can have on people and environments

6.0 The California Aqueduct, United States of America

6.1 Water scarcity

Water scarcity occurs when the demand for water exceeds the amount available. Water scarcity can lead to water stress, which affects people and environments. Many of the world's water-stressed countries are in Africa.

Types of scarcity

Water scarcity can be either physical or economic. Physical scarcity occurs when where there is not enough water to meet all demands, including those of ecosystems. Economic scarcity occurs when there has not been enough investment in the infrastructure needed to store and transport water to where it is needed.

Water stress

Water stress is the negative effect on people and environments that can result from water scarcity. Africa has the largest number of water-stressed countries. Most of these are found in North Africa.

Reasons for scarcity

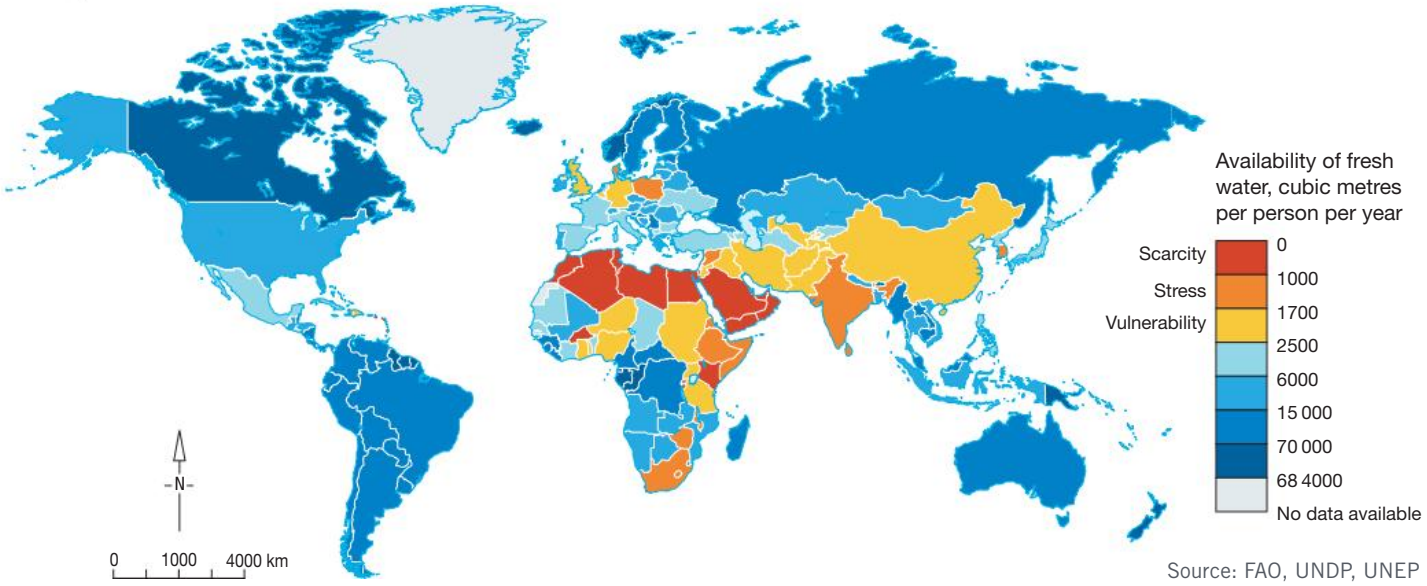
Water scarcity can occur in areas where there is plenty of rainfall. The quality of the water available determines whether there is enough to meet the needs of households, farmers, industry and the environment.

Figure 6.1 shows water availability in the world. Approximately 1.2 billion people, or almost one-fifth of the world's population, live in parts of the world where water scarcity is already a problem, and 500 million people are approaching that situation. Another 1.6 billion people face water shortages due to a lack of infrastructure to extract water from rivers and aquifers. Rapid population growth, urbanisation and increases in water use by households and industry are making the situation worse. The total amount of available fresh water is changing due to climate change, which is causing glaciers to recede, river flows to reduce and lakes to shrink. Many aquifers have been over-pumped and are not refilling quickly.

Effects on water quality

Water scarcity results in people having to rely on unsafe sources of drinking water. Maintaining personal hygiene is difficult. There is often not enough water to bathe or clean clothes properly. Much of the world's fresh water has become too polluted or salty for use in households, industry and agriculture.

6.1 World water availability



Source: FAO, UNDP, UNEP

Contaminated water also increases the risk of infection from waterborne diseases such as cholera, typhoid and dysentery. Water scarcity can lead to diseases such as trachoma (which can lead to blindness), plague and typhus. Contaminated, stagnant water provides a breeding ground for mosquitoes, which are carriers of diseases such as dengue fever and malaria.

The use of wastewater in agriculture is growing and puts people at risk from crop contamination. More than 10 per cent of the world's people consume food grown using wastewater that contains various chemicals or disease-causing organisms.

Solutions

To avoid a global water crisis, industries and cities will need to find ways to use water more efficiently. Farmers will have to increase productivity to meet growing demands for food without greatly increasing their water usage. People need to take personal responsibility and learn how to conserve and protect water resources.

Target 10 of the United Nations **Millennium Development Goals** is to halve the proportion of people without access to safe drinking water and basic sanitation by 2015. Water is an essential resource to sustain life.

SPOTLIGHT

Water scarcity in Africa

Fourteen countries in Africa already experience water stress. Another eleven countries are expected to join them by 2025. By this time, an additional 50 per cent of the continent's estimated population of 1.45 billion people will experience either water stress or water scarcity. In sub-Saharan countries, nearly 51 per cent of the population (300 million people) lack access to a supply of safe water, and 41 per cent lack adequate sanitation.



6.2 Searching for water in a dry riverbed in northern Kenya

ACTIVITIES

6.1

Knowledge and understanding

1. Explain the difference between *physical* and *economic* water scarcity.
2. Describe the nature and extent of water scarcity in Africa.
3. List the percentage of the world's population that is affected by water scarcity.
4. List the types of water issues that affect people around the world.

Applying and analysing

5. Can places with high rainfall experience water scarcity? Explain.
6. Study Figure 6.1.
   - **a** List the continents experiencing water scarcity, water stress or water vulnerability.
   - **b** List the continents not experiencing water scarcity, water stress or water vulnerability.
   - **c** List reasons for the different answers to parts **a** and **b**.

6.2 Case study: Drought in the Horn of Africa

By late 2011, 13 million people in the Horn of Africa needed urgent assistance due to severe drought and increasing food prices. Unreliable rainfall, lack of water storage infrastructure and reliance on subsistence agriculture mean that water scarcity can quickly turn into a disaster.

The drought of 2011–12

The severe drought affecting the Horn of Africa began after low rainfall levels in 2011 across Kenya and Ethiopia. In Somalia, low rainfall levels were recorded in 2009, 2010 and 2011. In many parts of the Horn of Africa, rainfall was less than 30 per cent of the long-term average. The low rainfall led to crop failures and the death of livestock. As a result, food prices increased sharply and people had to rely on food handouts to survive (see Figure 6.3). The crisis was made worse by violent rebel activity in southern Somalia.

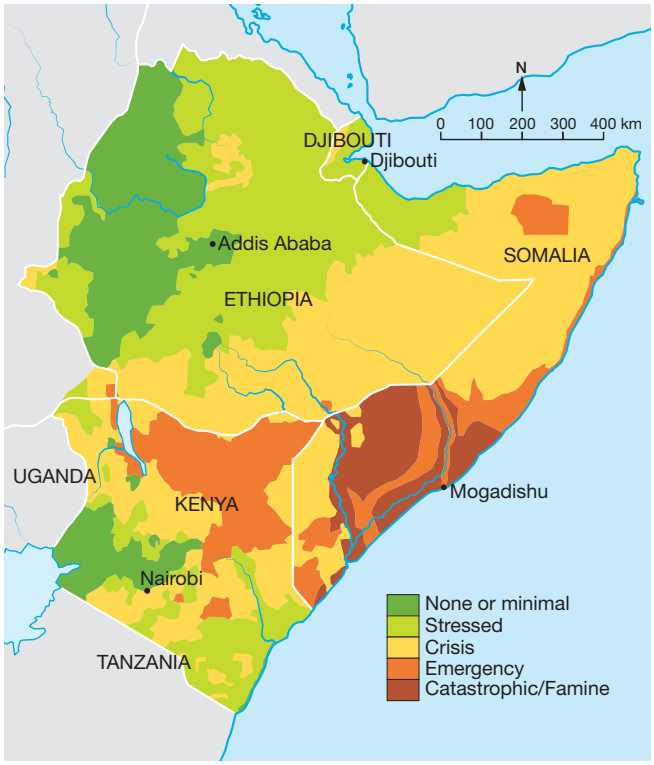
Families who were strong enough to flee drought-affected regions often travelled on foot for hundreds of kilometres, hoping to make it to a refugee camp. At the drought's peak, overcrowded camps in Kenya and Ethiopia were receiving some 3000 new refugees every day, seeking food and shelter. In total, nearly a million Somali refugees have fled to nearby countries. The extent of the food shortage can be seen in Figure 6.4.

As illustrated in Figure 6.5, rainfall totals for the Horn of Africa, even in the best of years, are well below what is necessary to support agricultural production. The unreliability of the region's rainfall makes the situation worse. Heavy rainfall in early 2012 did not bring an end of the suffering. In fact, it made outbreaks of disease in parts of East Africa more likely. This has worsened the situation for millions struggling to survive the severe drought and rapidly rising food prices.

6.3 Children queuing for food in the Somali capital, Mogadishu

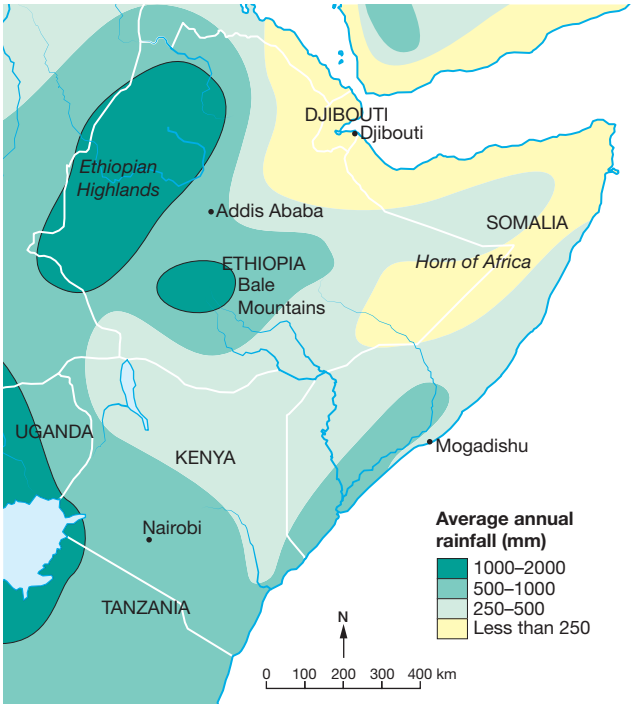


6.4 Food shortage crisis in the Horn of Africa, October 2011



Source: FAO, OCHA

6.5 Rainfall in East Africa

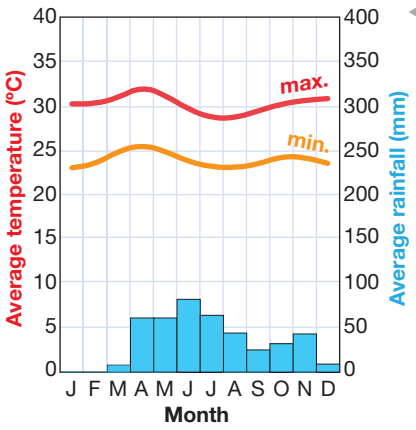


Source: *Heinemann Atlas* Fifth Edition

Rainfall in the Horn of Africa

The climate of East Africa reflects the region's high altitude and the rain-shadow effect caused by the Bale Mountains and Ethiopian Highlands. The mountains block the eastward movement of the monsoon. As a result, the lowlands of northern Kenya and Somalia are extremely dry. Mogadishu, for example, receives about 400 millimetres of rainfall a year (see Figure 6.6).

The climate in the Bale Mountains and the Ethiopian Highlands is tropical. There is rain during most of the year. The Highlands have a single wet season, from June to September.



6.6 Climate graph for Mogadishu

International response

Although violence disrupted aid delivery in some areas, international relief operations were ready by mid-2011. By November, the efforts of the international aid agencies had significantly reduced **malnutrition**. Aid agencies then turned their attention to recovery strategies, including the construction of irrigation canals and the distribution of seed. The United Nations requested US$2.5 billion to fund its relief program. Australia contributed $80 million, and non-government organisations appealed to the public for donations.

Long-term strategies to minimise the impact of future droughts include:

- building water-storage infrastructure such as **dams**
- improving transport infrastructure to move food from areas of surplus to areas of need
- implementing more sustainable and water-efficient forms of agriculture.

ACTIVITIES

Knowledge and understanding

1 Discuss the nature and scale of the suffering experienced in the Horn of Africa during the famine of 2011–12.
2 To what extent was the crisis linked to water scarcity in the Horn of Africa?
3 Outline the international response to the crisis. What do you think can be done to minimise the impact of future droughts?

Geographical skills

4 Study Figure 6.4. Describe the areas of the Horn of Africa that experienced *emergency* and *catastrophic/famine* status in October 2011. Is there a link between these areas and the location of rainfall? Explain.
5 Study Figure 6.5. Describe the distribution of rainfall in the Horn of Africa.
6 Study Figure 6.6. Using data from the climate graph, describe the climate of Mogadishu.

6.3 Managing water resources

The distribution of fresh water resources in Africa is uneven and unreliable. Areas such as the Sahara and the Sahel in the north, and the Kalahari in the south, suffer from long periods of drought, while the tropical belt of mid-Africa has plenty of water.

The problem

Water scarcity has always been a problem in Africa. Africa's share of the world's population is 14 per cent, yet its share of global fresh water is about 10 per cent. With its population projected to double from just over 1 billion in 2012 to 2 billion in 2050, the situation can only get worse.

- Most Africans living in rural areas do not have safe and reliable access to water. On average, Africans use only 30 to 40 litres of water per day for domestic consumption.
- More than 300 million people in Africa still lack access to safe water and adequate sanitation. In sub-Saharan Africa, just 51 per cent of the population have access to safe water and 45 per cent to sanitation.
- Africa is a dry continent. More than 40 per cent of Africa receives less than 200 millimetres of rainfall a year. Drylands and deserts together cover 60 per cent of the entire land surface.

The challenges

The water-related challenges facing Africa are enormous.

- To meet its 2015 Millennium Development Goals, Africa needs to reduce the proportion of people without access to safe water by 50 per cent.
- Africa needs to increase the area of irrigated land by 50 per cent if it is to meet its 2015 African Water Vision target.
- To meet the increased demands of agriculture, hydro-electric power, industry, tourism and transportation, Africa has to increase the development of its water resources by 25 per cent by 2025.
- Africa has to manage droughts, floods and **desertification** more effectively.
- It is a priority is to restore the environment through the supply of sufficient water for environmental sustainability and the conservation of watershed ecosystems.

A contemporary response

There are three broad approaches to water management. The first approach involves capturing and storing more water. This is the main approach taken by most African governments. The second involves realising that people need to conserve water in order to get more use out of every drop; for example, through efficient irrigation techniques. Thirdly, people need to do things differently with the water available; for example, include building reclamation or recycling plants such as the one in Namibia shown in Figure 6.7. Africa's **groundwater** stocks are enormous, but they could be depleted if they are used faster than they can be replenished. Sustainable approaches to water management will be essential.

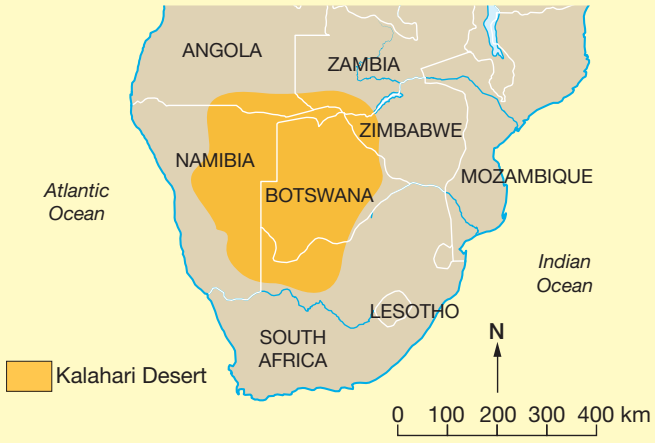
6.7 Water reclamation in Namibia. Water is re-used for irrigation and domestic consumption.



SPOTLIGHT

The San people of the Kalahari

The San people (sometimes referred to as the Bushmen of the Kalahari; see Figure 6.8) are the indigenous people of southern Africa. Traditionally, they have lived as hunter-gatherers, hunting game with poisoned arrows. In their dry environment the San get their water from baobab trees, plant roots (as shown in Figure 6.9) and desert melons. They often store water in springbok bladders and the blown-out shells of ostrich eggs. They also dig sip wells—holes that they dig in the earth and fill with soft grass. A reed is used to suck water from the hole, and send it bubbling up the reed to fill an ostrich egg.



6.8 For more than 20 000 years, the San have occupied a vast territory spanning parts of modern-day South Africa, Zimbabwe, Zambia, Botswana, Namibia and Angola.



6.9 San Bushman drinking sap squeezed from a tuber

ACTIVITIES

6.2

Knowledge and understanding

1 List the water-related challenges facing Africa.

2 Explain how the San people of the Kalahari learnt to live with water scarcity; that is, with having only a small amount of water.

Applying and analysing

3 Explain how the three broad approaches to water management will help ease Africa's water problems.

Geographical skills

4 Study Figure 6.8. Name the countries in which the Kalahari Desert is located.

5 Study Figure 6.9. Describe the living conditions of the San people with the help of Figure 6.9 and the information in this unit.

6.4 Increasing water supply

The global demand for water will continue to increase as the world's population heads towards 7.9 billion in 2025. Not only will we need to increase the amount of fresh water available, we will also need to use existing supplies more carefully.

Solutions

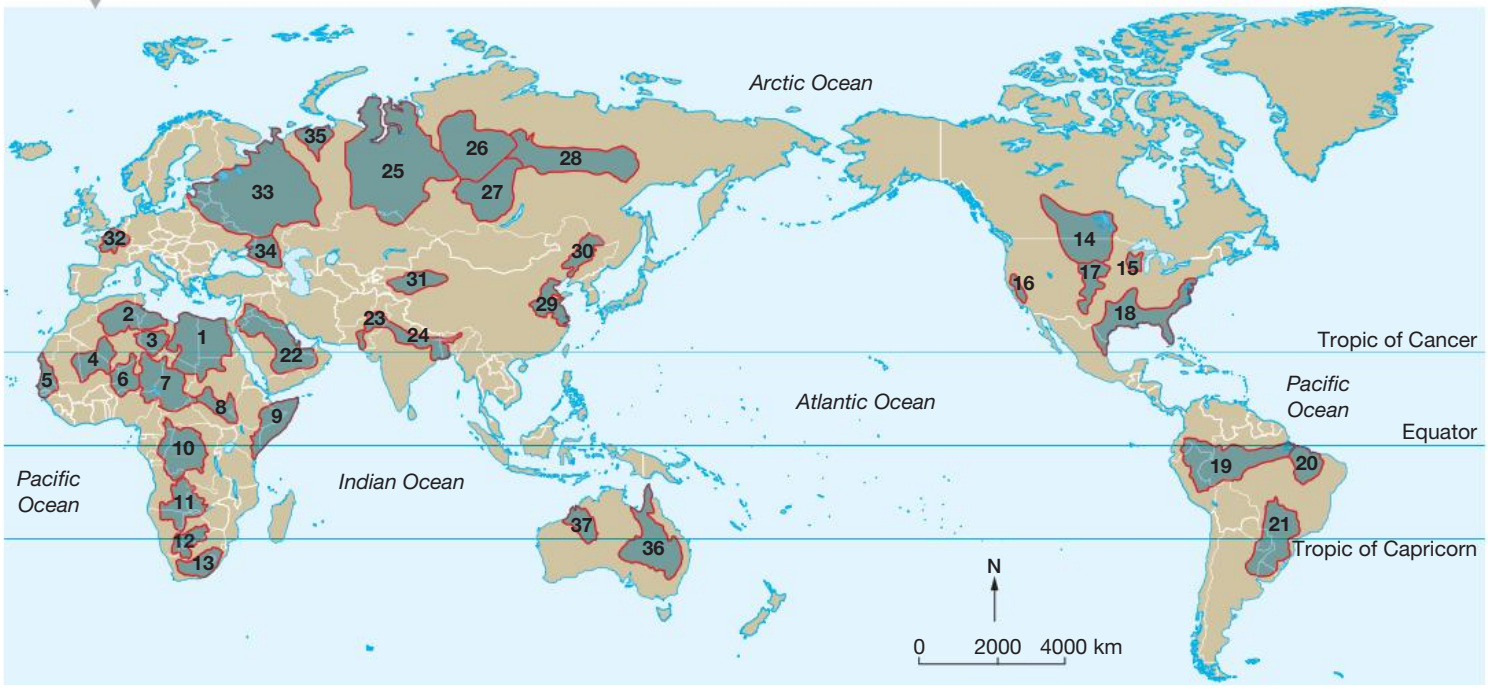
Different ways of increasing the water supply are:

- extracting more groundwater
- building dams and reservoirs
- transporting water
- desalination.

Extracting groundwater

Most aquifers are a renewable resource unless the groundwater they contain either becomes contaminated or is removed faster than it can be refilled by rainfall. At present, water tables in many places are falling because water is being withdrawn faster than the rate of natural recharge.

6.10 The world's large aquifer systems



Source: WHYMAP

Large aquifer systems

1 Nubian Aquifer System
2 North-west Sahara Aquifer System
3 Murzuk–Djado Basin
4 Taoudeni–Tanezrouft Basin
5 Senegalo-Mauritanian Basin
6 Iullemeden–Irhazer Aquifer System
7 Chad Basin
8 Sudd Basin
9 Ogaden–Juba Basin
10 Congo Intracratonic Basin
11 Northern Kalahari Basin
12 South-east Kalahari Basin
13 Karoo Basin
14 Northern Great Plains Aquifer
15 Cambro-Ordovician Aquifer System
16 California Central Valley Aquifer System
17 High Plains–Ogallala Aquifer
18 Gulf Coastal Plains Aquifer System
19 Amazonas Basin
20 Maranhao Basin
21 Guarani Aquifer System
22 Arabian Aquifer System
23 Indus Basin
24 Ganges–Brahmaputra Basin
25 West Siberian Artesian Basin
26 Tunguss Basin
27 Angara–Lena Artesian Basin
28 Yakut Basin
29 North China Plain Aquifer System
30 Songliao Basin
31 Tarim Basin
32 Parisian Basin
33 East European Aquifer System
34 North Caucasus Basin
35 Pechora Basin
36 Great Artesian Basin
37 Canning Basin

The world's **deep aquifers** are a largely untapped potential source of additional groundwater (see Figure 6.10). Tests indicate that some of these aquifers hold enough water to support billions of people for centuries. Unfortunately, deep aquifers are not considered a renewable resource because they have taken millions of years to reach their current state and cannot be replenished on a human timescale. In addition:

- little is known about the impact that withdrawing this water would have on the geology of the area
- some deep aquifers underlie more than one country, which makes them a potential source of conflict
- the cost of tapping this resource would be very high.

Dams and reservoirs

A dam is a structure built across a river to control the river's flow. The dammed water creates a **reservoir**, or lake, behind the dam. The main purpose of a dam is to capture and store water run-off. The water is then released when needed to control floods, generate electricity (**hydro-electricity**) or supply water for irrigation and for towns and cities. Reservoirs also provide opportunities for recreational activities such as swimming, fishing and boating.

There are now more than 45 000 large dams worldwide (22 000 of these are in China). Together, they capture and store about 14 per cent of the world's surface water run-off, provide water for almost half of all irrigated crop land, and supply more than half of the electricity used in 65 countries. These dams have increased the reliable availability of water for human use by nearly one-third.

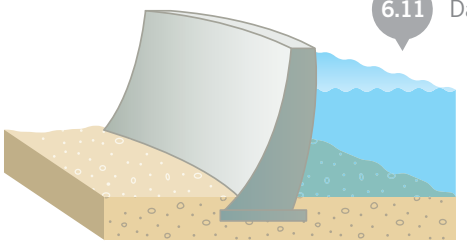
Large dams have both benefits and drawbacks. While they greatly increase water supplies in some areas, they also disrupt ecosystems and displace people.

Dams can be classified into different types according to their structure (see Figure 6.11).

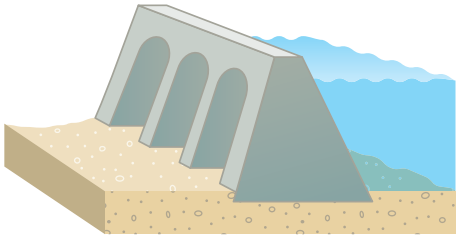
Transporting water

Water can be transported over long distances using dams, pumps, tunnels, pipelines and lined canals, or **aqueducts**. The California Water Project in California, USA, is one of the world's largest water transfer projects. It moves water from water-rich northern California to water-poor southern California, where it is mainly used in agriculture. In Australia, the Snowy Mountains Scheme takes water from the Snowy River, on the eastern side of the Great Dividing Range, and diverts it westwards into the Murray and Murrumbidgee river systems, where it is used for irrigation. There are some people in Australia who argue in favour of building large dams in northern Australia and piping the water south into the Murray–Darling river system.

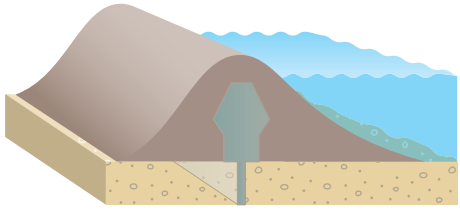
6.11 Dam types



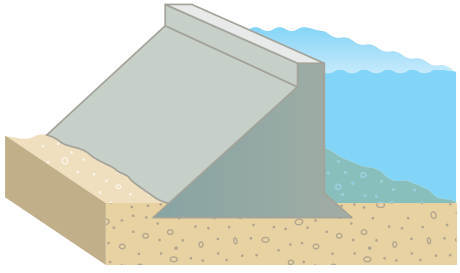
Arch dam
This has a curved shape. The inside of the curve faces downstream.



Buttress dam
This has a series of buttresses located on the side of the dam facing downstream.



Embankment dam
This is made of a huge pile of rocks and earth. The dam relies on its sheer bulk to hold back the water.



Massive dam
This is built of concrete and relies on its size and weight to withstand the pressure of the stored water.

DID YOU KNOW?

- Worldwide, big dam construction has displaced up to 80 million people from their homes and flooded an area of productive land equivalent to twice the size of Victoria.
- Only 21 of the earth's 177 longest rivers run freely from their source to the sea.

SPOTLIGHT

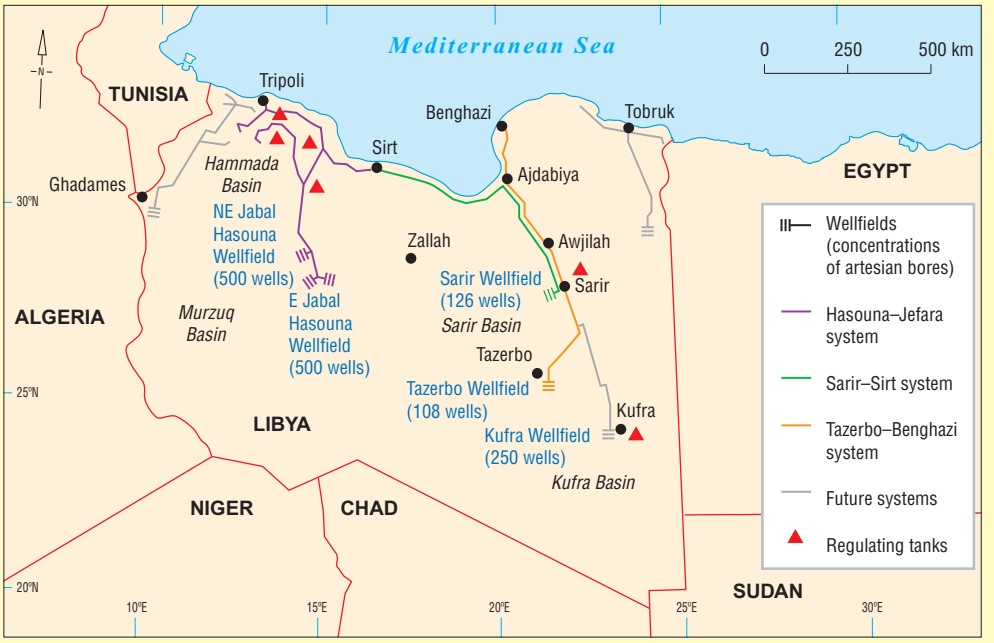
Securing Libya's water supply

While drilling for oil in Libya in the 1960s, engineers discovered huge reserves of water in aquifers beneath the Sahara Desert. This vast store of water had accumulated over some 70 000 years, much of it at a time when rainfall in northern Africa was much higher than it is now (see Figure 6.13).

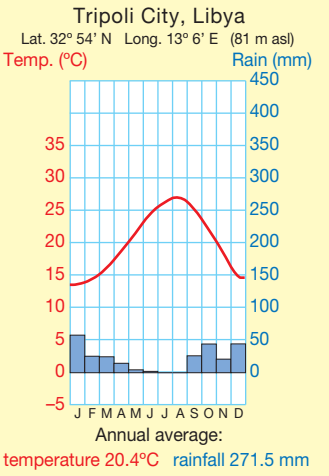
To develop its economy, Libya needed to use this water. In the 1970s, the country made huge profits by exporting oil to the countries of the developed world. Much of this money was invested in the Great Man-Made River Project. Construction started in 1983 and is still in progress. When completed, the project will improve access to water for over five million people and will irrigate dry areas so that the country can become self-sufficient in food production. The project will also generate electricity, which will help to promote industrial development.

To extract the water, more than 1300 wells, most over 500 metres deep, have been dug, and a network, some 3500 kilometres long, of pipelines 4 metres in diameter has been partially built and is still under construction. Three major reservoirs (at Ajdabiya, Sirt and Benghazi) store 35 gigalitres of water. The project has made 135 000 hectares of land available for production. Large quantities of fruit and vegetables, as well as 270 000 tonnes of crops and 760 000 tonnes of fodder, are now grown on irrigated land.

6.12 Libya's Great Man-Made River Project. Libya is a hot, dry country. The rainfall that does fall is limited to a narrow coastal zone. Seventy per cent of Libya's five million people live in the coastal cities of Tripoli and Benghazi.



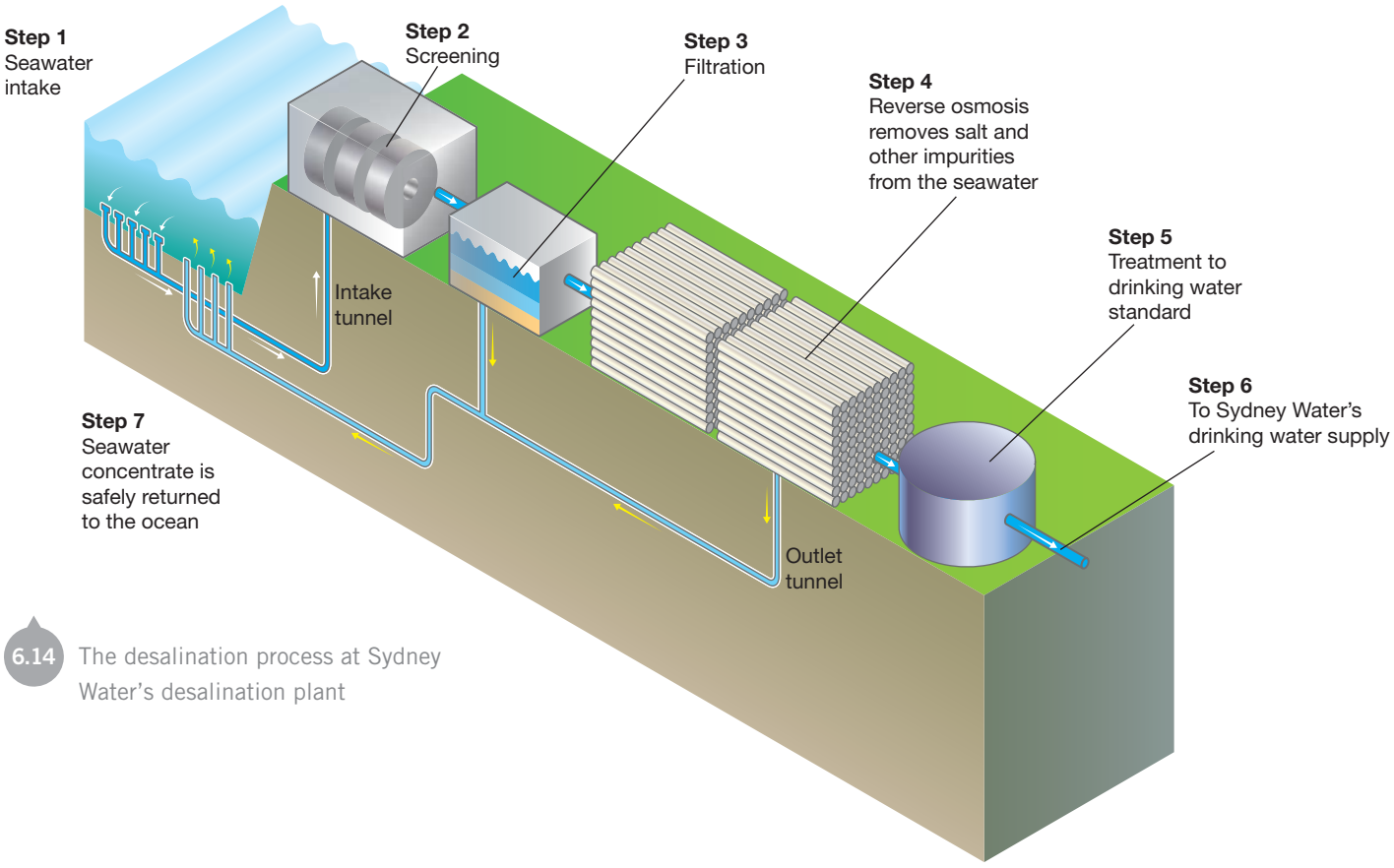
6.13 Climate graph for Tripoli



Desalination

Desalination is a process that involves removing the dissolved salt from ocean water. The process most commonly used is called **reverse osmosis**. This involves forcing water, under high pressure, through a filter that is fine enough to remove the salt. Today, there are more than 14 500 desalination plants operating in more than 125 countries. Australia has six desalination plants either operating or under construction. Desalination is an energy-intensive process that is very expensive.

Desalination plants are very expensive to build and operate, and they use enormous amounts of electricity. They can have a serious impact on nearby marine ecosystems from either the toxic chemicals used to kill algae or the **brine**, or concentrated seawater by-product, that has to be dumped back into the sea. When operated at capacity, Sydney's desalination plant (see Figure 6.14) supplies 15 per cent of Sydney's water needs. A large wind farm has been built to provide **green energy** for the plant.



6.14 The desalination process at Sydney Water's desalination plant

ACTIVITIES

6.3 6.4

Knowledge and understanding

1 List the ways in which the supply of water in an area can be increased.
2 State the condition under which groundwater can be considered a renewable resource.
3 Outline the potential benefits and dangers associated with extracting water from the world's deep aquifers.
4 State the role played by dams.
5 Identify the infrastructure needed to transport water.
6 Study Figure 6.14. Explain the process of desalination.

Applying and analysing

7 Discuss, as a class, the various options outlined in this unit for increasing water supplies. List the benefits and costs of each approach. Decide which is the most beneficial in terms of:
   a the economic benefits
   b minimising the environmental impact.
8 Study Figure 6.11. Identify the type of dam pictured in Figure 6.16 (Unit 6.5).
9 Study Figure 6.13. Describe the climate of Tripoli. Explain why water extraction, storage and transport are essential in Libya.

Investigating

10 Investigate the California Water Project. What has been the environmental cost of the undertaking?
11 Study the Spotlight box 'Securing Libya's water supply'. Using the internet, find another example of a large-scale water transfer project. Present your findings as an oral report supported by a multimedia presentation.
12 Investigate one of Australia's desalination plants. Why was it built? Is it necessary? What are the environmental impacts of the plant?

6.5 Big dam projects

Water shortages have increased the pressure on governments to fund engineering solutions. The infrastructure needed to store and transport water is very expensive and its construction often has significant social and environmental costs. The construction of dams can also contribute to international tensions when a river system flows through more than one country.

Arguments for big dams

- Stored water meets the needs of people and promotes economic growth.
- Dams supply secure and reliable water for irrigation, both upstream and downstream.
- Dams provide protection against drought.
- Destruction caused by flooding to downstream settlements and farms is reduced.
- Food production and industrial output increase.
- Reservoirs can be used to promote aquaculture.
- Hydro-electric power stations generate renewable electricity without producing greenhouse gases.
- Reservoirs can be used for recreational activities such as boating and fishing.

Arguments against big dams

- The seasonal pattern and volume of river flow is changed.
- The release of very cold water from deep in the dam disrupts the ecology of the river.
- Reservoirs flood large areas of fertile agricultural land and wildlife habitat.
- People's livelihoods are disrupted and communities are destroyed.
- Fish are prevented from swimming upstream or downstream.
- Water is lost through evaporation, especially in large, shallow dams.
- Less water is available for downstream users.
- The pressure created by the weight of the dam wall and body of water can cause earthquakes.
- Historic and culturally significant sites can be flooded.
- Damming rivers cuts off the supply of fertile sediments to the flood plain, resulting in reduced fertility and soil depth.
- Reduced sediment flows can increase coastal erosion.
- Sediment or soil is trapped behind the dam. The amount of sediment increases and reduces the amount of water the dam can store.
- The reduction in the volume of fresh water reaching river estuaries degrades the habitat where 80 per cent of the world's fish breed.



6.15 Location of the Three Gorges Dam, China



6.16 China's massive Three Gorges Dam

Three Gorges Dam

China's massive Three Gorges Dam project, shown in Figure 6.16, was built to provide hydro-electricity, stop seasonal flooding and ensure a reliable water supply for surrounding regions. However, the project cost just under $US39 billion (way over budget), and 1.24 million residents and 13 000 farmers were forced to move. The 600-kilometre-long reservoir formed behind the dam flooded an area of 632 square kilometres containing more than 1300 important archaeological sites and some of China's most spectacular landscapes.

DID YOU KNOW?

Scientists have suggested that dams have increased the time taken by the earth's rotation by eight millionths of a second since the 1950s. This is because of the shift of water from oceans to reservoirs.

ACTIVITIES

Knowledge and understanding

1 Explain why the construction of large dams can be controversial.

Applying and analysing

2 Construct and annotate a sketch of a dam. Note the arguments for and against big dams: the upstream, downstream and wider effects.

3 Write a short report about the following statement: 'The advantages of large dams outweigh any disadvantages.' Include in your response examples from dams you have studied.

Investigating

4 Undertake internet research to locate an example of a big dam project. Write a report outlining the proposed benefits of the project and note the concerns of any groups opposed to the undertaking.

6.6 Case study: Africa's big dam projects

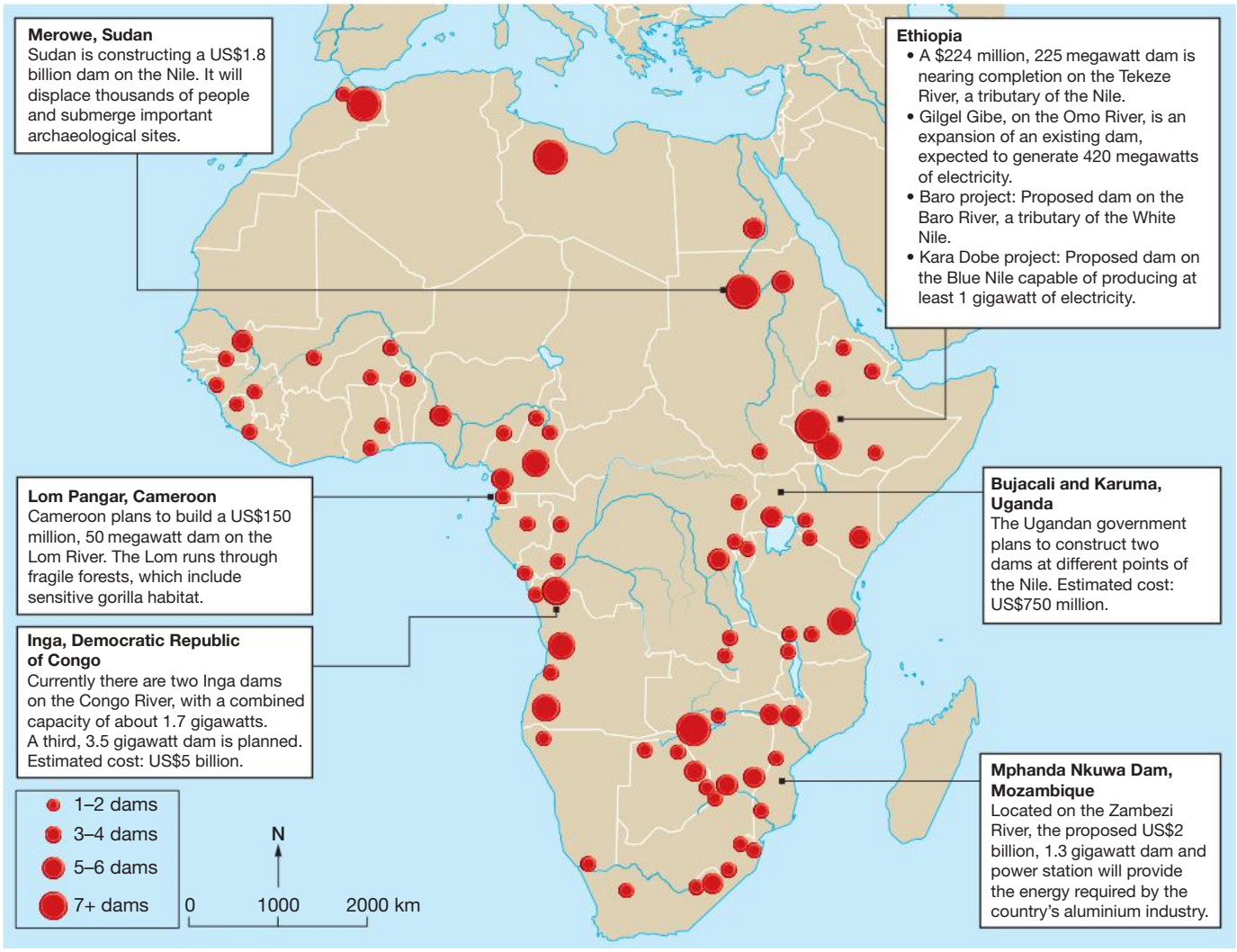
Big dam projects help to promote economic development, but they are often criticised because of their social and environmental impacts. By international standards, there are not many dams on Africa's great rivers, but this is about to change.

Big dam boom

A number of dam projects are planned or under construction in Africa. Many of these dams will be used to generate hydro-electricity. It is hoped that the power generated will help to promote economic development in Africa. Rivers affected by large dam projects currently planned for the African continent are shown in Figure 6.17.

In total, 1270 African dam proposals are under consideration. Many of them are to be built with Chinese expertise. It is estimated that US$750 billion could be invested in Africa during the next 25 years for hydro-electricity projects.

6.17 Africa's big dam projects



The Grand Inga project

The Grand Inga project, when constructed, will be the world's largest hydro-electricity power scheme. It will use 52 turbines to generate 39 000 megawatts of power. The proposed dam is the fourth of a series of dams that have been built or planned for the lower end of the Congo River in the Democratic Republic of the Congo. The dam site is 50 kilometres upstream from the mouth of the Congo River, on the Inga Falls—the largest waterfall in the world by volume. The Inga Falls are a series of rapids that extend over 14.5 kilometres and drop 96 metres in elevation.

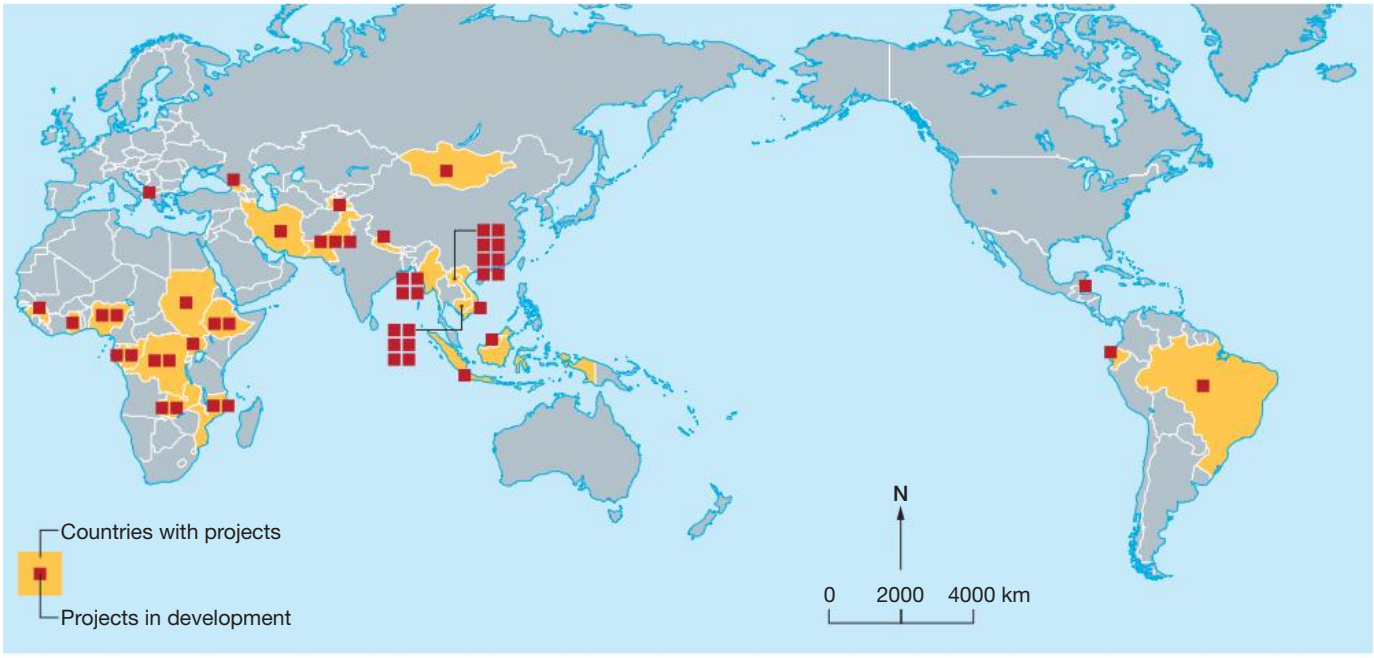
Criticisms

Africa's big dam projects have their critics. When a dam is built, local people are forced from their lands and their source of income. Rarely do these people receive proper compensation. The energy that dam projects generate benefits large businesses and the wealthy far more than ordinary people. Dam projects have a significant impact on the environment and many are the cause of political tensions in the region.

China building dams

China is exporting its dam-building expertise to developing countries, as shown in Figure 6.18. Chinese companies and banks are involved in constructing at least 47 major dams in 27 countries. For the Chinese, such projects form part of a campaign to build influence throughout the developing world. China provides development assistance in return for access to resources such as oil and copper.

6.18 Distribution of major Chinese-sponsored big dam projects



ACTIVITIES

Knowledge and understanding

1. Explain why there is so much focus on big dam construction in Africa. What is the principal purpose of these dams?
2. What are the criticisms of big dam construction in Africa?

Applying and analysing

3. Why is there such a focus on hydro-electricity production in Africa?
4. Do you think the construction of big dams is the best response to the development needs of Africa's people? Explain.
5. What is China's motivation for building big dams in Africa?
6. Study Figure 6.18. In which countries is China either building dams or planning to build dams? (An atlas may help you to answer this question.)

6.7 Case study: Ethiopia

Ethiopia is Africa's fourth-largest country. It has a rich cultural and religious history but it is also known for droughts, famines and conflicts. It is one of the world's poorest countries and for too many Ethiopians, meeting their water needs remains a daily struggle.

Ethiopia statistics

- Only 38 per cent of Ethiopia's 83 million people have access to a safe, reliable water supply.
- Sanitation is available to only 12 per cent of Ethiopians.
- One child in every ten dies before the age of five, usually from waterborne diseases.
- Diarrhoea kills 55 000 infants a year.
- Life expectancy is just 58 years.

A woman's burden

Few people in Ethiopia have access to safe water flowing from a tap. In rural areas, most women wake up at sunrise and walk for kilometres down dusty tracks to the nearest well to collect their family's daily water supply. The wells are little more than waterholes that are dug deeper and deeper as the dry season progresses. The wells can be very dangerous to reach and their sides are often steep and slippery. Sometimes a well collapses, burying women and children.

The containers women use to carry the water usually hold about 20 litres of water, and weigh about 20 kilograms when full. Constantly carrying such heavy weights, usually on the head, back or hip, has a severe impact on women's health and wellbeing. The water drawn from the well is filthy, with flies buzzing around and animals drinking from the same source.

This is the daily experience of many women in rural Ethiopia. The life of women in the urban slums is not much better. Without access to clean water, women either walk long distances to draw dirty water from ponds and rivers (often polluted by factories) or pay water sellers. Without land on which to grow food, women living in towns and cities need to find paid employment to support their families. This is difficult when they must collect water daily as well.

NGOs transform lives

In recent years, a number of aid organisations have worked with local communities to improve access to water. WaterAid, for example, has funded more than fifty water and sanitation projects in Ethiopia, benefiting more than 900 000 people. The projects include:

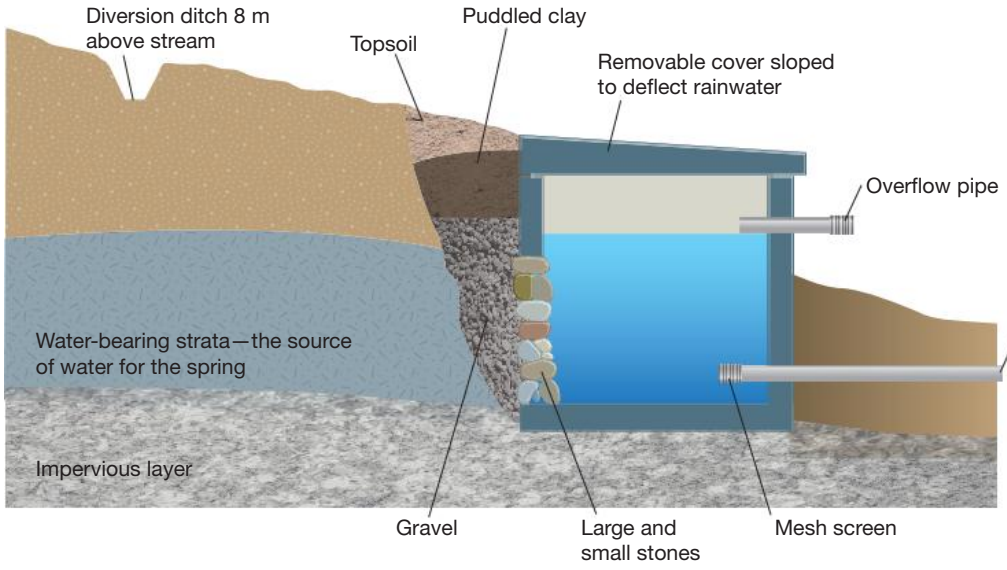
- rainwater harvesting
- the protection of springs
- the construction of tube wells and boreholes to access groundwater
- sand dams
- the construction of a spring-fed gravity-flow water network
- composting toilets
- communal toilet facilities in city slums.

WaterAid

WaterAid works with individuals and families in their communities, using low-cost technologies to deliver long-lasting, sustainable improvements in water supply, sanitation and hygiene. The organisation also ensures that women are closely involved in all stages of planning and implementing projects. This increases the chance of long-term improvement in the wellbeing of Ethiopian communities. As a result of WaterAid's work, thousands of women have been freed from the backbreaking daily task of fetching water. They are now able to spend more time caring for their children and educating themselves.

Sand dams and spring tanks

One project supported by WaterAid is building sand dams and spring tanks. In a sand dam, the water is stored underground. The dam is built under a riverbed, and traps and stores water. A spring tank (see Figure 6.19) is located where a small spring emerges. A tank is constructed to collect water; pipes can be attached to supply water.



6.19 Cross-section of a spring tank

SPOTLIGHT

The burden of thirst

'Aylito Binayo's feet know the mountain. Even at four in the morning she can run down the rocks to the river by starlight alone and climb the steep mountain back up to her village with 50 pounds (nearly 25 kilograms) of water on her back. She has made this journey three times a day for nearly all her 25 years. So has every other woman in her village of Foro, in the Konso district of south-western Ethiopia. Binayo dropped out of school when she was eight years old, in part because she had to help her mother fetch water from the Toiro River. The water is dirty and unsafe to drink; every year that the ongoing drought continues, the once mighty river grows more exhausted. But it is the only water Foro has ever had.'

Source: National Geographic website



6.20 Women collecting water in Foro, Ethiopia, before a WaterAid water point was opened

ACTIVITIES

6.5

Knowledge and understanding

1 Describe the daily water-collection routine of women in rural Ethiopia.

2 Outline the daily efforts involved in obtaining the family's daily water supply.

Applying and analysing

3 Contrast your access to water with that of people in Ethiopia.

4 Study Figure 6.19. Describe the benefits of spring tanks.

Investigating

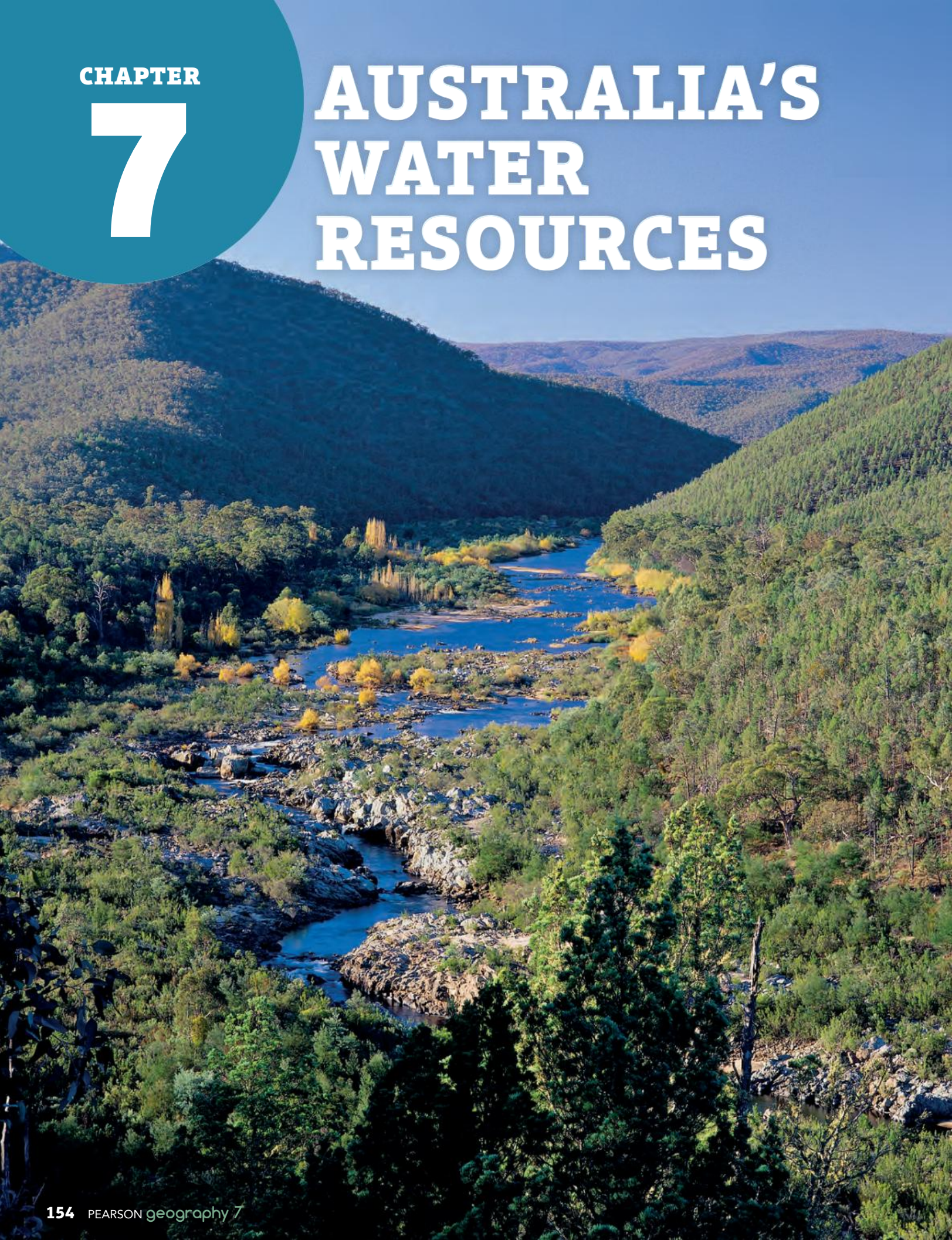
5 Visit the WaterAid website to help you complete the following activities.

- **a** State the mission and vision of the organisation.
- **b** Where is it based?
- **c** In what parts of the world does it operate?
- **d** How does WaterAid raise its funds?

CHAPTER

7

AUSTRALIA'S WATER RESOURCES



Australia's rainfall is variable and unreliable. Long droughts are common. As a result, water scarcity is an important environmental issue, and the water that is available needs to be managed very carefully.

The rate at which people have extracted water from Australia's river systems and underground aquifers is not sustainable. As well, precipitation patterns are changing as a result of climate change. These two facts are placing increasing demands on water across the country. Looking to the future, Australia will face major challenges in ensuring sustainable water supply in the face of a drying climate and rising demand.

In this chapter, we focus on Australia's water resources and their management. We look at the management strategies used by Indigenous Australians. Case studies are used to highlight key issues in the management of water resources in the Murray–Darling Basin and Queensland's wild rivers.

KEY IDEAS

- To be aware that Aboriginal and Torres Strait Islander people have contributed to the knowledge of water management in Australia
- To know how water resources are managed in Australia, and how to minimise personal consumption of water
- To develop skills in analysing and reviewing satellite images

GLOSSARY

anomaly	any deviation from the normal or predicted situation
crop yield	the amount of produce that is harvested from a crop
endangered	threatened with extinction
environmental flow	the amount of water that must flow in a river to maintain healthy, natural ecosystems
habitat	a place with a particular set of environmental conditions where a particular organism lives
headwaters	the upper tributaries of a river system
leaching	removal of salt from the upper layer of soils by the downward movement of water
nomadic	describes a way of life that involves moving across a territory with the changing seasons in search of food and water
parched	very dry; when referring to pasture, without much green growth
pasture	an area of grassland that is suitable for grazing animals
river basin	the area from which water drains into a river system
salt pan	a flat area covered in salt that is left when the water evaporates from a salt lake
sedentary	describes a way of life that involves little or no movement beyond one's usual place of living
soak	a hole, dug in a riverbed, into which groundwater soaks
spring	a place where underground water rises to the earth's surface
water buyback	the process by which a government buys back irrigation water permits from farmers
wild river	a river that is free, or almost free, from human interference

7.0 Snowy River, New South Wales

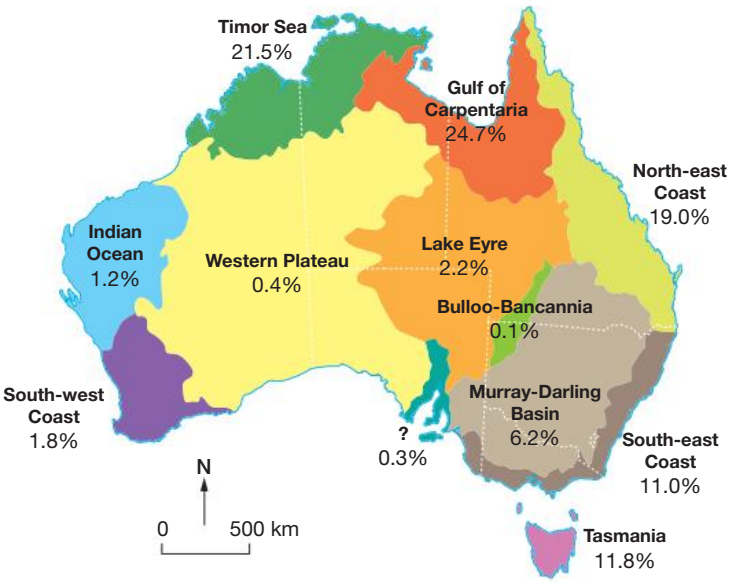
7.1 Water in Australia

Australia is a dry continent. Prolonged droughts, broken by flooding rains, are common. This creates a range of challenges for the managers of water resources.

Water availability

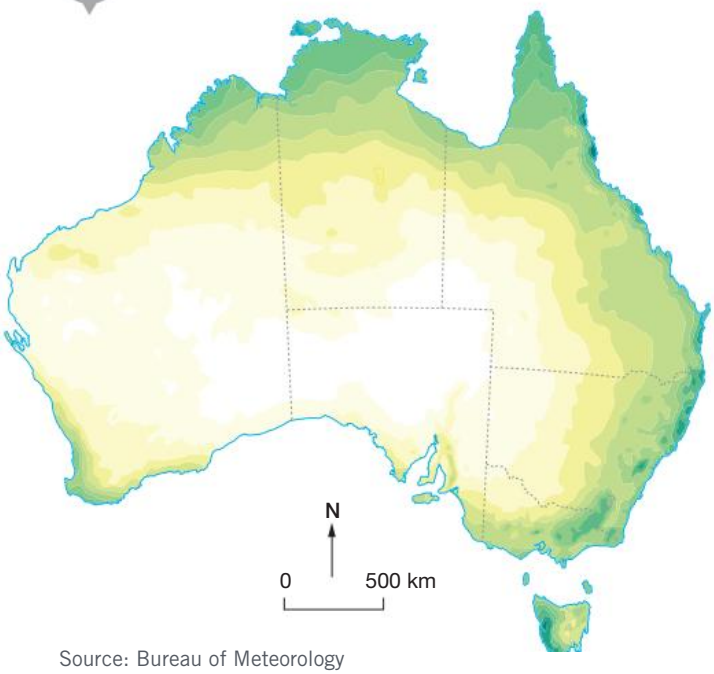
Australia's rainfall is unreliable and highly variable. Average annual rainfall is 469 millimetres per year (see Figure 7.1). While this is not very low, only 12 per cent of the water runs off into rivers. The remaining 88 per cent either evaporates or soaks into the ground.

In the more populated south-eastern states, water in dams, rivers and lakes is being used at a high rate. In response, all Australians, both in the city and in rural areas, are being encouraged to use less water. Strategies that encourage people to use less water and to use water more wisely include increasing the price of water and promoting water recycling and water trading.



Source: *Australian Natural Resources Atlas*

7.2 Rainfall run-off by major drainage division



Source: Bureau of Meteorology

7.1 Average annual rainfall in Australia

In northern Australia, a large number of river systems have not been dammed. This means that the wetlands, rainforests, eucalypt savannas and native grasslands associated with these river systems do not lose access to a water supply. As Figure 7.2 shows, nearly two-thirds of Australia' s water run-off occurs in this northern region. However, rainfall in northern Australia is highly seasonal, with heavy rains in summer and little rain in winter. The water that falls there is a potential resource, but it would have to be stored and transported to where it is needed. Building dams and pipelines to transport water would be very expensive.

Storing water

Because Australia's rainfall is so unreliable and variable, water run-off needs to be collected and stored in dams, moved to where it is needed and used with care in drier times. Australia has 447 large dams and, as Table 7.3 shows, they store nearly 84 000 gigalitres (GL) of water—equivalent to 168 Sydney Harbours. This water is used mainly to meet urban needs and for irrigation, flood mitigation and the production of hydro-electricity (see Figure 7.4). Australia also has several million farm dams, which are estimated to contain 9 per cent of all stored water.

The biggest 'store' of water is Australia's vast underground aquifers. These aquifers provide 25 780 GL of groundwater a year. This water is suitable for farming and domestic use, and for irrigated agriculture.

7.3 Storage capacity of large dams by state or territory

State or territory	Storage capacity (GL)
Australian Capital Territory	120
New South Wales	24 629
Northern Territory	280
Queensland	10 657
South Australia	258
Tasmania	23 652
Victoria	12 109
Western Australia	12 148
Australia	83 853

Source: National Water Commission, 2012

Learning from the past, looking to the future

For Australia's Aboriginal and Torres Strait Islander people, water and land are connected. This is significantly different from how other Australians have viewed water and land. Non-Indigenous Australians have in general seen the two as being separate, and have seen both as resources to be used for profit. However, this view is beginning to change. Water managers are beginning to understand that land and water cannot be managed independently of each other.

Due to changing climate and increasing demand for water, Australia faces major challenges in ensuring that it has a sustainable water supply. Any program aimed at securing Australia's future water security will include taking action on climate change, using water wisely, securing additional sources of water and supporting healthy river systems.



7.4 The 140-metre-high Gordon Dam, on Tasmania's Gordon River, is the tallest dam in Tasmania. It stores water for the production of hydro-electricity. The associated Gordon Power Station is Tasmania's largest power station.

ACTIVITIES

7.1

Knowledge and understanding

1. State the factors that complicate the management of water resources in Australia.
2. State why so little run-off finds its way into Australia's rivers.
3. Explain why the run-off from Australia's northern rivers is best described as a *potential* resource for use in other parts of Australia.
4. Identify Australia's principal stores of water.

Geographical skills

5. Study Figure 7.1. Describe the general pattern of annual rainfall in Australia.
6. Study Figure 7.2. Identify the drainage divisions with the highest and lowest run-off rates. What are the implications of this for the management of Australia's water resources?
7. Study Table 7.3. Explain why the amount of stored water varies from state to state.

7.2 Geoskills: Satellite images

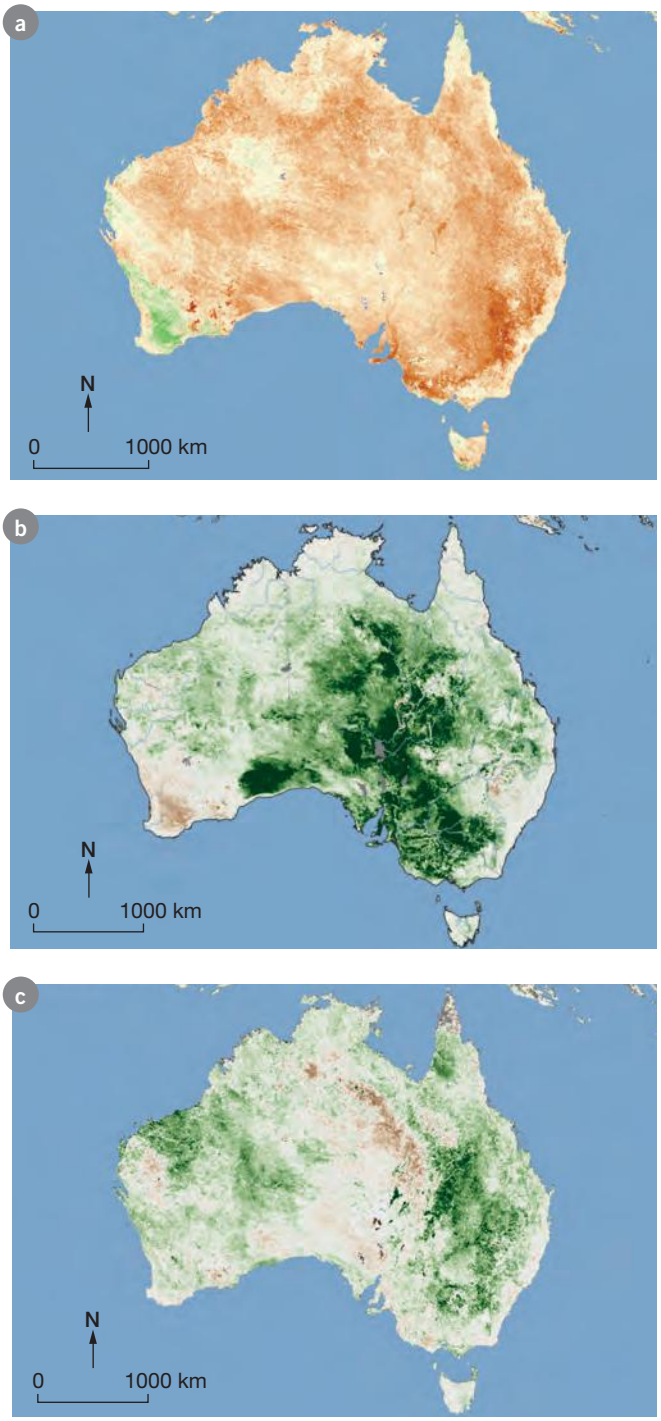
Satellites orbiting high above the earth take images that can be used to predict weather and monitor water availability. This process is referred to as remote sensing. Geographers use remote sensing to study different environments.

Interpreting satellite images

Dry conditions are so common in Australia that, even in the middle of relatively wet summers, large areas of the continent, especially the arid interior, can remain **parched**. Changes over time can be observed in Figures 7.5a, b and c. Figure 7.5a shows the continent during the long drought of the first decade of the twenty-first century. In all but the south-western corner, vegetation cover was less than might normally be expected (expressed as an **anomaly**). By 2011–12, shown in Figures 7.5b and c, the drought was over and above-average rainfall had occurred. Large areas of inland Australia had turned green, **crop yields** had increased and **pasture** was plentiful.

The greening was especially noticeable in the north-western part of New South Wales and southern Queensland. These are typically dry areas, dominated by grasses, shrubs and herbs that are particularly sensitive to changes in rainfall. An increase in soil moisture will bring to life the seeds of species adapted to the hot, dry climate of inland Australia.

The images were produced by NASA's Earth Observatory. They use remotely sensed data supplied by the US Department of Agriculture's Global Agricultural Monitoring program.



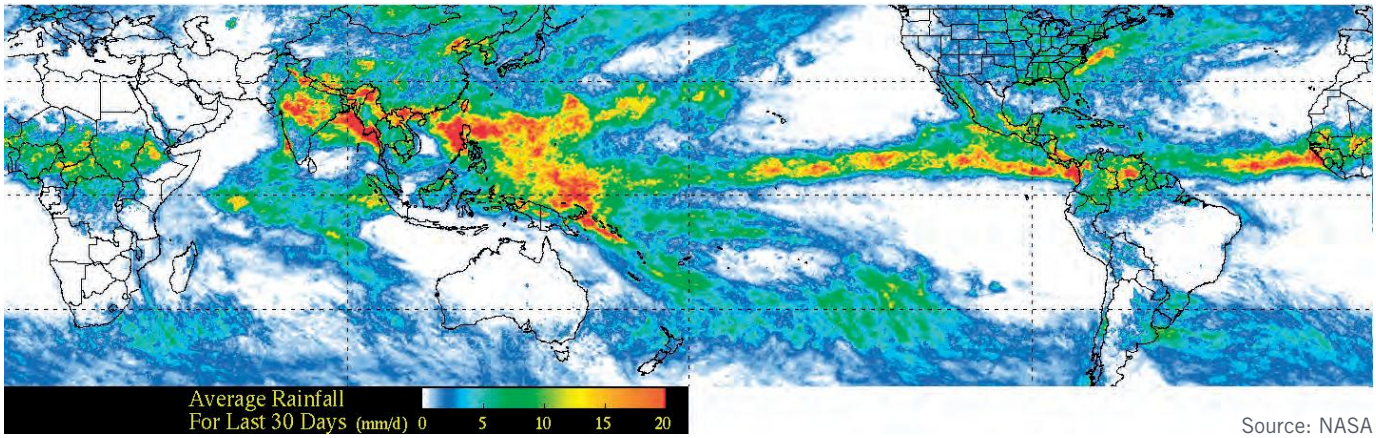
7.5 Vegetation anomaly—that is, vegetation cover compared with normal conditions—Australia, in (a) May 2005, (b) April 2011 and (c) February 2012

Source: Bureau of Meteorology, NOAA

Weather satellites

There are many types of satellite images. Figure 7.6 shows a NASA image from 19 August 2012 showing average rainfall for the previous 30 days.

7.6 Remotely sensed image showing average rainfall for the previous 30 days, 19 August 2012

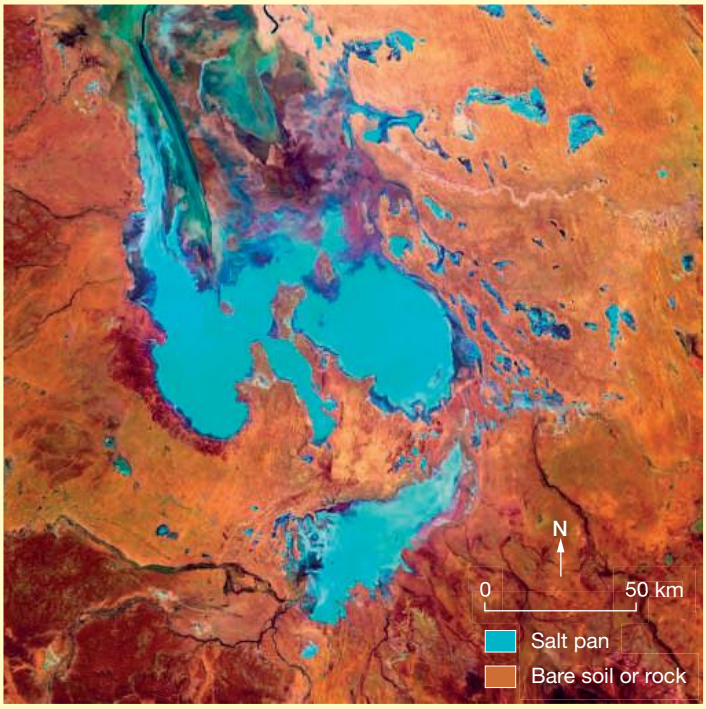


Source: NASA

SPOTLIGHT

Kati Thanda–Lake Eyre

Kati Thanda–Lake Eyre, South Australia, lies 15 metres below sea level, making it the lowest point in Australia. Kati Thanda–Lake Eyre is the world's largest **salt pan**, covering an area of 9300 square kilometres. The lake has only filled to capacity three times in the past 150 years. This happens when there has been heavy rainfall in the north and east of Queensland, filling the inland rivers that flow into the Lake Eyre Basin. When the lake fills, birds flock to the region and wildflowers bloom. The Arabana People have been living in the Lake Eyre region for thousands of years, and the lake has a central role in many of their stories and songs. Their traditional name for the lake, Kati Thanda, was added to South Australia's official list of placenames in December 2012.



7.7 Satellite image of Kati Thanda–Lake Eyre, South Australia, July 1999

Source: NASA

ACTIVITIES

Knowledge and understanding

1 Describe how satellite images are produced.
2 Where is the lowest point in Australia?

Geographical skills

3 Study Figures 7.5a, b and c. Write a paragraph describing the change between 2005 and 2012.
4 Study Figure 7.6 and complete the following questions.
   a Which areas have had the highest rainfall?
   b Which areas have had the least rainfall?
   c Areas of high rainfall are found between the Equator and the Tropic of Cancer. Explain.

7.3 Water scarcity

Australia is a continent of extremes. There is an abundance of water in the tropical north, where few people live, and relative scarcity in the more populated southern parts of the continent. In addition, neither north nor south receives reliable rainfall all year round.

Addressing past mistakes

Poor management of water resources has led to an over-allocation of water to farmers (irrigators), especially in the Murray–Darling Basin. There is also increasing competition between irrigators and mining, urban and industrial users of water. As a result, there has been a major deterioration in the health of many river systems and their environments throughout Australia.

For Australia to have environmentally sustainable and productive river systems, water needs to be managed better and used more efficiently. **Water buybacks** (paying irrigators to give back some of their allocated water) and the use of more efficient irrigation technologies are two strategies that could help to guarantee an environmental flow for river systems. Such plans are difficult to implement. Irrigators and river-dependent communities fear that their economic wellbeing will be affected.

Grand plans

Since European settlement, many proposals have been put forward to transport water from the north of Australia to the south. Some notable examples are described below.

The Bradfield Scheme

In 1938, John Bradfield, the designer of the Sydney Harbour Bridge, presented a plan to the Queensland government to divert water from northern Queensland's coastal rivers across the Great Dividing Range into central Australia. The aim of the scheme was to droughtproof much of inland Queensland and South Australia.

South-east Queensland water grid

In 2007, the Queensland government commissioned a report on a proposal to transport water from the north-east of Australia by diverting it from the Burdekin River to south-east Queensland, where it could be moved between various storage dams by pipelines.

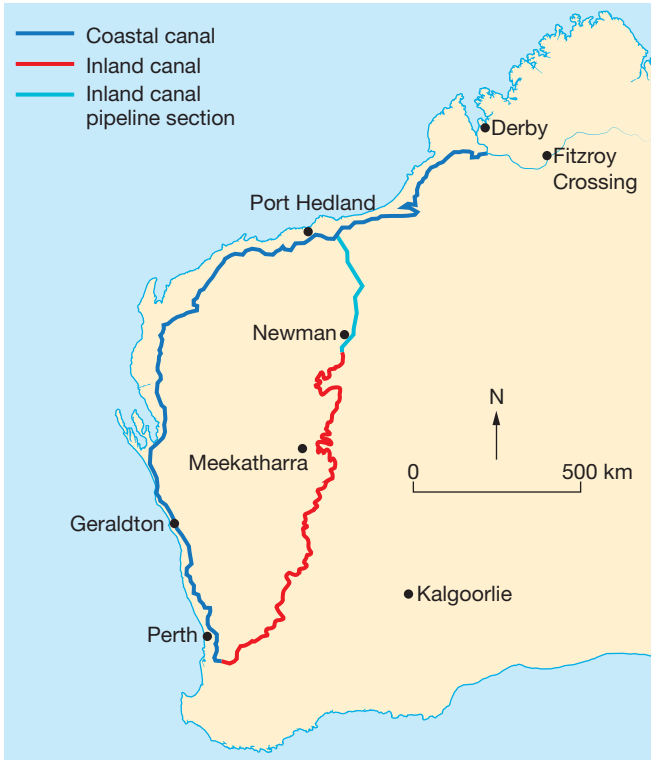
Northern New South Wales

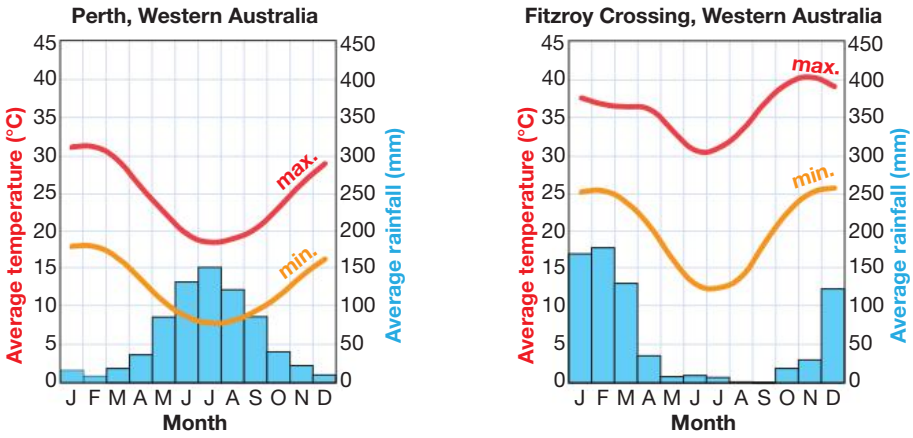
It has been suggested that water from coastal rivers of northern New South Wales could be diverted into river systems west of the Great Dividing Range.

The Kimberley–Perth Canal

Plans to build a 2500-kilometre canal from Western Australia's Kimberley region to Perth (see Figure 7.8) received considerable media and political attention between 2006 and 2008. At this time, Perth was suffering one of its worst-ever droughts. The Kimberley region receives higher rainfall than Perth at different times of the year, as shown in Figure 7.9. Rivers in the region could also supply water.

7.8 The Watering Australia Foundation's proposed route for the Kimberley–Perth Canal





7.9 Climate graphs for Perth and Fitzroy Crossing. The Kimberley's summer rains could be diverted by canal to meet Perth's water needs.

Alternatives to the canal proposal included a pipeline to transport the water from north to south and transporting the water by sea, in tankers or in large water bags towed by tugboats. The construction of a desalination plant proved to be a cheaper alternative.

Reality check

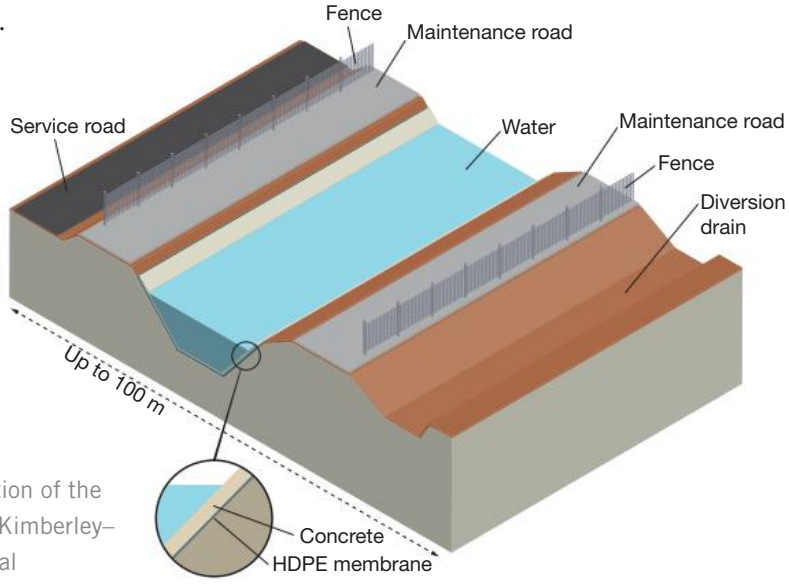
The cost of capturing and storing water, then transporting it from north to south would be enormous. Even if cost were not an issue, the concept is not without its problems. These include:

- the lack of suitable locations for building a dam, given that much of northern Australia is flat
- the variability of rainfall across northern Australia
- environmental impacts in the catchments being harvested
- the current and potential uses of the north's water resources.

Alternatives

Alternative ways of addressing the issue of water scarcity in Australia include:

- reducing consumption by improving efficiency of rural and urban water use
- pricing water at a level that discourages waste
- recycling and desalination.



7.10 Cross-section of the proposed Kimberley–Perth Canal

ACTIVITIES

Knowledge and understanding

1 Explain why effective water management is essential in Australia.
2 List the errors that were made in water management in the past.
3 Outline the aim of John Bradfield's water diversion scheme.

Applying and analysing

4 Create a PMI chart about moving water from the north of Australia to the south. Consider the economic, environmental and social costs.

Geographical skills

5 Study the climate graphs in Figure 7.9.
a Describe how the climates of Perth and Fitzroy Crossing differ.
b What is the link between the seasonal pattern of rainfall received by each station and proposals to transport water from the north to the south?

7.4 Indigenous management of water resources

The history of Aboriginal people in mainland Australia spans at least 50 000 years (or more than 2000 generations). For most of this time, the majority of Aboriginal people lived semi-nomadically as hunter-gatherers. In doing so, they developed a close relationship with the land and its resources, including water.

Aboriginal people and the environment

Aboriginal people have always had a very close relationship with the land. They learnt to adapt to the environment and at the same time to exploit its resources. They understood the rhythms of nature and its signals, and could live from the land without depleting the supply of food and water.

In recent years, there has been a debate about the degree to which Aboriginal people modified the environment. One controversy focuses on the role that Aboriginal people may have played in the extinction of the marsupial megafauna (big land animals that evolved after the dinosaurs). Some people argue that natural climate change led to the extinction of the megafauna; others claim that, because the megafauna were large and slow, they were easy prey for hunters. Another possibility is that their extinction was indirectly caused by the way in which Aboriginal people modified the environment, particularly through the use of fire. Aboriginal people practised regular burning. Over time, plant species that found it difficult to survive this use of fire were replaced by fire-tolerant species such as eucalypts.

Aboriginal people and water

Most Aboriginal people were semi-**nomadic**; that is, they moved from place to place in search of food and water. Each group moved over a well-defined area with boundaries that were respected by other groups. They established camp sites around waterholes such as **springs**, **soaks** and billabongs. When travelling through arid regions, groups of Aboriginal people would move from waterhole to waterhole. Their shelters were simple and temporary, and were made of materials that were available locally. Some Aboriginal groups led a more **sedentary** life, staying in the place they had settled.

The ability to find water was vital, especially in arid areas. Aboriginal people were skilled in finding 'hidden' water in the root hollows of trees such as the boab tree. They knew exactly where to dig for soaks in sandy riverbeds, even in times of severe drought. In some parts of Australia, the locations of waterholes were recorded on sacred boards, which served as maps. Given the importance that water played in the survival of Aboriginal people, it is not surprising that many waterholes feature in Aboriginal Dreaming stories.

Murray–Darling Basin

Despite a history in the region spanning tens of thousands of years, Aboriginal people today own less than 1 per cent of the land in the Murray–Darling Basin. Many Aboriginal people nevertheless retain a strong link with the Basin's rivers and a desire to protect and preserve the rivers. In 1998, twenty-one groups of traditional landowners from the southern part of the Murray–Darling Basin formed an organisation called the Murray Lower Darling Rivers Indigenous Nations. A similar organisation, the Northern Murray–Darling Basin Aboriginal Nations, was formed in April 2010. It comprises representatives of twenty-two Aboriginal Nations from the northern part of the Basin and representatives of other Aboriginal and Torres Strait Islander organisations.

Ngarrindjeri elder Tom Trevorrow sums up the traditional owners' approach to the management of water and other resources in this way:

> Our traditional management plan was: don't be greedy, don't take any more than you need, and respect everything around you. That's the management plan—it's such a simple management plan, but so hard for people to carry out.
>
> Source: *A Yarn on the River: Getting Aboriginal Voices into the Basin Plan*, Murray–Darling Basin Authority, Canberra

SPOTLIGHT

Managing the Barmah Forest wetlands

The Barmah Forest is found on the flat flood plain of the Murray River, about 220 kilometres north of Melbourne. The forest is one of the largest stands of river red gums found in Australia. These trees are under threat, but they provide habitat to more than 200 different bird species and many other animals. Since 2010, the Barmah Forest has been protected in a national park.

The Yorta Yorta People, who are the traditional custodians of the Barmah Forest, play an important part in the management of the park environment. Over many years of European settlement, the wetlands of the forest have suffered. The use of four-wheel drive vehicles, logging, grazing and the activities of feral animals have all taken their toll on the environment. Some of the important fish species within the wetland have now disappeared, but, by using the knowledge of the area's Indigenous custodians, scientists are gaining an understanding of the role of these fish in the broader environment.

A partnership has been formed between the Yorta Yorta People and the Goulburn Broken Catchment Management Authority, the government agency responsible for managing the wetlands. Each group is learning from the other, and the Yorta Yorta People are able to pass on their knowledge of the wetlands to the scientists, helping them to make better decisions.

7.11 A representative of the Yorta Yorta People monitoring work in Barmah National Park



ACTIVITIES

Knowledge and understanding

1. Describe the nature of the relationship between Aboriginal people and the land.
2. Outline the extent to which Aboriginal people modified the Australian environment.
3. Outline the role that water availability played in the Aboriginal way of life.

Applying and analysing

4. Study the Spotlight box 'Managing the Barmah Forest wetlands', then answer the following questions.
   - **a** Why is the Barmah Forest considered so important?
   - **b** Outline the reasons the forests are threatened.
   - **c** How have the Aboriginal traditional custodians of the Barmah Forest become involved in its management?
   - **d** What do you think are the advantages of having Aboriginal traditional custodians involved in the management of Barmah Forest?

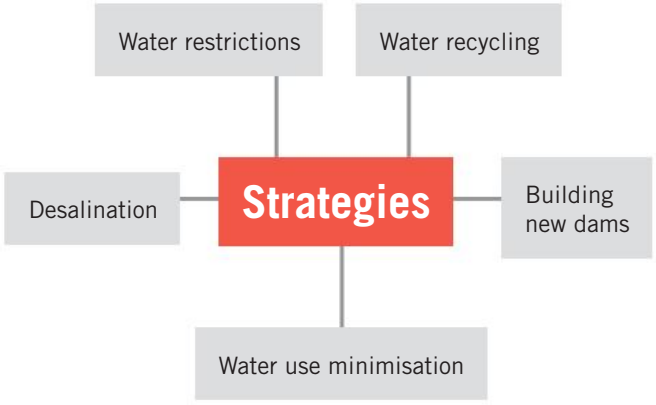
7.5 Water management

Australia is the driest inhabited continent on earth. It is essential that we carefully manage our water resources. Water is needed for our urban areas, for agriculture and also for industry. In addition, water is vital for the environment.

Water for Australia's cities

Most of Australia's large urban centres are located along the coastline. These coastal areas receive higher rates of rainfall than inland Australia. Even so, most cities face a challenge to meet the water needs of a growing population. In recent years, Brisbane, Sydney, Melbourne and Adelaide have all had to place restrictions on how and when people can use water. Many smaller cities and towns have also had to impose water restrictions.

Figure 7.12 summarises some of the strategies that cities around Australia are beginning to use to secure their water supplies for the future.



7.12 Some of the strategies used in Australian cities to secure water supplies

Managing the impacts of irrigation

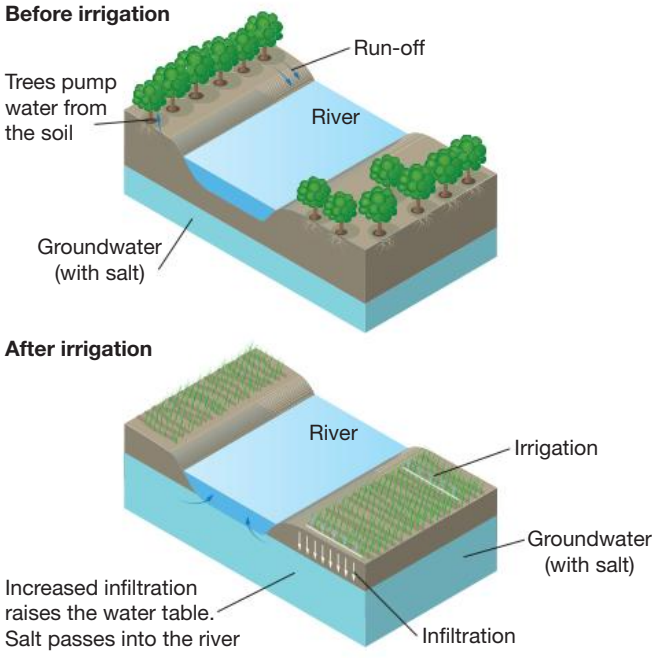
Irrigation allows us to grow crops in areas where it is normally too dry. Unless irrigation water is managed carefully, it can have serious environmental impacts. One of the most serious impacts is salinity, or an excess of salt in the soil. There are two types of salinity.

Dryland salinity

Salinity of soils and water is a natural characteristic in semi-arid and arid climates. This salinity results from low, unreliable rainfall and high rates of evaporation. Soils become salty when there is not enough rainfall to remove the salt; this process is known as **leaching**. Flat landscapes and inward-draining regions (such as the Lake Eyre Basin) do not have the advantage of rivers running through them that can carry salt to the sea.

Irrigation salinity

Irrigation salinity occurs when irrigation water seeps down into the soil, causing the water table to rise. When this happens, dissolved salts move up into the root zone of plants. Dissolved salt can also move towards watercourses (see Figure 7.13). This results in an increase in the salinity of rivers.



7.13 Irrigation salinity. Irrigation water causes the water table to rise, bringing dissolved salt to the surface.

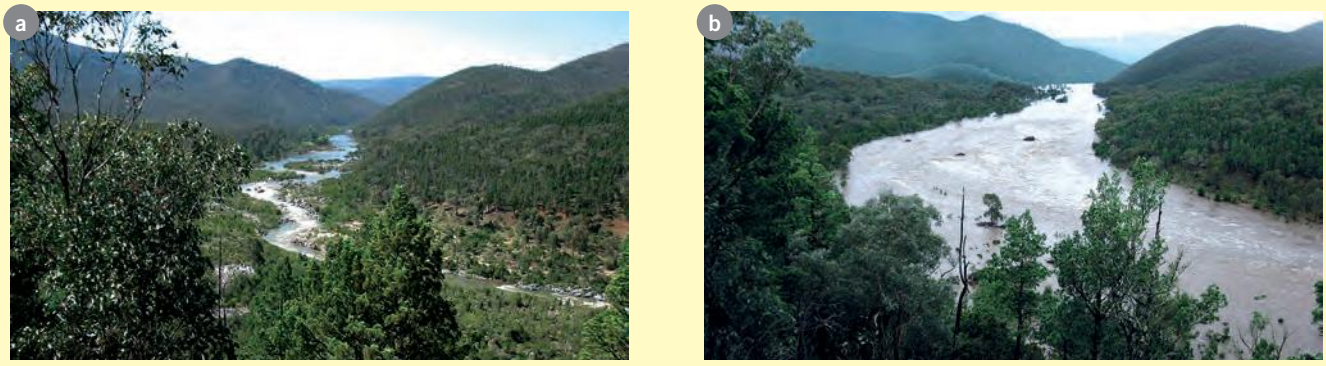
SPOTLIGHT

Total catchment management

The best way to protect water quality in our waterways is to manage the whole catchment. Sources of pollution need to be identified, and pollutants (such as sewage, industrial pollution, agricultural fertilisers and pesticides, and salty groundwater) need to be captured and treated before they find their way into a catchment's waterways.

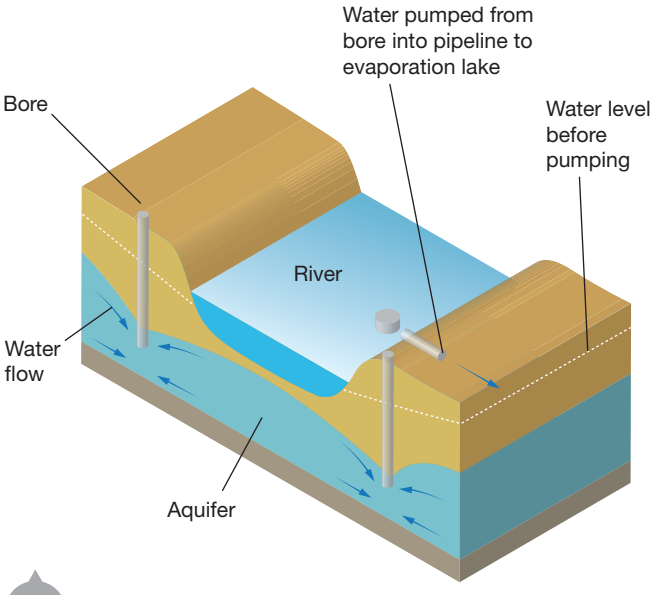
There is also a need to manage the amount of water taken from rivers for irrigation and for urban and industrial uses. Scientists now talk of maintaining an adequate **environmental flow** to protect the health of river and wetland ecosystems.

7.14 Two views of the Snowy River, showing the level of the river (a) when most of its flow had been diverted into the Murray–Darling Basin and (b) after water was released to simulate environmental flow



Solutions

While it is unlikely that there will be a total solution to the salinity problem in Australia, steps can be taken to stop water tables from rising. One way to do this is by pumping and draining water, as shown in Figure 7.15. A second way is by planting deep-rooted vegetation, which reduces the amount of water reaching the water table by increasing the rate of transpiration.



7.15 Expensive engineering can be used to lower water tables and protect waterways. The disposal of the salt that accumulates is another significant problem.

ACTIVITIES

7.4

Knowledge and understanding

1 Explain why it is important that water resources are carefully managed in Australia.
2 'Total catchment management' refers to protecting waterways. What needs to be identified so that this protection can commence?
3 Explain the concept of an environmental flow.

Applying and analysing

4 Study Figure 7.12. Write a paragraph outlining the strategies used in Australian cities to manage water resources.
5 Study Figure 7.13. Write a paragraph outlining the relationship between irrigation and salinity.
6 Study Figure 7.15. Write a paragraph outlining how an engineering response can be used to address irrigation salinity.

Investigating

7 Working in small groups and taking the perspective of a government department responsible for managing water in your town or city, prepare either a brochure, a digital presentation or the script for a television or radio advertisement about strategies that could be used to reduce water usage.

7.6 Case study: The Murray–Darling Basin

The Murray–Darling Basin is the most important catchment area in Australia. The Basin is regarded as the 'food bowl' of Australia because approximately 40 per cent of Australia's food is produced in it.

Geography

The Murray River is Australia's longest river, with a length of approximately 2508 kilometres. It has its source in the Australian Alps and drains the western side of the Great Dividing Range. At Wentworth, the Murray River is joined by the Darling River. The Darling River is approximately 1545 kilometres in length and begins its journey in southern Queensland. The Murray then flows into South Australia. It turns south near the town of Morgan, and continues southwards to reach the Southern Ocean near Goolwa. The catchment or **river basin** (the area over which rain falls that eventually flows into the river) of the Murray and the Darling, shown in Figure 7.16, covers about one-seventh of Australia's landmass.

Ecosystem

The ecosystem of the Murray–Darling Basin is very diverse. The aquatic environment contains a number of important fish species, including the very large Murray cod. There are also complex communities of mussels and other important animals, including the Murray crayfish and freshwater turtles.

More than 7000 wetlands are found along the Murray and its tributaries. These wetlands are an important **habitat** for a whole range of animals, including birds, frogs and other amphibians, and larger, land-based animals, such as wallabies and kangaroos.



A very important part of the Murray–Darling Basin, and one of its most threatened environments, is the river red gum forests (see Figure 7.17). These trees have evolved over thousands of years to live on the flat flood plains adjacent to the river. They provide important habitats for many species.

7.16 The Murray–Darling River Basin is so large that it includes the catchments of many large rivers. These include the Murrumbidgee River, which flows westwards across south-western New South Wales, and the Darling River, which flows southwards from Queensland through far western New South Wales before flowing into the Murray.



7.17 A Murray River wetland dominated by river red gums

Economic importance

The Murrray–Darling Basin is Australia's most important food-producing area. It is where 98 per cent of oranges and 54 per cent of apples are grown. All of Australia's rice is grown in the Basin. Of the food that Australia exports, 39 per cent comes from the Murray–Darling Basin. Exporting food grown in the Basin creates billions of dollars.

The Murray–Darling Basin is also an important destination for recreation and tourism. People travel to the area to make use of its rivers for boating, skiing, swimming and canoeing. Each year in December, canoeists paddle 404 kilometres down the Murray during the five-day Murray Marathon event.

The most important economic benefit of the Murray–Darling Basin is to the 1.26 million people who live in Adelaide and rely on the Basin for their water supply.

Human impacts

Since European settlement, the Murray–Darling Basin environment and its ecosystems have undergone major changes.

Land clearing

There has been extensive land clearing across the Basin. The native scrub and river red gum forests have been replaced with pastures for grazing animals. Large areas have also been cleared for rice, wheat and other cereal crops, as well as citrus fruits and vineyards.

Water extraction

Large amounts of water are needed to support agriculture and communities across the Basin. Water is extracted from the Basin's rivers for this purpose.

Water diversion

The Snowy River rises on the eastern side of the Australian Alps and flows south towards Bass Strait. Between 1949 and 1974, a huge system of tunnels and dams was built to divert the majority of the Snowy River's water into the Murray River. First, the water is stored in huge dams. Then it is sent westwards across the mountains through tunnels. This water is also used to generate hydro-electricity.

Habitat destruction

Land clearing for agriculture and urban development, as well as the flooding caused by the huge dams and lakes used for irrigation, has led to the destruction of many wetlands and forests. Important habitats for waterbirds and countless other animals have been lost.

Turbidity and nutrient run-off

Turbidity is a measure of the cloudiness of water. It increases when soil and other materials enter the water. High levels of turbidity reduce the amount of sunlight that penetrates the water, and this affects plants growing in the water.

Nutrients such as fertilisers can flow into rivers from nearby farms and cause algae to grow. When large blooms of algae die, the bacteria responsible for their decomposition remove oxygen from the water, reducing aquatic life further by limiting access to vital oxygen.

Soil salinity

The origins of the Murray–Darling Basin stretch back more than 500 000 years. At that time, the area was covered in a shallow saltwater sea. As the sea retreated, it left a deposit of sand, which still covers the area, as well as salt. This means that the soils of the Basin contain huge amounts of salt.

Typically, the salt was once trapped deep in the soil. As the land has been cleared and irrigated, the salt has come to the surface with rising groundwater. Before land clearing, trees acted as huge pumps, sucking up large amounts of water and keeping the water table deep below the surface. The removal of the trees has allowed the groundwater to rise towards the surface, bringing the salt with it. This salt scars the surface and becomes poisonous to plants, and subsequently destroys the environment, as shown in Figure 7.18.

River regulation

The process of river regulation involves the construction of weirs, dams and other engineering works in and around rivers. Such regulation has changed the nature of the rivers of the Murray–Darling Basin. The regular flooding that once came each spring with the alpine snowmelt has been replaced by a more regular flow. Constructions in the river prevent fish from swimming up and down the river, making breeding more challenging.

River mouth

As a result of extracting water and building dams and weirs to control the river, less water flows down the Basin's rivers. This means that sediments such as sand, which are normally carried along by the water, build up in the rivers. The mouth of the Murray at Lake Alexandrina, near Goolwa, can require dredging to keep it open (see Figure 7.19).

7.18 Soil salinity brings salt to the surface, killing trees and destroying habitats, on Disher Creek, South Australia.





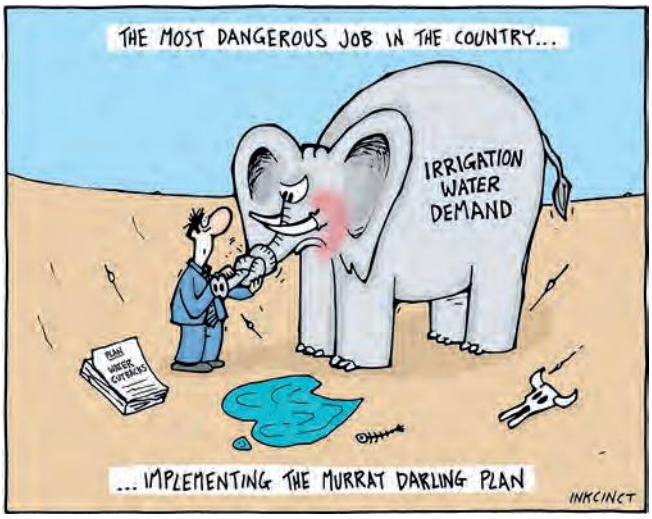
Management

The Murray–Darling Basin is so important to Australia's environment and economy that it is very carefully managed. In late 2012, the Australian Parliament passed laws to return 2750 gigalitres of water to the system to help restore the Basin's environment. This water will be allowed to flow freely down the river to flush it of sediment and salts. It will also help to reduce turbidity and the build-up of nutrients that promote the growth of algae. Despite this huge allocation of water, environmentalists claim that it is less than half of what is needed to keep the river healthy.

Other strategies being used to fix the problems of the Murray include:

- the installation of fish ladders to help fish migrate upriver, past dams and weirs
- reductions in land clearing and increased planting of trees
- careful management of wetlands.

7.19 So much water is taken out of the Murray for irrigation and town use that the mouth of the river often fills with sand and needs to be dredged.



7.20 There are many competing demands on the water in the Murray–Darling Basin.

ACTIVITIES

7.3

Knowledge and understanding

1 Explain the importance of the Murray River.

2 Copy and complete the following table.

Problem	Cause	Impact	Solution
Salinity			
Habitat loss			
Turbidity			
Nutrient run-off			
River regulation			
Water extraction			
Land clearing			

Applying and analysing

3 Using Figure 7.16 and the text, write a paragraph describing the location of the Murray–Darling Basin. List all the states across which the Basin is located.

4 List the reasons why it is important to protect the Murray River. Summarise your findings using a mind map.

Investigating

5 Select one of the impacts of human activity on the Murray–Darling Basin. Using the internet and library sources, prepare a digital presentation outlining how humans cause this impact and how it affects the environment of the Basin.

7.7 Case study: Wild rivers of Queensland

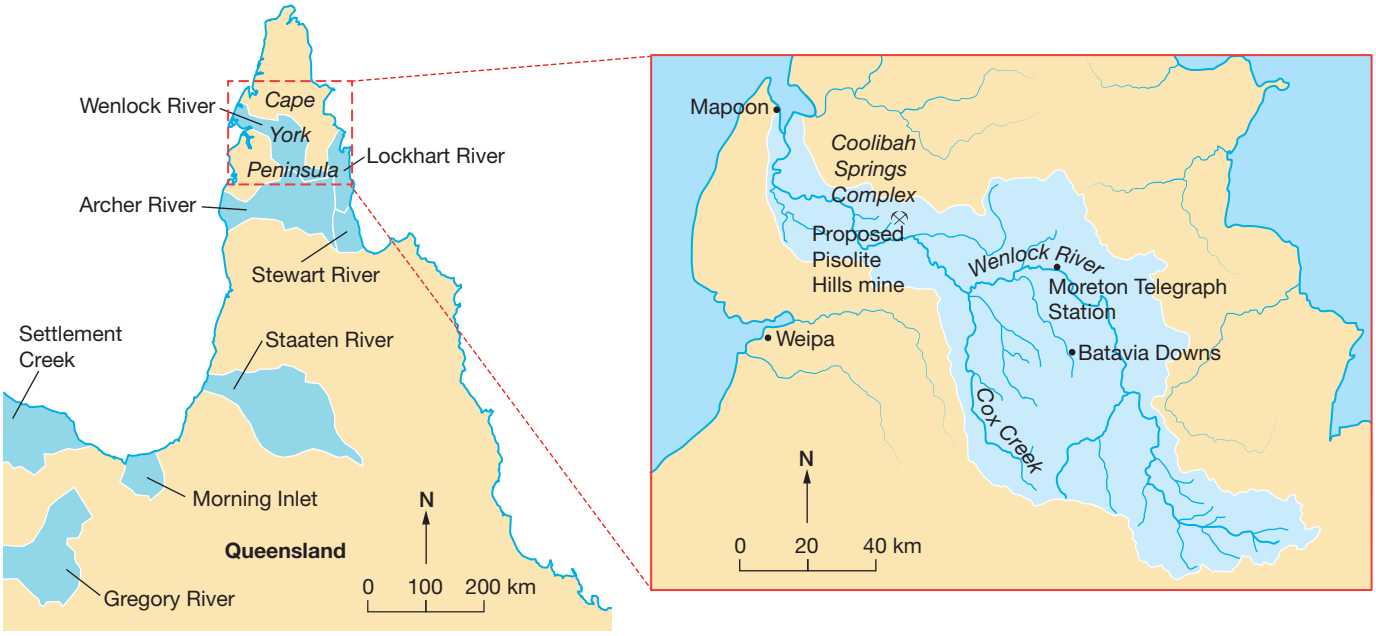
Fewer than 1 per cent of the world's rivers are considered to be 'wild'. Queensland has a number of wild rivers. Four of them—the Archer, the Lockhart, the Stewart and the Wenlock—are found on Cape York Peninsula.

Wild river status

To be considered a **wild river**, a river must be free, or almost free, of human influences. For example, there are no dams or weirs on wild rivers.

In 2004, the Queensland Parliament passed laws to protect wild rivers in Queensland from human development. Since the introduction of the *Wild Rivers Act 2005*, however, there has been much debate about the law's impact on communities. Many people have argued that the law has placed too much emphasis on keeping the rivers wild, and that this has held back agricultural, mining and tourism development in their catchments. The most significant criticism came after the four Cape York river systems shown in Figure 7.21 were declared wild and protected under the law.

7.21 The Wenlock River is one of four significant wild river systems on Cape York Peninsula.



Wild river controversies

When the Wenlock River was added to the protected rivers list in late 2008, the idea of 'wild river' protection became a major issue in the Australian media. Cape Alumina, a company that mines bauxite, or aluminium ore, claimed that a major mine it had planned (the Pisolite Hills project) would not be able to go ahead. Environment groups such as the Wilderness Society welcomed the decision to protect the river and the habitats of species such as the marbled frogmouth, shown in Figure 7.22.

The controversial mine was to be developed in the environmentally significant Coolibah Springs Complex. Although they are less than 40 kilometres from the river mouth, the springs are some of the **headwaters** of the Wenlock River, shown in Figure 7.23. The flow of the river is very dependent on the springs, especially during the dry season.



7.22 The marbled frogmouth is one of the threatened species found in the Coolibah Springs Complex, which flows into the Wenlock River.



7.23 Queensland's wild Wenlock River system is home to many threatened and vulnerable species.

The springs are also a habitat for a significant number of **endangered** and vulnerable species of both animals and plants. Birds such as the marbled frogmouth, red goshawk and palm cockatoo are found in the springs, where the flow of water provides a permanent habitat even at the height of the dry season.

A number of endangered plants are also found in the Coolibah Springs Complex and along the Wenlock River. One is the pitcher plant. This carnivorous plant has evolved to live in the nutrient-poor soils of the Wenlock River basin. The pitcher plant traps insects inside a pitcher—a special curled leaf—and digests them to get the nutrients it needs (see Figure 7.24).

Wild rivers and Aboriginal people

The Wenlock River and the Coolibah Springs Complex have great spiritual significance to the area's Aboriginal traditional owners. Some Aboriginal community groups on Cape York Peninsula, however, have been critical of the impact of the wild rivers laws on their communities. They point to the decision to stop the development of the Pisolite Hills mine as evidence that the law has stopped developments that are important to the future wellbeing of their communities.

7.24 Endangered pitcher plants are found in the Wenlock River basin.





7.25 The 2012 decision to allow development along the Cape York wild rivers has angered environmental groups such as the Wilderness Society.

Noel Pearson, a lawyer and Aboriginal leader who is vocal on issues relating to Cape York Peninsula, has said: 'This legislation impedes development and cuts off a future for Aboriginal communities.' He argues that the laws made by Queensland's then Labor government prevent Aboriginal communities from making decisions about developments on their own lands. Aboriginal communities in other parts of Australia have formed partnerships with mining companies, allowing mining on their lands.

The debate is very complex. There are two main differing views held among Aboriginal people in the region.

- The protection that the laws give to the rivers is important, the rivers should remain wild and human development should be minimised.
- The laws restrict the rights of Indigenous people to build economic independence and are unfair.

Complicating the debate are two differing views among non-Aboriginal people.

- There are so few wild rivers on earth that every one that remains is important and needs protection. This view is illustrated in the advertisement in Figure 7.25.
- The economic benefits from developing are more important than the environmental impacts.

In early 2012, the newly elected Queensland Liberal National Party government argued that the wild rivers laws were too restrictive and have too much of an impact on the ability of Cape York residents to profit from economic development. The government has also said that it is important that the rivers are protected and that any development would have to meet very strict environmental standards.

ACTIVITIES

7.2

Knowledge and understanding

1 State what a wild river is and outline the purpose of the *Wild Rivers Act 2005*.
2 Outline why the listing of the Wenlock River as a wild river been controversial.
3 Explain why it is argued that the Coolibah Springs Complex is so important.

Applying and analysing

4 Copy and complete the following table by outlining the arguments for and against the wild rivers legislation that the different groups put forward. Include in your response the impact that the law has on each group's interests.

Group	Arguments
Cape Alumina	
Aboriginal groups	
Noel Pearson	
Wilderness Society	
Queensland's (then) Labor government	
Queensland's (later) Liberal National government	

5 After listing all the arguments put forward in Question 4, write a newspaper editorial in which you adopt the argument you most agree with. Remember: the purpose of an editorial is to give your opinion and to convince an audience that you are right, so be sure to use facts that support your view.

7.8 Reducing household water use

Conserving water is almost always more effective and less costly than trying to provide a new supply of water. The key idea in water conservation is that there are many ways in which we can use water resources more sustainably.

Price

Increasing the price of water is one way to reduce water use. When water is cheap, people do not use it wisely; when the price of water rises, people use it more carefully. But, while higher water prices encourage conservation, they can make life difficult for farmers and households on low incomes.

In irrigation

About 60 per cent of the water used in agriculture does not make it to the plants. Flood irrigation systems of agriculture (for example, paddy rice cultivation) typically lose 40 per cent of their water through evaporation, seepage and water run-off. With advanced systems of centre pivot irrigation and drip irrigation, between 90 and 95 per cent of the water gets to the crops.

Strategies for reducing irrigation water waste include:

- using the most efficient irrigation technology available (for example, drip irrigation)
- lining canals to reduce seepage
- irrigating at night to reduce evaporation
- monitoring soil moisture and only applying water when necessary
- avoiding growing water-thirsty crops in arid areas
- irrigating with treated grey water
- pricing water at a level that encourages conservation.

In industry and at home

While agriculture is the biggest user of water, industrial and domestic consumption is also significant. In developing countries, between 30 and 60 per cent of the urban water supply is lost through leaking water mains. Even in the cities of the developed world, leakage can account for between 20 and 30 per cent of the water supply. Fixing these leaks is cheaper than building additional storage capacity.

Strategies for reducing water waste in urban and industrial settings include:

- redesigning manufacturing processes so that they use less water
- recycling water, especially in industry
- landscaping public parks and private gardens with plants that have low water needs
- using drip irrigation systems in gardens
- fixing leaking water mains
- using water-saving fixtures in commercial and residential properties
- collecting domestic grey water and using it to water lawns and non-food plants
- purifying and re-using water from homes and commercial buildings
- pricing water at a level that encourages conservation.

Personal responses

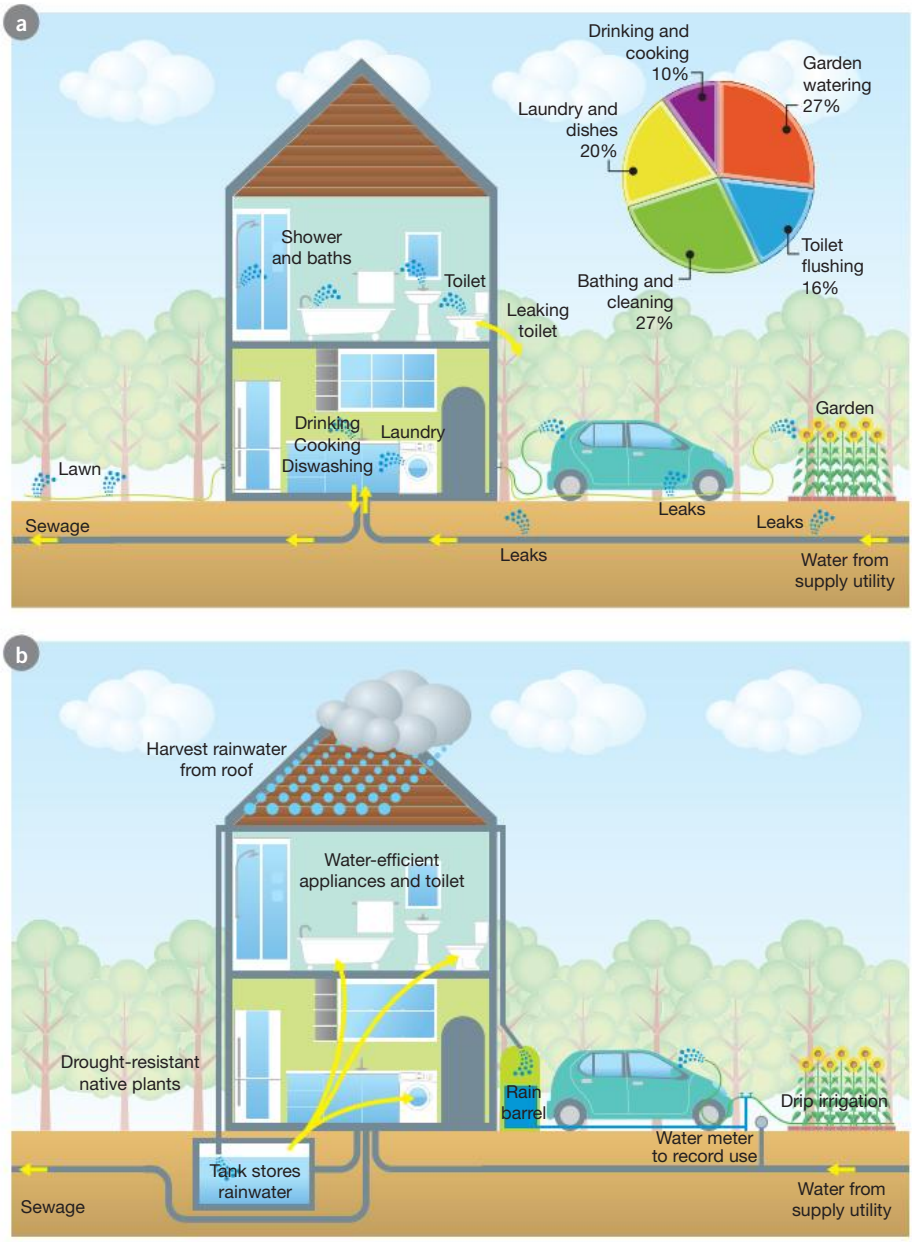
There are a number of actions individuals can take to reduce water consumption (see Figure 7.26). These include:

- installing water-saving household appliances, showerheads and toilets
- taking shorter showers
- turning off the tap when cleaning your teeth
- washing clothes only when you have a full load
- using grey water on lawns and gardens
- washing the car using a bucket rather than a hose
- fitting timers to all garden hoses
- planting plants and grasses with low water demand
- watering lawns and gardens early in the morning or late in the afternoon
- installing drip irrigation systems.

Sustainable water use

In addition to personal responses, there are a range of programs to use the earth's fresh water more sustainably. These include:

- wasting less water and promoting water conservation through education programs
- researching and developing new technologies for efficient water use and recycling
- ensuring that aquifers are used sustainably
- maintaining water quality by protecting forests, wetlands and other natural systems that store and release water
- developing agreements between countries that share water resources
- slowing population growth
- pricing water at a level that encourages conservation (the higher the price, the less water will be used).



7.26 Making your home water wise: (a) before, and (b) after

ACTIVITIES

7.5

Knowledge and understanding

1. State what is meant by water conservation.
2. Describe how water pricing can be used to reduce water waste.
3. Discuss how irrigation water can be used more effectively.
4. State the ways in which the sustainable use of water can be promoted.
5. Study Figure 7.26. Identify the ways in which this Australian household has become more water wise.

Applying and analysing

6. Draw up a poster promoting water conservation in one of the following locations.
   - an urban environment
   - an industrial setting
   - a rural environment

Investigating

7. Respond to the following statement: 'I am only one person. How will changing my behaviour make a difference when it comes to water conservation?' Give your response as an oral presentation. Include images, data and other resources to support your response.

Review and reflect 2

Activity 1

a Using an atlas: For the record books 1

Use an atlas to locate each of the places mentioned in Table R&R2.1. Using a blank outline map of the world, annotate (label) a map with the climatic record for which each place is known.

R&R 2.1 World climatic records

Climatic record	Location
Highest recorded temperature: 56.7°C	Death Valley, California, USA
Lowest recorded temperature: –88.3°C	Vostok, Antarctica
Most consecutive sunny days: 768 days (1967–69)	St Petersburg, Florida, USA
Highest average annual rainfall: 11 430 mm	Cherrapunji, Assam, India
Lowest average annual rainfall: 0.88 mm	Arica, Chile
Most rainy days in a year: 350 days	Wai'ale'ale, Hawaii, USA
Most rainfall in a day: 1870 mm	Cilaos, Réunion, Indian Ocean
Most rainfall in a year: 26 461 mm	Cherrapunji, Assam, India
Most thunder in a year: 322 days	Bangor, Java, Indonesia
The world's driest place: the first rain for 400 days fell in 1971	Atacama Desert, northern Chile
Highest recorded wind speed: 317 km/h	Mt Washington, USA

b Using an atlas: For the record books 2

i With the aid of an atlas, locate and label each of the places named in Table R&R2.2. Using a blank outline map of Australia, annotate (label) a map with information about the climatic record associated with each place.

ii Add any other records that you come across in your reading and research.

R&R 2.2 Temperature and rainfall records, Australia

Temperature
The lowest recorded temperature in Australia is –23°C. It was recorded at Charlotte Pass, New South Wales, on 28 June 1994.
The coldest place in Australia is Crackenback (above Thredbo Village), New South Wales. It has an annual average minimum temperature of –5.1°C.
The highest recorded temperature in Australia is 50.7°C. It was recorded at Oodnadatta, South Australia, in 1960.
Wyndham, Western Australia, is Australia's hottest town. It has the highest annual average maximum temperature: 36.2°C.
Rainfall
The place with Australia's highest average rainfall is Bellenden Ker Top Station, Queensland. It has an average annual rainfall of 8629 millimetres.
The wettest town in Australia is Tully, Queensland. It has an average annual rainfall of 4321 millimetres.
Darwin is Australia's wettest capital city, with an average annual rainfall of 1536 millimetres. Sydney is second, with 1215 millimetres. Adelaide is the driest, with 531 millimetres.
The driest town in Australia is Oodnadatta, South Australia. It has an annual average rainfall of just 117 millimetres.
Hobart is the capital city with the highest average number of rainy days: 162. Sydney is second with 148 days.
Snow has fallen in Sydney on fourteen days in the last 148 years.

Activity 2

Comparing water availability

a Many countries around the world experience water scarcity and stress. In response to these stresses, a variety of strategies to manage a country's water supply have been developed. Investigate these strategies and complete the PMI chart on the next page.

	Plus	Minus	Interesting
Building new dams			
Transporting water			
Extracting groundwater			
Desalination			
Recycling water			
Harvesting stormwater			
Cloud seeding			
Increasing the price of water			
Using water-saving devices, e.g. dual-flush toilets			
Irrigation developments			
Planting crops that use less water			
Personal responses			
Other			

b Investigate the quantity and variability of water supply in Australia and two other countries. Each country must come from a different country. Your investigation needs to include the following information.
- a map of the country showing rainfall, major cities and rivers
- a map of the country showing access to safe water and sanitation
- an overview of water issues
- per capita water use

c Respond to the following question. 'Which water management strategies from Activity **a** would you suggest each country adopt to solve their water stress issues?' Present your findings as a multimedia presentation.

Activity 3

Reclaimed water

Reclaiming or recycling water consists of removing solids or other impurities from water and using the water for irrigation or putting it back into the water table. In Victoria, reclaimed water has been used on market gardens in Werribee. In Singapore, reclaimed water is added to the water supply; the reclaimed water is safe enough for human use but it is mainly used in industry.

Around the world, some cities are planning to use reclaimed water and add it to their water supply so the water can be used for human consumption.

Develop a marketing and advertising campaign to promote water recycling in your city, state or local area. The campaign can include one or more of the following formats:
- a poster
- a short multimedia presentation
- a social media plan
- a short video.

Activity 4

Desalination investigation

Desalination plants are expensive to build and operate. They are, however, seen by many as a solution to the growing demand for water at a time when rainfall is becoming less reliable due to climate change.

Your task is to investigate the advantages and disadvantages of desalination. Your investigation should consider the following:
- the process of desalination
- the reasons why desalination plants are being built
- the location of desalination plants in Australia and worldwide
- the economic, social and environmental benefits and impacts of desalination
- other relevant information.

After examining the advantages and disadvantages, write an extended response to the following statement: 'Desalination is the best response to meeting the water needs of a growing urban population.'

Activity 5

Big dam hypothetical

For decades, people have had different ideas about ways to irrigate and droughtproof Australia's arid interior. Many of these schemes have involved diverting rivers of northern Queensland to central and southern areas of the state.

Outlined on the following page is a range of views regarding the proposal to dam and divert the waters of Queensland's rivers.

- The project will be of great economic benefit to the whole country. Thousands of jobs will be created.
- The scheme will be hugely expensive and any economic benefit will be very small. The money could be better spent helping farmers to use existing water supplies more efficiently.
- The project will be a great economic boost to the area. Our towns will grow and there will be work for our young people.
- The diverted water will enable us to irrigate our crops and reduce the risk associated with Australia's unreliable rainfall.
- We don't need the dams. We need to use the land and water more sustainably. We should focus on conserving water and growing crops that can cope with the unreliable rainfall.
- The water currently just flows out to sea. Why not put it to work irrigating Australia's arid interior?
- Pumping vast amounts of additional water into the system will simply create problems with salinity, just as it did in the Murray–Darling Basin.
- The proposed dams will flood some of Queensland's most fragile forest ecosystems. Endangered species will be lost.
- The spirits of the Dreaming inhabit these sacred lands. Cultural heritage must be respected.
- More water in the lake means more tourists to see the region's spectacular birdlife.
- Dig dams have a major impact on river systems. They cut off the supply of fertile sediments to the flood plain, resulting in reduced fertility and soil depth. Reductions in the flow of sediment can increase coastal erosion. Cold water released from deep in the reservoir can affect the downstream ecology of the river.
- Big dams are not without their environmental impacts. The focus needs to be on conserving existing supplies of water and making sure that we maintain healthy river systems as close to their natural state as possible.

a Read each of the statements above and copy and complete the following table by placing each statement in the correct column.

In favour of the dam project	Neutral about the dam project	Against the dam project

b In groups of four or five students, discuss the different statements about the proposal. Reach agreement on what you think should happen. Prepare to defend your group's viewpoint when you report back to the class.

c Conduct a class debate on the following topic: 'The Australian government should adopt and fund the proposal to dam and divert the waters of Queensland's northern rivers.'
At the end of the debate, conduct a secret ballot to determine whether the class will support or reject the proposal.

Activity 6

Sustainable futures

We can use the earth's non-renewable resources for short-term gain, or we can plan for a future time when those resources are no longer available. Some countries have made provision for the future by establishing sovereign wealth funds (SWFs). An SWF fund is a government-controlled investment fund. Such funds invest some of the revenue from the use of non-renewable resources for the benefit of future generations (see Table R&R2.3). The money is invested in stocks, bonds, real estate or other financial products to provide a continuing source of income.

Norway, for example, requires companies that extract the oil reserves beneath the North Sea to pay a tax. The revenue raised will be used to fund public pensions. Australia does have an SWF, which is called the Future Fund. The Future Fund was established in 2006, and it manages the revenue received from the privatisation of Telstra and from budget surpluses. It will be used to pay the future superannuation entitlements of Commonwealth public servants.

As a class, discuss whether Australia needs an SWF to preserve the benefits of the current mining boom for future generations. List the arguments for and against the establishment of an SWF. Identify the types of things such a fund should be used to pay for in the future. Decide whether you support the establishment of such a fund. Write a letter outlining your view on the issue as if you were writing it to the Prime Minister.

R&R 2.3 Sovereign wealth funds in selected countries, 2010

Country	Assets ($ billion)	Source of funds*
Australia	93.1	Non-commodity
Canada (2 funds)	304.0	Non-commodity
China (4 funds)	1118.3	Non-commodity
Norway	556.8	Oil
Qatar	85.0	Oil
Russia	142.5	Oil
Saudi Arabia	439.1	Oil
Singapore	247.5	Non-commodity
United Arab Emirates	627.0	Oil

* Non-commodity: Funds accumulated from non-resource based sources (for example, budget surpluses and the sale of assets)

Source: Sovereign Wealth Institute

Activity 7

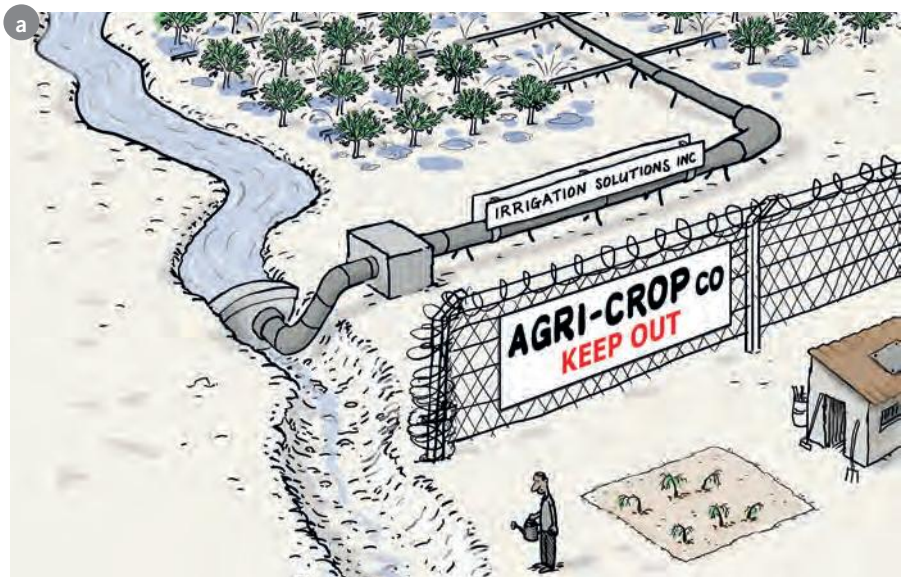
Cartoon interpretation

a Study each cartoon and identify the perspective or point of view of the cartoonist. Copy and complete the table below.

	Cartoon a	Cartoon b	Cartoon c
Location			
Images			
Themes			

b In your opinion, which cartoon has the most impact and which has the least impact. Why?

a



R&R 2.4 Three cartoons that offer different perspectives regarding contemporary geographical issues

b



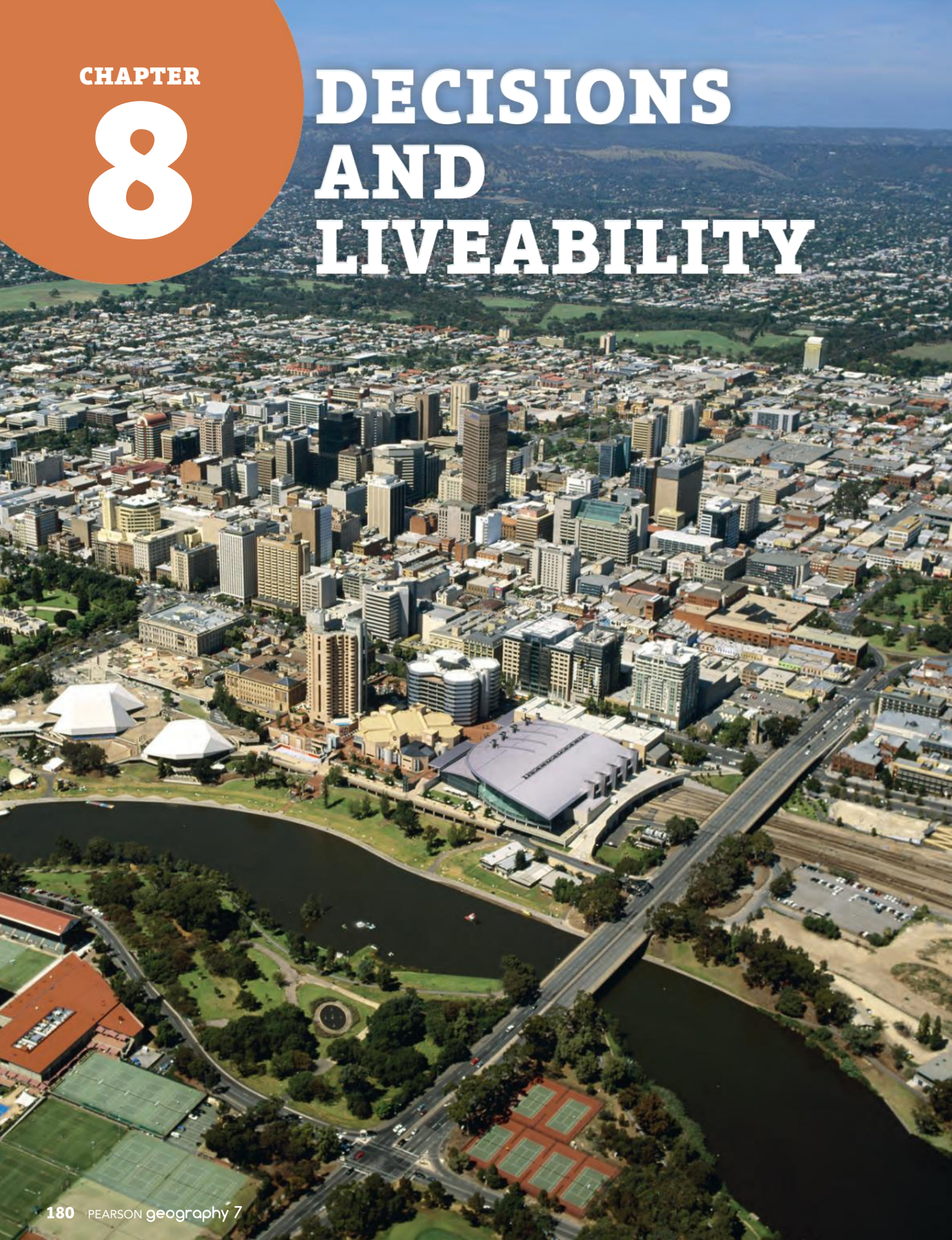
c



CHAPTER

8

DECISIONS AND LIVEABILITY



Choosing where to live is one of the most important decisions we will make during our lives. There are many factors that will influence such decisions. Our perception about the liveability of places is one factor. The term 'liveability' is used to describe the extent to which a place (town, city, or neighbourhood) is able to support a quality of life that maximises residents' wellbeing. Liveability, however, has different meanings to different people. The majority of the world's people have little choice in where they live. For people who have the means to choose where they live, liveability of places is important. People want to live in neighbourhoods that are good places in which to raise families. They want a choice of housing types, recreational activities, shops and services within walking distance, and easy access to quality schools and open space.

In this chapter, we focus on the factors affecting the decisions people make about where to live, the concept of liveability and how it is measured and perceived.

KEY IDEAS

- To understand liveability and how it can be measured
- To appreciate that perceptions of liveability may vary from person to person according to age, education, income, cultural background and other factors
- To develop an appreciation of how crime affects perceptions of liveability
- To develop a knowledge of the factors that influence people's decision about where to live.

8.0 CBD, Adelaide

GLOSSARY

accessibility	the extent to which a product, device, service, or environment is available to as many people as possible
aesthetics	the value of a landscape based on its beauty or attractiveness
antisocial	relating to behaviour that demonstrates a lack of consideration for others and may cause damage to the society, whether intentionally or through neglect
demographic	relating to the different groups of people who make up populations
good	a tangible (or touchable) thing that meets a human need
human rights	the basic rights to which all people are entitled, irrespective of their citizenship, nationality, race, ethnicity, language, gender, sexuality or ability
liveability	the qualities of a place (city, town, suburb or neighbourhood) that contribute to the quality of life experienced by those who live or visit there
perception	how something is seen or regarded by someone
quality of life	the happiness, wellbeing and satisfaction that a person experiences. Among the many factors that influence quality of life are a person's family circumstances, income and access to services
relative location	a place's location in relation to other places
sense of place	the distinctive characteristics or features of a place that make it unique
service	a non-tangible good—this is, a good that cannot be touched, held, handled, looked at, smelled or tasted
site	the features of land on which a place is located
spatial	relating to a characteristic of a location and/or an area
spatial inequality	distinct geographical divisions between poor and wealthy populations
telework	work that involves the use of telecommunications technologies as a substitute for physical travel

8.1 Deciding where to live

Some people live out their entire life in the village, suburb, town or city in which they were born. Others migrate to distant places to start a new life. Australians move home, on average, every seven years.

The decision

There are many factors that people think about before choosing where to live. Some of these are emotional; some are responses to circumstance at a particular time. Because the decision-making process is such a personal one, there is no complete list of factors. The following are some of the most common factors affecting the choices people make about where to live.

8.1 (a) Geelong, (b) Tennant Creek and (c) Sydney—examples of places to live





Attachment to place

We all develop an attachment to places that are special to us. It may be the place in which we were born and grew up. It may be a place we visited on holidays. It may be somewhere we have always wanted to live. These are powerful forces that influence the choices we make.

Distance from family and friends

Being close to family and friends is a powerful factor influencing people's decisions about where to live. Family and friends provide emotional and practical support and meet one of our most basic social needs—the need for companionship.



Employment opportunities

Earning an income to support yourself and your family is an important factor in deciding where to live.

Affordability

The greater a person's income and/or wealth, the wider their range of options for where to live. The wealthy can afford to buy or rent housing in the most desirable suburbs. The choices of people on lower incomes are limited to areas where housing is relatively cheap or rents are affordable. This accounts for the **spatial inequalities** we see in Australia's large cities.

Stage of life

The factors influencing people's decisions about where to live change throughout the life cycle. When you are young, you live where your parents decide to buy or rent a home. In your 20s, you may live in rented group housing with friends.

Lifestyle considerations

The way of life a person aspires to is an important influence. Some people opt to live in the country; others find the casualness of the coastal lifestyle more appealing; still others like the buzz of the inner city. Some people like areas that are diverse, crowded and colourful, while others seek out places that are quiet, isolated and natural.

Personal safety

Perceptions about the level of crime in an area influence people's decisions. People who can afford to live elsewhere avoid areas with high crime rates.

Environmental factors including climate

People's decisions about where to live are sometimes influenced by climate, aesthetics and environment. The increasing number of people moving to the south-eastern corner of Queensland can be linked to Queensland's climate and beaches. Others move to the hills and mountains surrounding some of our large cities for their scenic beauty, milder temperatures and lower humidity.

For many people, especially older people, access to quality health care is important. For young families, access to good schools may be important. Some people will buy a house in a particular suburb so that their children can attend a well-regarded school nearby.

Culture and ethnicity

New immigrants often settle in suburbs with an established community of people from a common cultural or ethnic background. This provides them with a support network that makes settling into their new homeland easier. As a result, parts of our cities become associated with people of particular cultural backgrounds.

Travel time and transport options

Some people choose to live close to where they work. Others are willing to travel, sometimes over long distances, to live in a place that is more affordable or appealing. Access to public transport is an important factor for people living in large, congested cities.

The choices people enjoy

For a majority of the world's population, the choice of where to live is restricted by issues such as poverty, culture, **human rights** and individual freedoms. For many people, there is little choice. Life is a daily battle for survival. In some places, conditions in rural areas have deteriorated to a point where people have been forced to migrate to large cities.

DID YOU KNOW?

Of all Australians aged 15 years and over, 27 per cent have been living in their current home for 15 years or more, 30 per cent have been there for 5–14 years, and 43 per cent have moved within the last 5 years.

ACTIVITIES

9.3

Applying and analysing

1. Draw a mind map showing the factors that influence people's decisions about where to live.
2. Write each of the factors affecting where people choose to live on a separate piece of paper. Rank these from the most important to the least important. Compare your ranking with those of others in the class. Explain your reasoning.

Investigating

3. Interview your parents or guardian. What factors did they take into account when selecting the place in which you live?

8.2 Choices people make

Everywhere there is a tendency for people, and especially the young, to leave rural communities and move to the city. Yet there are those who choose to stay in the country and are quite happy to do so. Others try city living and return to the country.

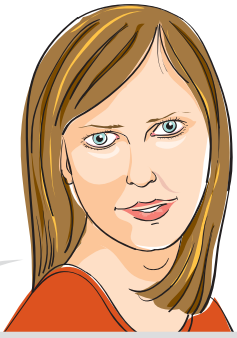
Choosing where to live

Choosing where to live is a complex process. Sometimes we live in a place, not because it is our preference, but because that is where we were born or where our parents chose to live. Sometimes we live in a place because that is where we find work. Ultimately, we look at the advantages and disadvantages associated with living in a particular place, and form an opinion that influences the choices we make. Outlined in Figure 8.2 are the opinions held by thirteen Australians.

8.2 Different views on the advantages and disadvantages of different places to live



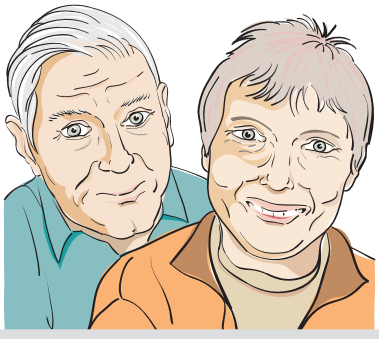
Joel: I moved to live in the city because that is where the jobs are. There are limited opportunities for school leavers in the country. Also, there was not much to do in the town where I grew up. The city has plenty of entertainment. My friends and I can meet at cafes, pubs, clubs and go to footy, concerts and the movies. We can go shopping at Westfield or the big department stores.



Sarah: I moved to the city to go to university but I don't like it much. It's too crowded and the traffic is terrible. I look forward to moving to a large regional centre in the country when I graduate as an accountant. I prefer the wide open spaces and the relaxed, friendly ways of country people. The big regional centres have many of the advantages of the city without all the hassle.



Zaheer: We have just started our family and are considering a move up the coast to a small town close to a beach. We are looking for a place where our kids can grow up free from the hectic and stressful pace of city living.



Paul and Irene: We moved to the mountains when we retired but as we get older we are finding it too difficult to get the medical care we need. We worry about being so far from a major hospital if there is a medical emergency. Our children and grandchildren live in the city and we would like to see them more often.



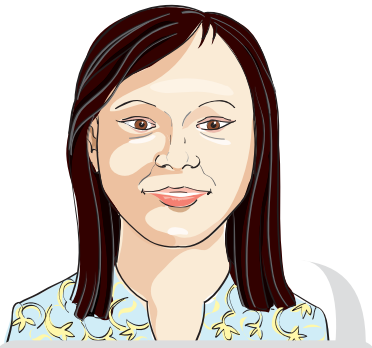
Dominic and Amelia: We have worked hard all our life and look forward to buying a hobby farm in the country. We want a quieter and more peaceful way of life. We love having trees and native animals around. We are sick of the noise and pollution of the big city.



Antonio: I love living in the inner city. I don't need a car because I have plenty of public transport options. I have never lived in the country but I imagine it would be very boring. What do people do for entertainment?



Kristen: I have lived on our family's farm all my life. We make our own fun in the country. We don't need expensive clubs to keep us entertained. We enjoy riding our horses and quad bikes. We follow the rodeo circuit and the local rugby team. City life is too impersonal. Everyone is in a rush and they don't say hello.



Yan: Everything is so close and convenient. Restaurants and shops stay open later. There are lots of things to do, lots of people to hang out with, and everything you could think of is right at your fingertips. Can you tell I'm a city girl?



Matt: One advantage of country living is that it is safer than life in the city. In most small towns the crime rate is very low and people do not need to be afraid of having their house broken into or of being attacked and robbed in the street.



Stephanie: Life in a remote township has its challenges. Housing is expensive, so is petrol and fresh food. We do, however, have a strong sense of community. Everyone knows each other and everyone is happy to pitch in and help out when needed. The salaries offered by the mines in the area are much better than we could ever hope to earn in the city.



Tommy: I live in a remote Aboriginal community. I go to school but I've lost count how many teachers I have had. They don't last long. Every month or so, we drive for five hours into Alice Springs to stock up on groceries. It's always good to get back to our Country. I am not sure what I'll do when I leave school. I would like to play footy but I'm not tall enough. Perhaps I could be a carpenter.

ACTIVITIES

9.4

Applying and analysing

1. Read each of the statements in Figure 8.2. Make a list of the advantages and disadvantages of living in cities, the country, and remote communities. Are there any other advantages or disadvantages you can think of?
2. Compile a list of the advantages and disadvantages of the neighbourhood, town or city in which you live. Do the advantages outweigh the disadvantages?
3. Write your own statement about what you like about the place in which you live.

8.3 Sense of place

Geographers often refer to a particular location as a having a 'sense of place'. This means that the place has distinctive characteristics or features that make it unique.

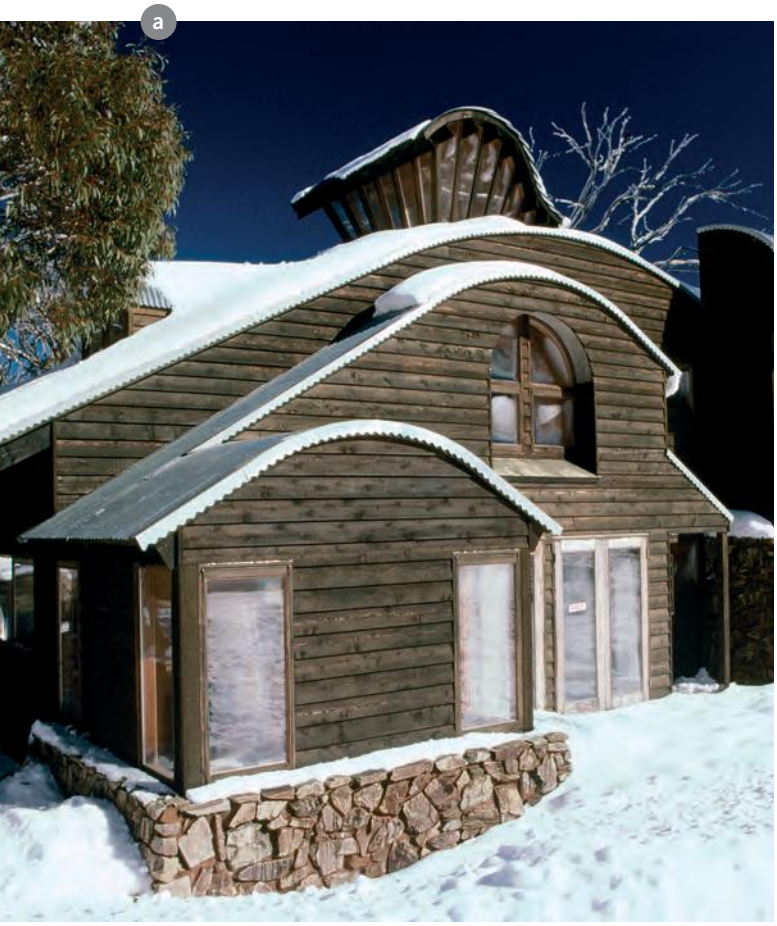
Characteristics of place

The factors that contribute to a **sense of place** include:

- **relative location**
- the **site** or the shape of the land (topography)
- the nature of the constructed environment
- the range of functions provided
- people
- climate
- people's own experience of the place.

8.3 (a) Chalet at Dinner Plain in the Victorian Alps and (b) a traditional Queenslander house

a



Relative location and site

'Relative location' is a term used to describe a place's location in relation to other places. 'Site' refers to the features of land on which a place is located. A place's relative location and site shape its character, form and function.

Relative location can have a range of meanings, and can influence a place in different ways.

- A place's latitude is one example of relative location: the constructed features of places close to the Equator are quite different from those of places closer to the poles.
- Distance from the sea is another example: inland towns are quite different from places located on the coast (see Figure 8.3).
- Distance from larger urban centres is another example: places close to larger urban centres might serve what is known as a 'dormitory' function—that is, residents return there to sleep, and commute to the larger centre each day for work.

b





8.4 Melbourne's sports precinct includes the Melbourne Cricket Ground, Melbourne Park (venue for the Australian Open Tennis Championships) and the Melbourne Rectangular Stadium, or AAMI Park.

The nature of the site on which a place develops is also an important influence on its character, form and function. The shape of the land (topography), the aspect (or direction it faces), the presence of a river (and whether it is navigable) or the nature of a coastline might all be important factors. A town could, for example, be located next to a river, wrap around the base of a mountain or spread along a coastline to take advantage of views and access to beaches.

Functions

Places can differ in the functions they perform. Some places produce food. This results in features and characteristics that will be different from a place that has a residential function. Other common examples of places with a particular function are:

- ports
- rural service centres
- resort destinations
- educational centres
- administrative centres
- commercial centres
- industrial centres.

Most places are multifunctional. While one function may dominate, others are also evident. Canberra is Australia's administrative and political capital, but it is also a commercial centre and a tourist destination, and supplies all the goods and services a city of 358 000 people needs.

The functions that a place performs contribute to its character and distinctiveness. Canberra's Parliament House, public service office complexes, museums, parklands, galleries, monuments and memorials all contribute to the city's uniqueness or sense of place.

Spatial patterns

The way that features in the landscape are arranged and connected helps to determine what a place is like. This spatial pattern will vary from one place to another. The density of features in the environment can differ: for example, the number of trees or buildings per square kilometre can vary from one place to another. Or the density of objects may be the same but they may be arranged differently—clustered or scattered. How the objects are clustered can be a further difference between places. The pattern of clustering could follow a major road or be focused on a central point such as a town square.

The Melbourne sports precinct shown in Figure 8.4 is an example of a clustered pattern. Several sports facilities are located together in an area that is well served by public transport.

Social, cultural and economic characteristics

One place can differ from another as a result of a variety of social and cultural factors. These include population density, the age and ancestry of the people, and their income. These factors are evident in the way that open spaces are used or the range of goods and services that are provided. For example, a significant number of people with a common ancestry living in one place will give a neighbourhood or suburb a particular sense of place. Think about any of the culturally distinctive neighbourhoods in a large Australian city you know.

Age

The **demographic** profile of the population can influence what a particular place is like. A place dominated by families with young children will be quite different in character from a place where older people or singles are in the majority. While most places have a mix of ages, some, such as retirement villages, may exclude people on the basis of age.

Population density

Population density refers to the number of people living within a given area, usually 1 square kilometre. Some places have a very high population density while others have a low population density. One of the most densely populated cities on earth is Tokyo, Japan, where the average population density is 6000 people per square kilometre. Even within densely populated cities such as Tokyo, there are often places that are more densely populated than others.

Ancestry

A person's ancestry is all the people they are descended from, including their ethnic or racial background. These things can have a significant influence on place. They create what are termed cultural landscapes, where the environment is a reflection of the practices, traditions and beliefs of a culture. Sometimes these cultural landscapes are so distinct or strong that they can be identified with particular ethnic groups. Most ethnic enclaves are vibrant and rich places. The 'Little India' district in Singapore, for example, is a place where the Indian, Sri Lankan and Bangladeshi cultures are shared with a wider community.

Melbourne is a city that is influenced by a great variety of ancestry. One-quarter of the city's population were born overseas. In all, 180 countries are represented and 233 languages are spoken within Melbourne.

SPOTLIGHT

Shinjuku

Shinjuku is a major centre for business within Tokyo. Its population density is a staggering 17 140 people per square kilometre. However, because of the large number of people who visit for work or shopping, the number of people in the location at one time can appear much greater. Shinjuku can get very crowded.

Shinjuku's train station is the busiest in the world. Over 3.5 million people use this train station each day (see Figure 8.5). In order to deal with the huge volumes of people, Shinjuku, like many other areas in Tokyo, has extensive underground pedestrian areas. On the street, movement for people can become quite difficult.



8.5 The crowded Shinjuku train station



8.6 Jerusalem contains many religious buildings.

Religious beliefs

Religion is expressed most notably in the architecture and the festivals of a place. Places of worship have traditionally been among the most visible buildings in a town or city. For example, Jerusalem, a holy city for Christians, Jews and Muslims, is dominated by places of worship (see Figure 8.6). The Cathedral of Notre Dame in Paris is an important element of the city's landscape, as are St Paul's Cathedral and Westminster Abbey in London.

Education, occupation and income

There is a clear link between education, occupation and income in almost all places in the world. The general view is that the higher the level of education, the better the occupation and therefore the higher the income. This also means that people will tend to live in locations that match their income.

In Australia, areas close to the centre of the city were once seen as grimy and harsh places. Increasingly, most of these inner-city areas are being occupied by people employed in highly skilled occupations, with higher incomes and higher levels of education. We call this process 'gentrification'.

Some places have a unique concentration of one group of occupations. People working in the creative arts industry, for example, often benefit from living near each other, where they can share and develop ideas. An example is the artists' colony of Montsalvat in Eltham, Victoria. Twelve buildings set amid established gardens are home to a number of artists.

ACTIVITIES

Knowledge and understanding

1. Identify the factors that contribute to a sense of place.
2. Outline how relative location and site affect the character, form and function of places.
3. Explain what is meant by the term 'multifunctional'.
4. State how places differ spatially.
5. Outline how social, cultural and economic characteristics influence sense of place.
6. Explain what an ethnic enclave is.
7. Explain how places are affected by the ancestry of their inhabitants.
8. State how religion can affect places.
9. Describe the links between education, occupation and income.

Applying and analysing

10. Study Figure 8.3. Describe how climate has influenced the architectural style of the homes shown.
11. List at least three benefits of living in places where many different ethnic groups are represented in the population.

Investigating

12. Select one of the factors that shape sense of place. Think about the neighbourhood in which you live. Investigate how has it been shaped by either relative location, site, climate, its demographic profile or its economic, cultural or social characteristics.

8.4 Liveability of places

Some cities, towns and neighbourhoods are seen as being better places to live in than others. These perceptions differ from person to person depending on what each one considers to be important. The way a person sees the world around them is influenced by factors such as their age, gender, income or wealth, ethnicity and family type.

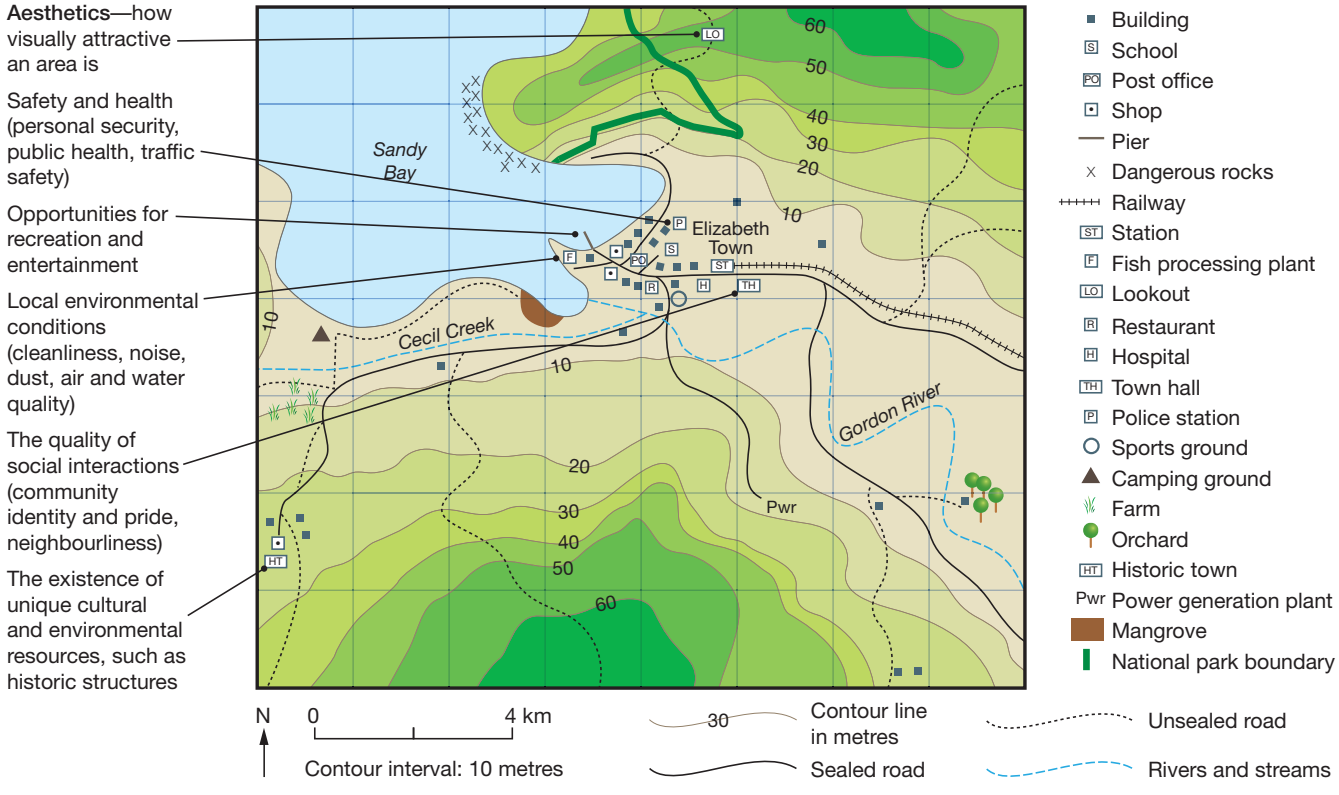
Perceptions of liveability

The **liveability** of a city, town or neighbourhood depends on the environmental and social quality of the area and how it is perceived by residents, workers, customers and visitors. The term '**quality of life**' is sometimes used as an alternative to 'liveability'. Some of the factors people take into account when they judge a place's liveability are shown in Figure 8.7.

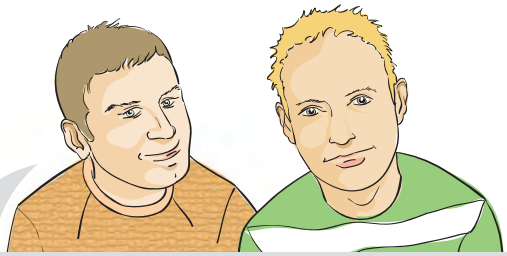
The liveability of places is largely affected by public places where people interact with others in the community. These places include streets, parks, sporting facilities, shopping centres, public transport interchanges and other public facilities. This means that the liveability of a city, town or neighbourhood is influenced by public policy and planning decisions.

The liveability of a place has a direct impact on the people who live, work or visit there. In areas considered to be 'nice' places in which to live and work (that is, as having high liveability), property values and levels of business activity are higher. In neighbourhoods that are perceived to have low levels of liveability, housing is cheaper because people are less likely to choose to live there.

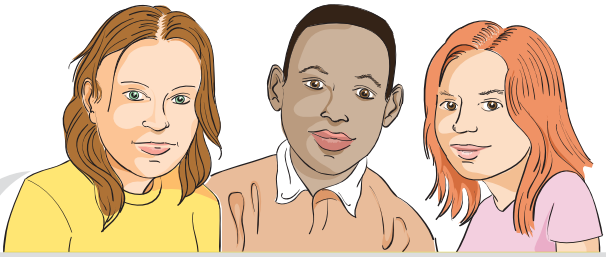
8.7 Topographic map of Elizabeth Town (population 10 000)



8.8 Different people perceive the world differently. They base their perceptions of liveability on many factors.



We moved to the inner city to be closer to work. The other big attraction was being close to the cafes, nightclubs and bars we hang out at. We can walk to work and we hardly ever use our cars.



Being able to get about easily is important. It's boring at home. We can hang out with our friends or go to movies. We can get to the beach by train in summer. Riding the train can be a bit scary late at night so our mums and dads will often pick us up after the movies. Otherwise it's OK, especially when we go out as a group.

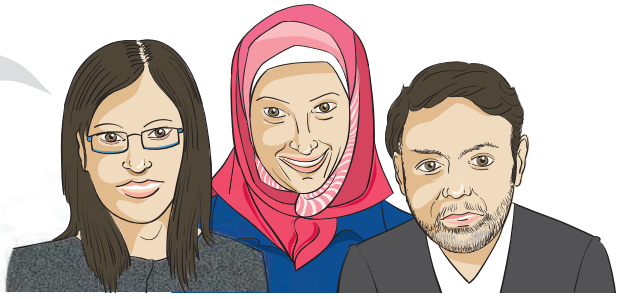


I live in the inner city, close to where I practise law. I enjoy living in the city, but I often find my thoughts wandering back to the traditional lands of my people—my Country. It's difficult to explain to non-Indigenous people.

Lifestyle factors are important. We fled the city 5 years ago. Life here in this small coastal community is much simpler. We have a lot of time to spend as a family doing the things we enjoy: swimming, surfing and tennis. There is hardly any traffic except in summer, when the city people come for holidays. We would never go back to the city!



We settled here because this is where people of our cultural background have settled for some time now. Their support has made it easier to adjust to living in Australia. There are doctors, lawyers and community workers who speak our home language, and it's good to meet with others who come from the same place we do, and share our experiences. We often help each other out.



ACTIVITIES

8.1

Knowledge and understanding

1 Define 'liveability'.

2 List the factors that help determine people's perception of the world around them.

Analysing and applying

3 Study Figure 8.7.
   - **a** List the community facilities in Elizabeth Town and the surrounding area.
   - **b** Would you describe Elizabeth Town as a liveable place? Explain.

4 Study what the people in Figure 8.8 say about the places they live in. Identify each of the different groups represented. As a class, discuss how each person's perception of liveability differs, and the reasons why these differences might exist.

5 Write two short statements outlining the liveability of the place you live in from:
   - **a** your parents' perspective
   - **b** your perspective.

   Compare your answers with those of others in the class. What factors do the answers to part **a** have in common with the answers to part **b**? What differences are there?

6 List the liveability criteria you would use to describe the ideal place in which to live.

8.5 Measuring liveability

The term 'liveability' refers to the qualities of a place (city, town, suburb or neighbourhood) that contribute to the quality of life experienced by those who live or visit there. Indicators of liveability typically include political stability, availability of goods and services such as health care and education, low personal risk and efficient infrastructure.

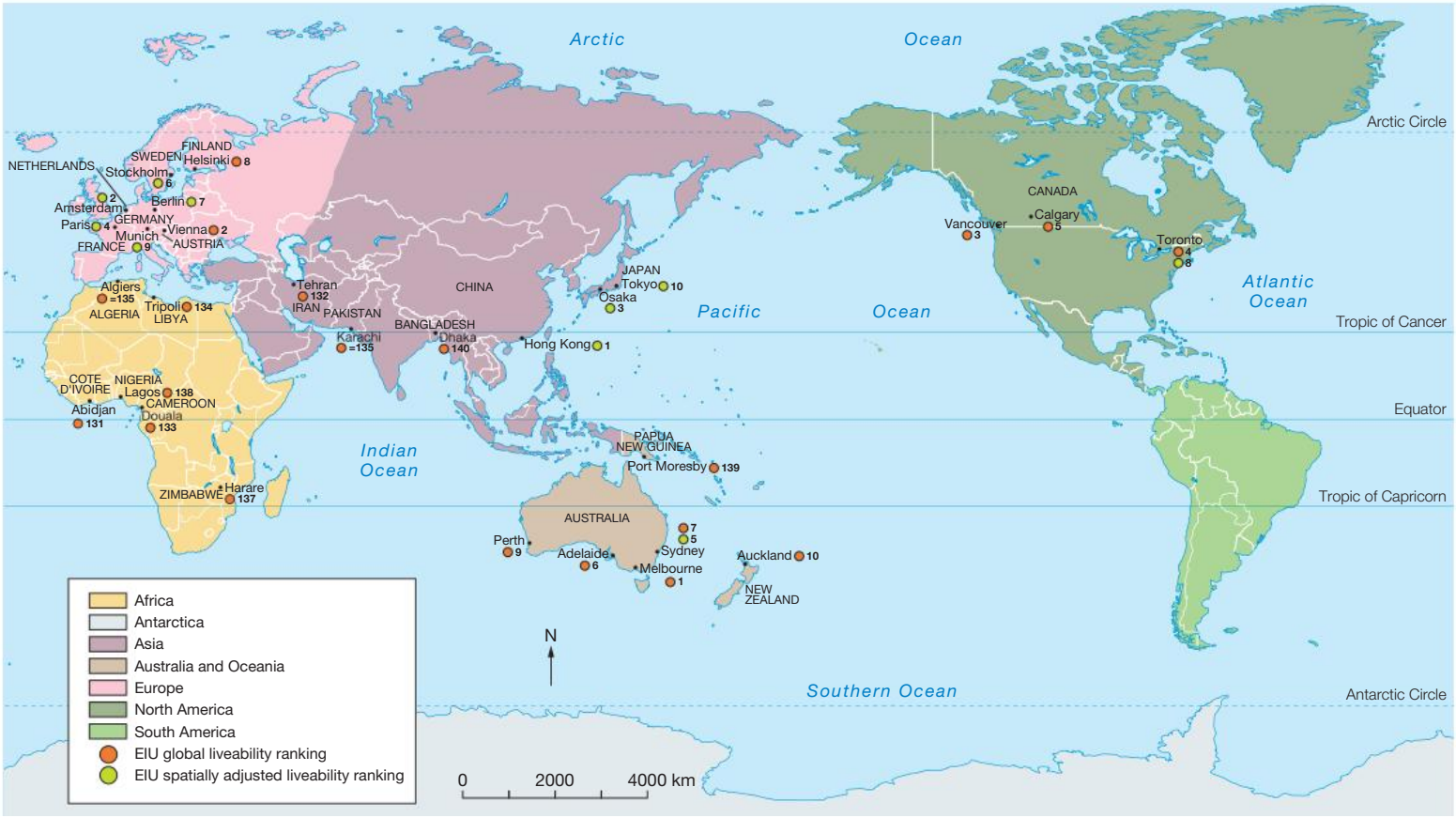
Liveability surveys

There are a number of liveability rankings published each year that compare cities around the world. The London-based Economist Intelligence Unit (EIU) publishes one of these. Each city is given a rating on thirty criteria across five broad categories:

- ***stability***—the city and country are free from war and conflict, crime rates are low and the government is stable
- ***health care***—access to hospitals and doctors is good
- ***culture and environment***—air and water pollution are low, and there are green spaces, restaurants and entertainment facilities
- ***education***—there is good access to high-quality schools and universities, and high levels of literacy for both males and females
- ***infrastructure***—roads, public transport, telecommunications and power sources are accessible and reliable, and there is access to good sanitation and a safe water supply.

The ratings are then totalled to give each city a score.

8.9 The world's ten most liveable and least liveable cities, as ranked by the Economist Intelligence Unit, 2012



The EIU's 2012 liveability report ranked cities in Australia, Austria, Canada, Finland and New Zealand as the top ten most liveable cities in the world. Cities in Africa, Papua New Guinea and South Asia were ranked among the least liveable cities. See Figure 8.9.

New criteria

In 2012, the EIU experimented with an alternative method of ranking cities, which added new **spatial** criteria:

- population density (urban sprawl)
- connectivity (proximity to other cities)
- green space
- air quality.

The new method compared only half as many cities overall, and Melbourne, Vancouver and Vienna, among others, were not considered. European cities filled five of the top ten positions, with three from Asia, one from North America and one from Australia. Hong Kong (see Figure 8.10) was ranked first, and Sydney came in fifth.

Alternative surveys

Another annual survey is the quality of living survey conducted by the New York–based firm Mercer, the world's largest human resource consulting firm. European cities dominate Mercer's ranking, with cities in Australia, New Zealand and Canada also ranked highly. Vienna, the capital of Austria, was Mercer's top-ranked city in 2011. At No. 25 in 2011, Singapore was the first Asian city ever to rank in the top twenty-five.



8.10 The EIU's new spatially adjusted liveability ranking judged Hong Kong the world's most liveable city in 2012.

The London-based lifestyle magazine *Monocle* has published an annual list of the most liveable cities since 2007. Finland's Helsinki was ranked the most liveable city in 2011, followed by Zürich (Switzerland). Melbourne was ranked fifth and Sydney seventh. The criteria used in this survey include personal safety and crime, climate, environmental issues, urban design and architecture, health care, public transport and international connectivity.

ACTIVITIES

8.2

Knowledge and understanding

1 Describe the criteria used to determine the liveability of a city, town, suburb or neighbourhood.

Applying and analysing

2 Why do you think Australian cities rank highly on all the liveability rankings?

3 Rank the seven categories used by the lifestyle magazine *Monocle* from 1 (the most important) to 7 (the least important). Justify your response.

4 Would you add any new categories to *Monocle*'s list of criteria? Why, or why not?

Geographical skills

5 Study Figure 8.9, then complete the following tasks.

- **a** List the continents in which the top ten most liveable cities are located according the EIU's 2012 global liveability ranking (GLR).
- **b** List the continents where the GLR locates the ten least liveable cities.
- **c** List the continent (other than Antarctica) that has no city in either the top ten or the bottom ten in the GLR.
- **d** Name the only Australian city in the top ten according to the spatially adjusted liveability ranking (SALR).
- **e** Describe the differences in location between the top ten cities in the global liveability ranking and those in the spatially adjusted liveability ranking.

8.6 Attachment to Country

Land means different things to people of different backgrounds. Non-indigenous people tend to regard land as a resource, as something to be bought, sold and owned, or simply as 'home'. For indigenous people worldwide, the relationship is much deeper. They see land as having spiritual, physical, social and cultural value.

Aboriginal and Torres Strait Islander people

Australia's Indigenous people, the Aboriginal and Torres Strait Islander people, consider that the land owns the people and that every aspect of their lives is connected to the land. They have a strong spiritual connection to the land. In Aboriginal society, in particular, law and life originate in, and are governed by, the land.

The connection to land contributes significantly to Indigenous people's identity and sense of belonging. In non-Indigenous society, a person's home is the structure in which they live, but for Aboriginal and Torres Strait Islander people 'home' means their traditional lands—the lands on which their ancestors hunted and gathered food, and held ceremonies and gatherings. Many Indigenous Australians are drawn back to their traditional lands, which they refer to as their Country. Returning to Country, even just to visit, brings a sense of wellbeing that non-Indigenous Australians find difficult to understand.

SPOTLIGHT

Torres Strait Islander people, the sea and the four winds

The Torres Strait lies between Cape York Peninsula, in Far North Queensland, and Papua New Guinea. The waters of the Strait are dotted with reefs and sandbanks as well as the islands that are home to the Torres Strait Islander people. The sea is central to Torres Strait Islander culture. The people of the region travel by sea and rely on the sea for fish and other resources. They are skilled navigators, and they have a detailed knowledge of the sea and the wind as well as the land. Knowledge of the winds is especially important because the wind affects both the conditions for growing food on land and the conditions at sea. The Islanders have names for the four major winds (Naygay Gub, Sager Gub, Zey Gub and Kuki Gub), and each of these names is associated with one of the major clans of the region. People inherit a wind name from their father.



8.11 Many Torres Strait Islanders are skilled navigators.



8.12 The land and the sea are central to Aboriginal and Torres Strait Islander art forms such as dance.

Stewardship of Country

The health of the land is central to Indigenous culture. Traditionally, Aboriginal and Torres Strait Islander people saw themselves as being part of the land, not separate from it. As a consequence of this, many still feel strongly that they have a responsibility to care for their traditional lands, or Country.

Plants, animals and ecosystems are at the core of Aboriginal and Torres Strait Islander people's attachment to the land and the sea. Plants and animals are valued as part of Country. The continued use of wild foods ('bush tucker') and traditional medicines allows Indigenous Australians to pass on their cultural knowledge, and to use and maintain places of cultural value.

Care of cultural sites

This spiritual and cultural connection to the land also obliges Aboriginal and Torres Strait Islander people to look after cultural sites, including Dreaming sites, archaeological sites, waterholes and burial grounds.

The land and the sea are also central to Indigenous art, such as theatre, dance, music and painting (see Figure 8.12).

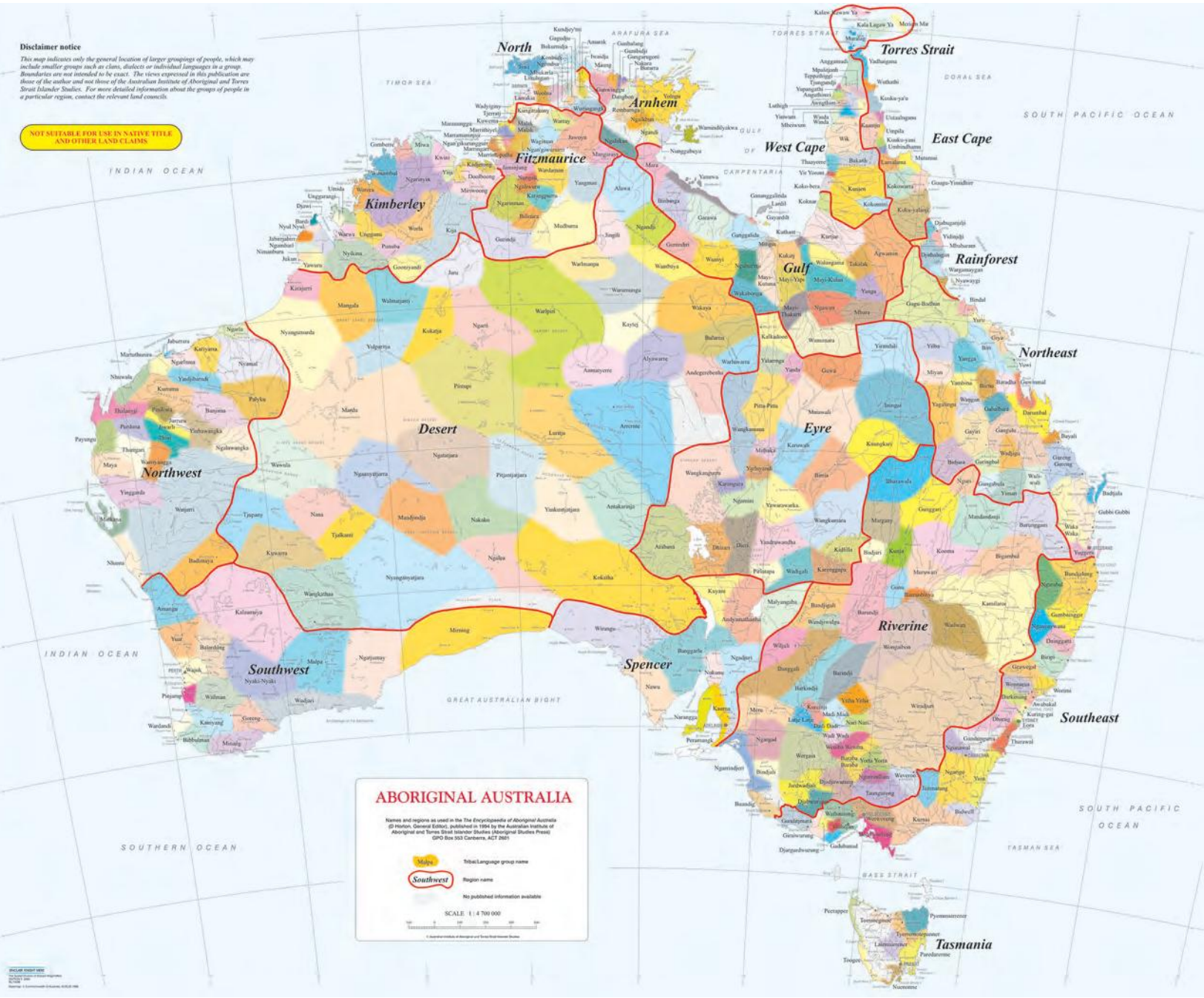
The Dreaming and Country

Central to Aboriginal culture, along with the connection to Country, is the idea of the Ancestral Spirits or Beings that created the land and forever remain within it. The time when Ancestral Spirits or Beings were creating the landscape and, with it, human groups and their societies, is known as the Dreaming. The cultural values of the Dreaming were embedded in the traditional lands of each group, which they recognised as their Country. Different cultural and language groups have their own words for this concept. The Anangu of the Central Desert, for example, know it as Tjukurpa or Wapar, depending on the particular language group they belong to.

Cultural diversity

Ever since its first occupation by the very first Aboriginal people, Australia has always been rich in cultural diversity. Each language group had its own name and Country, and developed its own special culture, including customs, beliefs, totems and relationships with the group's land. Yet Australians of European descent have not always acknowledged this fact, or even been aware of it. When Europeans first arrived, they applied the name 'Aborigines', a term that refers to the original inhabitants of any country, to all Indigenous Australians. There was little or no recognition of the hundreds of different language and kin groups that had existed for tens of thousands of years across the continent (see Figure 8.13).

Increasingly, Aboriginal people today tend to call themselves by the name of the language or territory group to which they belong, such as Pitjantjatjara, Wiradjuri or Kamilaroi. Torres Strait Islander people use the name of their own island community, such as Yam or Boigu.



8.13 The map of Indigenous languages illustrates the cultural diversity of Australia before the arrival of the British First Fleet in 1788.

Acknowledgement of Country

An 'acknowledgement of Country' is a way in which all people can show respect for Aboriginal and Torres Strait Islander heritage and the ongoing relationship of traditional owners with the land.

Acknowledgement can take many forms. Most commonly, it involves spoken or written recognition of the traditional owners of the land on which people are gathered. Alternatively, more specific recognition can be given to the language group on whose land an event takes place. An Indigenous person of the language group on whose land the event is being held may perform a 'welcome to Country'.

Aboriginal rock art

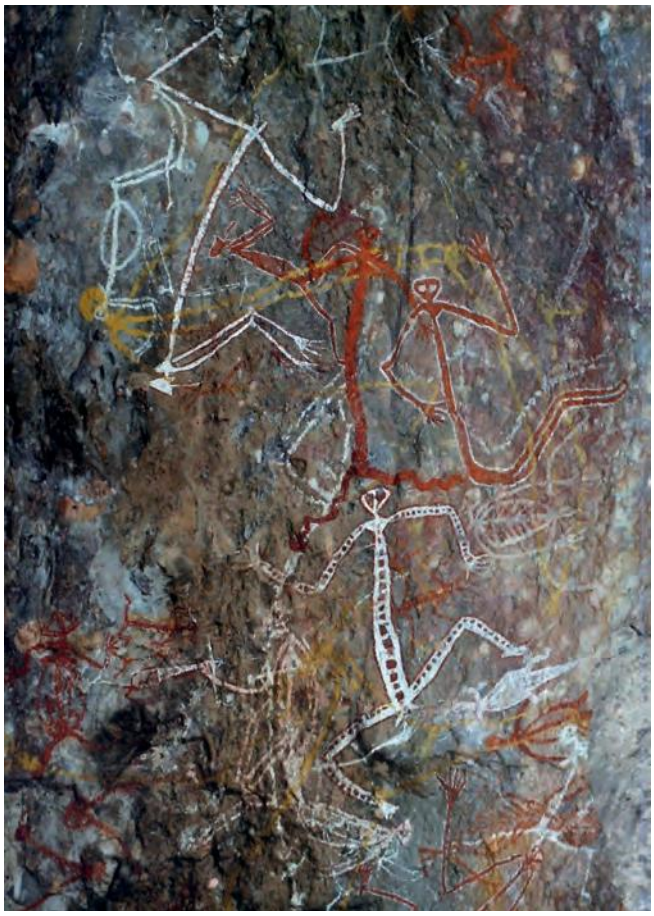
Aboriginal rock art is found all around Australia. It forms a rich record of the long history of Aboriginal life and culture. Rock engravings near Olary, in South Australia, are more than 35 000 years old. Some paintings found in north-western Arnhem Land, in the Northern Territory, show Macassan traders from Sulawesi and their boats. The Macassans are believed to have been the first people from outside Australia to have made contact with Aboriginal people.

Rock art of Kakadu

For more than 50 000 years, or more than 2000 generations, the Bininj/Mungguy People have been the custodians of an area that today forms part of Kakadu National Park. Kakadu contains 5000 identified rock art sites, and there are thought to be many more sites that have not been catalogued. Some of the paintings are believed to be more than 20 000 years old.

The subjects depicted in Kakadu's rock art include the day-to-day activities of the Bininj/Mungguy People, and the animals they hunted. Animals were a common subject, as it was thought that painting them would ensure that they remained plentiful, and that it would bring success in hunting. Many paintings show ceremonies; some of these paintings are considered sacred and may only be viewed by Aboriginal elders.

The paintings at Ubirr and Nourlangie Rock (see Figure 8.14) are some of the most famous in Kakadu. Among them are excellent examples of X-ray art, which depicts the internal organs of people and animals as if viewed using X-rays. The thylacine, or Tasmanian tiger, appears in a painting at Ubirr, though it has been extinct on the Australian mainland for at least 2000 years.



8.14 Rock painting at Nourlangie Rock, in Kakadu National Park

ACTIVITIES

Knowledge and understanding

1. Explain in your own words the relationship between Aboriginal and Torres Strait Islander people and land.
2. Describe how Europeans viewed Aboriginal and Torres Strait Islander people when they settled in Australia.
3. Explain the importance of 'acknowledgement of Country'.

Geographical skills

4. Study Figure 8.13.
   - **a** List the names of the regions in which each language group is placed.
   - **b** Tribal/language groups are larger in the Desert region than in the Southeast region. Explain why this might be the case.
   - **c** List other regions in which tribal/language groups are smaller than in the Desert region.

8.7 Perceptions of liveability

Different people use different criteria when making judgements about the liveability of places. The factors that influence people's perceptions include their age, income, household type, gender, cultural background and education.

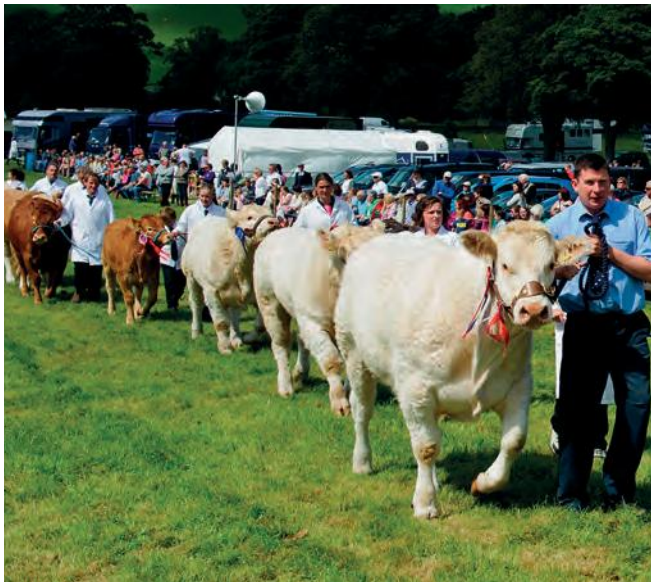
Different priorities, different choices

Age

A person's age is one of the most important factors affecting their **perceptions** of liveability. Adults, for example, are most likely to focus on factors such as good transport links and access to work and shops. Teenagers might be more likely to value entertainment and sporting facilities, and access to shopping malls. While some factors appeal to all age groups, others are perceived as more or less important depending on people's individual needs.

Household type

Household type is also important. People without children may have different liveability preferences from people with children. Access to child care, playgrounds, good schools and detached houses with gardens are often important considerations for parents. People without children might prefer inner-city living with access to work, restaurants and entertainment venues.



8.15 The annual agricultural show is a major community event across rural Australia.



8.16 Christmas markets are an important community event in many European cities.

Income and education

Income is another important consideration. The higher someone's income, the greater the range of choices they have of where to live. People often choose to live in the most liveable suburb or neighbourhood where they can afford to buy or rent a property. People with the lowest incomes are often forced to live in those parts of the city perceived to be the least liveable.

Cultural background

People's cultural background can also influence their perceptions of liveability. Immigrants, for example, often see ethnic-based community support networks as an important consideration. It is not unusual to find people with a common ethnic background living in a particular neighbourhood.

Liveability ratings

Some general categories that can be used to assess liveability are:

- perception of public safety
- housing affordability
- friendliness and consideration
- community cohesion (the degree to which residents cooperate and interact)
- attractive and well-maintained public spaces
- walkability and its impact on how people interact and experience their neighbourhood
- accessibility and transport choices that reduce commuting times and allow people to access goods and services and recreation facilities
- quality of independent mobility (for example, special buses) for children, the elderly and people with special needs
- recreational facilities such as sportsgrounds, restaurants, cinemas
- utilities (electricity, water, sewerage systems)
- educational facilities
- health services and facilities
- environmental factors such as climate, open space, air and water quality
- telecommunications infrastructure, especially broadband and mobile phone coverage.

City versus country

Many people have a strong preference for living in either the city or the country. Those who live in the city might say they prefer living there because of:

- the greater range of jobs available
- access to a wide range shops and service providers
- greater choice of schools
- more entertainment choices
- the excitement of a faster pace of life
- access to a wide range of medical facilities.

People who live in the country might say they prefer living there because of:

- the space around them and the lack of crowds
- cleaner air and less pollution
- safer and friendlier neighbourhoods
- cheaper housing
- more opportunities for outdoor activities.

Some of the preferences listed above are being influenced by the spread of technologies such as the National Broadband Network (NBN). The use of the internet for work, educational, medical and social needs is changing the reasons why some people need to live, or want to live, in a particular place. It is, for example, making **telework** possible. Telework involves the use of telecommunications technologies as a substitute for physical travel. Thanks to telework, people who are self-employed may be able to work from a home office. This can help improve liveability by reducing traffic congestion.

ACTIVITIES

Knowledge and understanding

1 Outline the factors that affect people's perceptions of liveability.

2 Contrast the different perceptions of liveability for the following groups.
   - **a** older people and teenagers
   - **b** people with children and people without children

3 Describe how a person's income can influence the liveability choices they make.

Applying and analysing

4 Study the lists of factors focusing on the differences in liveability between the city and country. Some of these contrasts in preference are based on facts and others are based on opinions. Copy the table below and place each factor in the correct column.

Fact	Opinion

8.8 Environmental quality and liveability

People consider environmental factors when deciding about the liveability of places. The type of environment is one of the factors people think about when choosing where to live. For some people the biophysical environment is important, while for others it is services and infrastructure.

The positive and negative

A good way of thinking about the ways in which environmental factors affect liveability is to classify them as either push or pull factors. Places in which the pull factors outweigh the push factors are normally regarded a being the more liveable. As a result, people compete to buy homes in these areas and houses become more expensive.

Areas in which the push factors dominate are often seen as being less desirable places in which to live. Housing therefore tends to be more affordable (relatively low-cost). High-income, wealthy individuals and families are able to afford to live in the most environmentally favourable places. For example, waterfront suburbs or residential areas with spectacular views are often popular and thus more expensive places in which live.

Pull factors

Lifestyle

Some people rank lifestyle-related factors above all others when they make judgements about the liveability of places. Some are attracted by the lifestyle attractions of the coast while others prefer the mountains or bush. Some people prefer a rural lifestyle. Common to all these places is the attraction of the biophysical environment and the often quieter, slower-paced lifestyle that these places offer.

Aesthetics

For some, an aesthetic appreciation of the biophysical and constructed environments is a major factor in rating the liveability of places. Many people feel that their quality of life is made better by what they see and how they interact within a place. In many instances, aesthetic considerations are closely related to people's lifestyle considerations. Winter sports enthusiasts, for example, may find the beauty of mountain landscapes inspiring and a key to their emotional wellbeing.

Urban design

Good-quality urban design contributes to the liveability of cities. A well-designed city, town or suburb will attract people to visit, live and work. Good urban design can have a positive influence on physical and mental health by providing opportunities for better lifestyles and community interaction. Darwin's Wave Lagoon, shown in Figure 8.17, is an example of a community facility that attracts people to an area.

Special places

People often have places that are special to them. Indigenous Australians, for example, have a strong spiritual attachment to the place in which they were born—their Country. Others have places they associate with enjoyable time in their past, perhaps a place where they spent holidays when they were young.

Climate

While many people have a preferred climate that influences their perceptions of the liveability of places, most will seek to avoid climate extremes—places that are either very hot or very cold; or very dry or very wet. Places with warm summers and mild winters are popular with many people, but especially retirees. The shift of people to Queensland's Gold and Sunshine Coasts from the southern states can be explained, at least in part, by the attractions of the region—warm climate, beaches and a relaxed lifestyle.

Recreational spaces

Many people rate a place's recreational spaces highly in terms of liveability. These are places where people can engage in sporting and leisure activities. The range and quality of these places are important and are closely related to people's preferred lifestyle choices.



8.17 Darwin's Wave Lagoon is a safe, stinger- and crocodile-free wave and swimming lagoon

Heritage

Protecting the unique heritage values of an area is important for some people's perceptions of a place's liveability. For example, in some suburbs planning laws ensure that the architectural heritage of the constructed environment is maintained. In others, whole streetscapes, street plantings and long established parks and gardens are protected to retain an area's 'leafy' and historical character.

Push factors

Pollution

Air and water pollution affect not only people's health, but also their perceptions of a place's aesthetics and amenity. Air pollution is associated with large cities and industrial complexes. While the quality of air in Western cities has improved as a result of the shift away from heavy industry and manufacturing, and advances in fuel and engine technologies, air pollution remains a major environmental issue in the cities of the developing world.

Congestion

Traffic congestion, often a result of under-investment in public transport, robs people of time with their families, or participation in sport and leisure activities. It also has an economic cost because it adds to the expense of doing business. Traffic congestion has a negative impact on people's perceptions of the liveability of places.

Climatic extremes

People will normally avoid living in places where there are extremes of climate. Many people find hot and humid climates unpleasant places in which to live and work, while very cold climates affect people's ability to engage in a range of day-to-day activities, especially in winter.

Vulnerability to natural disasters

People are aware of the risks associated with living in particular places. They will, whenever possible, avoid living in places that are vulnerable to natural disasters. If they do choose to live in such places they will seek to reduce the risk. They can, for example, live in homes designed to resist the forces of nature.

Water shortages

A shortage of water places limits on the number of people a place can support. It also affects lifestyle-related activities of people such as gardening and water-based recreational activities. Water shortages can also affect affordability.

ACTIVITIES

Knowledge and understanding

1 Discuss the difference between push and pull factors.

Applying and analysing

2 Rank push and pull factors from the most to the least important. Explain why you ranked the factors in this order.

3 Identify any additional environmental factors that affect people's perceptions of the liveability of places.

8.9 Access to services and facilities

The ability to access the goods and services needed to support an acceptable standard of living is an important factor in determining the livability of places. It is also an important consideration in where people choose to live.

Goods and services

A **good** is a tangible (or touchable) thing that meets a human need. A **service** is a non-tangible good—this is, it cannot be touched, held, handled, looked at, smelled or tasted. The term **'accessibility'** refers to the extent to which a product, device, service, or environment is available to as many people as possible. Accessible goods and services include:

- childcare facilities and schools
- cultural and entertainment venues
- healthcare services
- public transport
- aged care facilities and residential care services
- recreational and sporting facilities
- service stations and motor mechanics
- clubs, restaurants and cafes
- banks and other financial institutions
- high-speed broadband
- legal advice
- shopping malls and other retail outlets
- road systems
- places of worship
- sporting and leisure venues
- police, ambulance and fire services.

Changing needs

People's needs change throughout their lives. An important marker of liveability is how well cities support the wellbeing of people at different life stages. There are some goods and services that all people need access to, such as shops. There are others that relate to a person's stage of life or circumstances. For young families, childcare, schools and healthcare services are important. For retirees, healthcare services, aged care and other support services are an important consideration. For young people, access to public transport, shopping malls and entertainment venues might be important. For those with a disability, accessible public transport and buildings, and the support services they need, are important. For those in the workforce, access to public transport or an uncongested road network is important.

Older Australians

An increasing proportion and number of older people will require different housing, better access to health and transport services, more accessible public transport and pedestrian areas that are easier for people with poor mobility or disabilities to manage. In Australia, the proportion of the population that reported a disability in Australia in 2009 was 18.5 per cent, or just more than four million people.

Locational disadvantage

Locational disadvantage results when households find it difficult to access the goods and services that enable them to improve their wellbeing over time. Those living in the poor neighbourhoods of large cities are most at risk of experiencing locational disadvantage. Most of these neighbourhoods are found on outer edges of cities, where housing is more affordable. These suburbs are the most likely to be isolated from many of the services on which people depend, such as healthcare, child-support agencies, counselling, public transport and legal aid.

The concentration of the economically and socially disadvantaged in such neighbourhoods often results in these areas becoming associated with high rates of crime, drug dependency, domestic violence, urban decay and vandalism. In some neighbourhoods the problem becomes so bad they become known as 'no-go' areas.



8.18 Those living in the poor neighbourhoods of large cities are most at risk of experiencing locational disadvantage.

ACTIVITIES

Knowledge and understanding

1 Explain why accessibility to goods and services is an important element of liveability. How does the concept vary from person to person depending on their age or life circumstances?

2 Explain what is meant by the term 'locational disadvantage'.

Applying and analysing

3 Working in groups, brainstorm a list of the goods and services you have consumed in the last two weeks.

a Create a mind map of the goods and services you have used.

b How well serviced is the place in which you live in terms of the goods and services you listed? For how many did you have to leave the place in which you live?

Investigating

4 Interview an aged person or a person with a disability. Ask them to outline the types of goods and services they use regularly and whether they are available in the place in which they live. Also ask them to assess the accessibility of the goods and services.

8.10 Crime and liveability

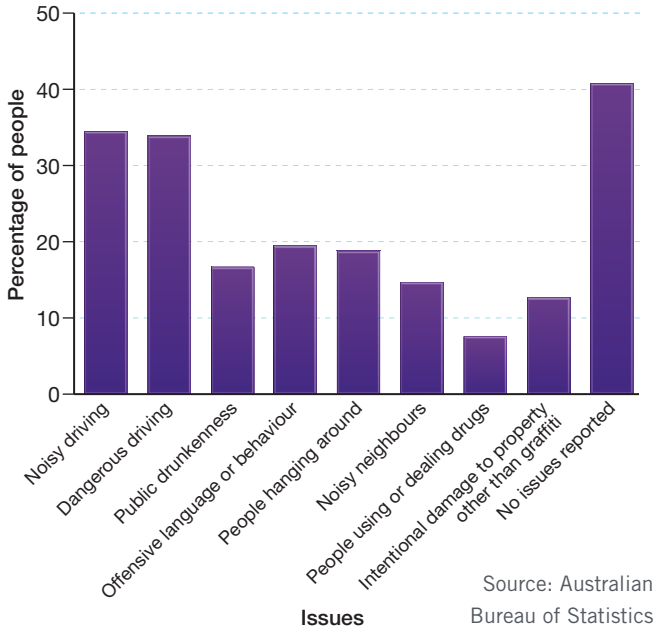
It is widely acknowledged that the liveability of a community is closely linked to perceptions of the crime rate in that area. An important element of social wellbeing is people's sense of personal safety and security.

Fear of crime

The liveability of a neighbourhood can be influenced by people's perception that it is not a safe place. The fear a person feels that they might become a victim of crime can affect their lifestyle and their day-to-day living. Walking to school, waiting at a bus stop, travelling on a train or meeting friends at a shopping mall may be perceived as being dangerous. Concerns about crime can stop people from becoming fully involved in their community and interacting with others.

The percentages of people who perceive certain social issues to be a problem in their neighbourhood are shown in Figure 8.19. Note that some of the people surveyed reported more than one issue to be a problem, so the percentages displayed on the graph add up to more than 100.

8.19 Issues that people consider to be a problem in their local neighbourhood



Source: Australian Bureau of Statistics

Young people and crime

Young people tend to gather in groups in public places. These places can be shopping centres and malls as well as parks, game arcades and railway stations. Gathering in public spaces can make young people more vulnerable to crime.

Gathering in public places can also bring young people to the attention of police. In 2009–10, people aged 15 to 19 years were arrested or cautioned for an alleged offence at a rate nearly four times greater than the rate for all other age groups. In part, this is because young people are more likely than adults to commit offences in groups, and in public places.

A small proportion of young people become caught up in illegal activities and fall into a pattern of repeated offending. Many young offenders, however, 'grow out of' crime as they mature, and the majority of young people never have any formal contact with the criminal justice system in the first place.

Police programs

In Australia, the police in the states and territories run programs to improve relations between police and young people. Another aim of these programs is to connect young people with their community and stop them entering the justice system. In New South Wales and the Australian Capital Territory, police and youth clubs give young people a place where they can be involved in physical activities. In Western Australia, a community partnership between the police, local councils and arts groups, called Reel Connections, brings together young people from different cultural and language backgrounds. It has several aims:

- to build intercultural understanding through community arts practice
- to enhance social cohesion and reduce antisocial behaviour



8.20 Victorian Police youth leadership program

- to promote awareness of legal rights and responsibilities
- to prevent young people from entering the justice system.

In Victoria, the police organise a youth leadership program (see Figure 8.20). The aim of this program is to equip young people with the skills they need to make a positive difference in their communities.

Media reporting of crime

Incidents of crime, and especially those of youth violence, receive strong coverage in the mass media. Radio 'shock jocks' also play on people's fears, and in some cases—as in the riots in Cronulla, New South Wales, in 2005—may incite violence.

Sensationalisation of youth violence in the media has contributed to a widespread public perception that gangs are on the rise and pose a real danger to the community. This is not necessarily an accurate perception. Young people in groups are often depicted in the media as threatening and **antisocial**, but this is not always the case. Such groups are generally law-abiding and, in general, Australian cities are among the safest in the world.

Improving safety

In communities that do have high rates of crime, there are measures that can be taken to improve safety. As many such communities are found in places where socio-economic disadvantage is common, tackling the causes of poverty is a good place to start.

Adequate support for individuals and groups, with appropriate educational and vocational skills programs, can increase young people's skills and improve their chances of finding employment.

Tensions between different groups of people, within schools and in public places, also need to be tackled. Cross-cultural issues need to be addressed so that there is less tension and discrimination, and greater acceptance and empathy between different ethnic groups.

Personal safety

Anyone can take certain precautions to improve their personal safety when away from home. Some precautions that may be particularly relevant to young people are:

- determining the safest routes to destinations, and using those routes that are better lit (if at night) and have more people around
- avoiding shortcuts through dark or less populated areas
- informing your parents or guardians of your movements
- knowing when the bus or train leaves, and thus avoiding waiting around
- when on public transport, sitting near the driver (on a bus) or with most of the passengers (on a train)
- in a situation where you are becoming anxious, seeking help without hesitation.

ACTIVITIES

8.3 8.4

Knowledge and understanding

1 Identify what the social wellbeing of a community depends on.
2 Describe how perceptions of crime can limit the lifestyle of a person who feels at risk.
3 Describe the measures that can be taken to improve personal safety.

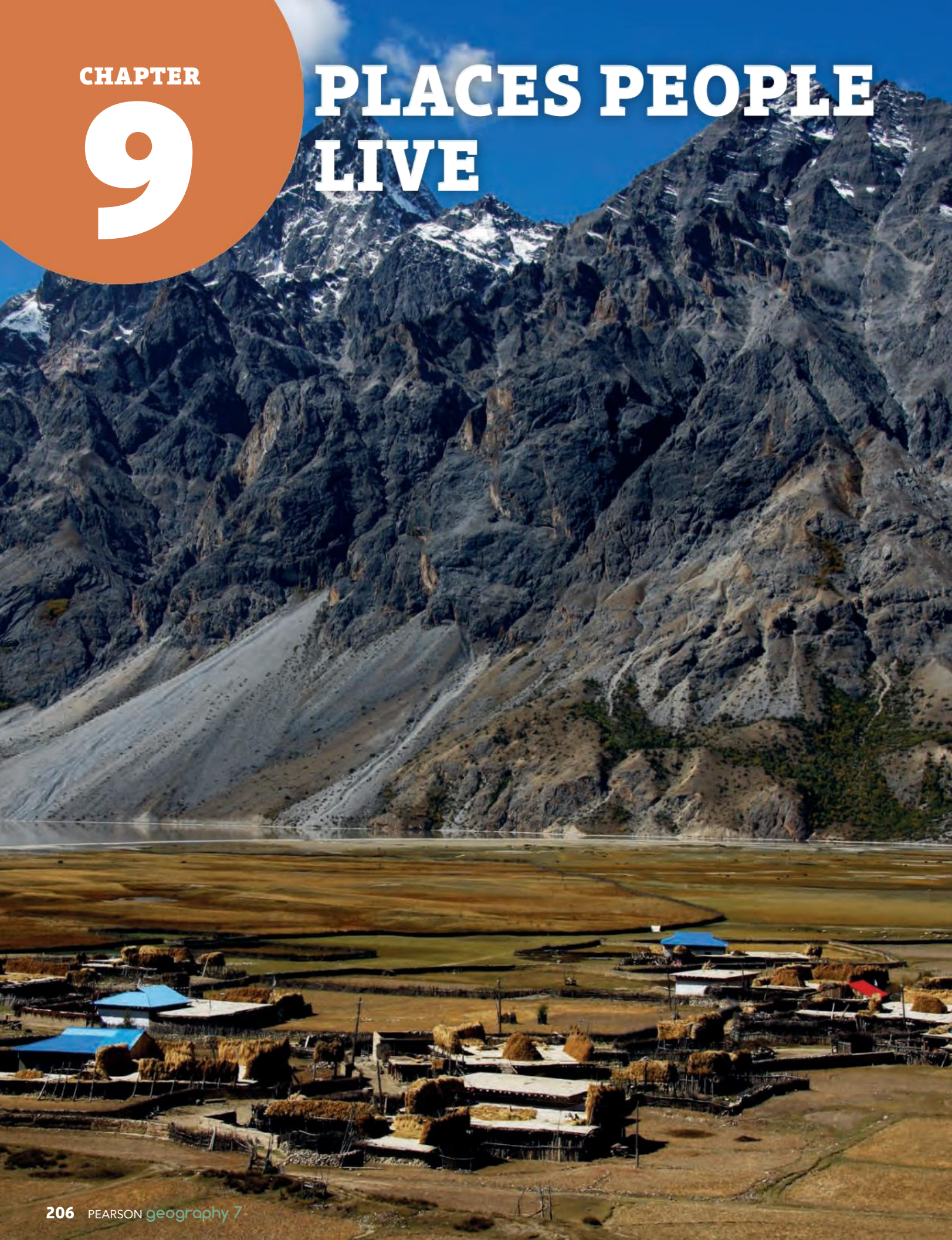
Geographical skills

4 Study Figure 8.19, then complete the following tasks.
   a List the issues in order of their perceived importance, from greatest to least.
   b Would you list these issues in the same order? Explain.

CHAPTER

9

PLACES PEOPLE LIVE



Place is one of the key concepts in Geography. The term 'place' is used to describe a part of the earth's surface that has been named and given meaning by people. The places we are most familiar with are often those in which we live. In Geography, we often say that a town, suburb or neighbourhood has a 'sense of place'—distinctive characteristics or features that make it unique. In a sense, every place has its own identity.

In this chapter we focus on settlements: the factors that affect their location and make them distinctive; the process of urbanisation; urban housing densities; the relationship between urban densities and modes of transport; the advantages and disadvantages of high urban densities; and policies designed to slow the rate of urban sprawl.

KEY IDEAS

- To recognise that the places in which people live vary in relative location, size and function
- To be aware that urbanisation is transforming the distribution of the world's population
- To appreciate that housing densities influence what places are like to live in and the modes of transport people use
- To recognise that policies promoting urban consolidation seek to slow urban sprawl by increasing urban housing densities
- To understand that high urban densities have both advantages and disadvantages

GLOSSARY

compromise	the settlement of a dispute by agreement on some middle position
confederation	a country made up of states that have united to achieve shared goals
ecological footprint	the area of land required to produce the resources an individual or a population uses, and to absorb its waste
infrastructure	physical structures that allow a society to function, such as buildings, roads, water pipelines, sewers, electricity distribution systems, railways and airports
master-planned housing estate	a settlement that is carefully planned and, typically, is constructed in a previously undeveloped area
multifunctional	having multiple functions
replacement rate	the birth rate at which a population maintains its current size without growing
rural settlement	a small community, such as a hamlet or village
suburbanisation	the process by which people and businesses move out from the central areas of cities and into the suburbs
tree change	a lifestyle-related change that involves moving from an urban settlement to a rural or semi-rural community
urban consolidation	a set of planning policies designed to increase population densities in existing built-up areas
urban settlement	a relatively large centre of population dominated by houses, apartment buildings, factories, shopping centres and transport infrastructure
urban sprawl	the outward spread of a city and its suburbs as they grow
urbanisation	the process by which an increasing proportion of a population lives in towns and cities

9.0 Hamlet beside Ranwu Lake, Tibet

9.1 Classifying settlements

A settlement is a place where people live, work and obtain goods and services. Settlements range in size from individual farmhouses and small rural hamlets to large cities with their surrounding suburbs. Settlements can be classified by type, by size, by function or by the pattern created by the distribution of their buildings.

Rural or urban

Rural settlements are centres of agriculture and provide a small range of goods and services. A clustered rural settlement is a place where a number of families live close to each other, and fields surround the houses and buildings. A dispersed rural settlement is characterised by farmers living on individual farms some distance from each other, as shown in Figure 9.1.



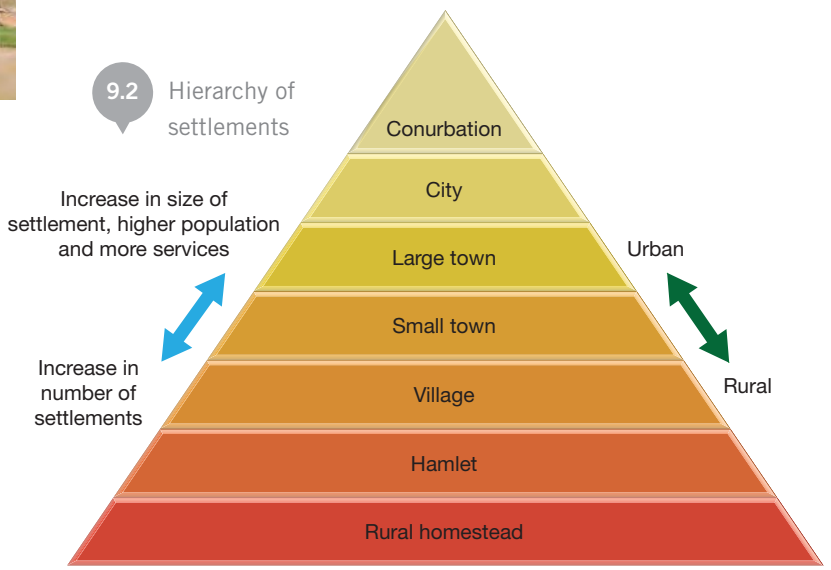
9.1 An Australian rural homestead

Urban settlements are large centres of population dominated by built features such as houses, apartment buildings, factories, shopping centres and transport **infrastructure**. Urban settlements also have a wide range of consumer and business services and are major centres of employment. In Australia, urban settlements are defined as population clusters of 1000 or more people, with a density of at least 200 people per square kilometre.

Classification by size

Figure 9.2 shows a way of classifying settlements of different sizes. Categories are:

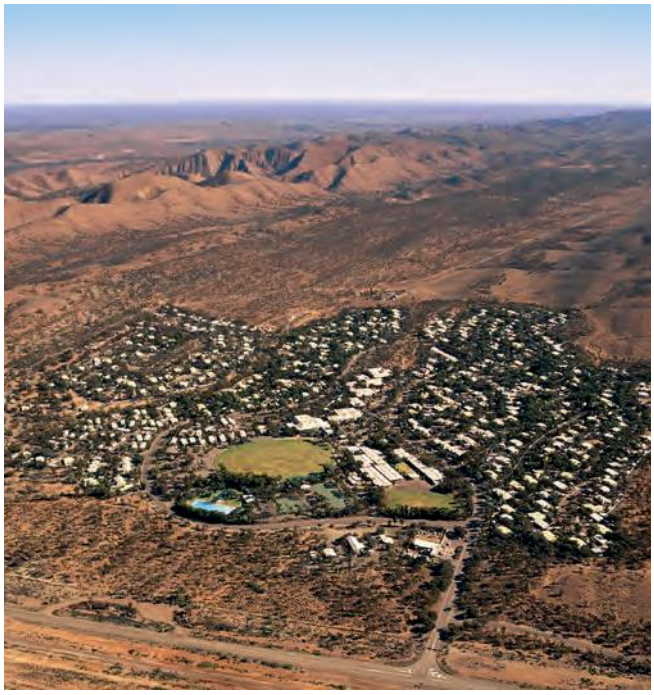
- ***rural homestead***—an isolated settlement consisting of one house
- ***hamlet***—a settlement with only a few houses and few, if any, services (suppliers of goods and services)
- ***village***—a settlement with a few services such as a church, a hotel and a small shop
- ***town***—a larger settlement with several shops, banks, places of worship, a high school, supermarkets, doctors, dentists and a small hospital. In Australia, a town is a settlement with a population of more than 250 people. Figure 9.3 shows an example of a town
- ***city***—a very large settlement with an advanced transport infrastructure (suburban railway system and airport), shopping centres, cathedrals, large hospitals, museums, educational institutions (one or more universities) and a central business district with office blocks
- ***conurbation***—an extremely large settlement that was originally two separate cities.



9.2 Hierarchy of settlements

Remote settlements

Remote settlements are those places that are a long way away (isolated) from the main centres of population. Many of Australia's mining communities are regarded as being remote (see Figure 9.3), as are many of the Aboriginal and Torres Strait Islander communities across northern Australia. Twenty-five per cent of Aboriginal and Torres Strait Islander people live in remote communities.



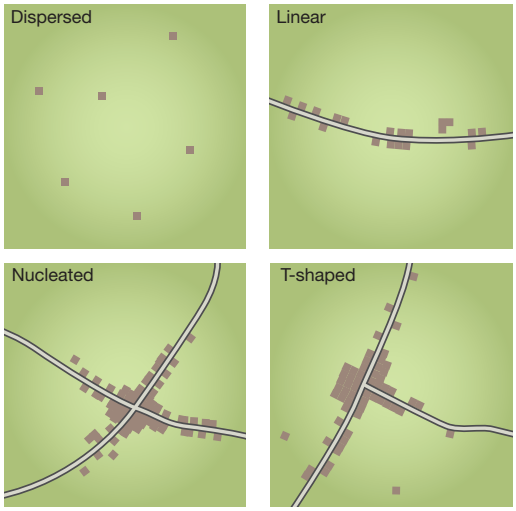
9.3 The small mining town of Leigh Creek, South Australia

Classification by function

Settlements can also be classified according to their main economic activity or purpose. Large regional centres such as Bathurst and Wagga Wagga in New South Wales, and Ballarat and Shepparton in Victoria, act as rural service centres. The main function of rural service centres is to supply goods and services to farmers in the surrounding area. Examples of industrial centres are cities such as Geelong in Victoria and Elizabeth in South Australia. Examples of port cities are Newcastle and Port Hedland. Examples of resort settlements are Thredbo and Mount Hotham in the Australian Alps, the Gold and Sunshine coasts, Torquay, Margaret River and Victor Harbor. Canberra's principal function is government and public administration. Most cities, however, are **multifunctional**, meaning that they have many functions. The larger the place, the more numerous and complex its functions.

Settlement patterns

Most settlements develop according to a particular pattern. Typical patterns can be observed in Figure 9.4. Dispersed settlements are found in farming regions. Clustered settlements or nucleated settlements are those in which buildings are close together, often clustered around a central point. The location of nucleated settlements is influenced by a range of factors, such as being easy to defend, close to a water supply or located at the intersection of major roads and railways. Linear (ribbon) settlements usually develop along roadways. T-shaped settlements develop as a result of the form taken by road junctions. Shops, schools and hospitals develop at the road junction.



9.4 Dispersed, nucleated, linear and T-shaped settlements

ACTIVITIES

9.1

Knowledge and understanding

1. Outline the characteristics of rural and urban populations.
2. Distinguish between hamlets, villages, towns and cities.
3. Identify the factors that are taken into account when we classify settlements by function.
4. Explain what is meant by the term 'multifunctional settlement'.

Applying and analysing

5. Study Figure 9.3. State what we mean by 'remote' when referring to settlements.
6. Study Figures 9.3 and 9.4. What type of settlement pattern can you observe in Figure 9.3? Explain.

9.2 Location of cities

The factors affecting the location of urban places (towns and cities) have changed over time. An easily defended site was once the most important consideration. Later, other factors became more important, such as access to trade routes, raw materials, cheap power, skilled labour, markets for goods produced and cheap transportation.

Earliest settlements

An easily defendable site was an important locational consideration for the earliest settlements. The Ancient Greeks, for example, built their settlements on promontories or islands. Athens was built on and around a hilltop (the Acropolis). Ancient Rome was built on a series of seven hills. Paris was first founded on an island in the Seine River, and London on low-lying land surrounded by wetlands. Salzburg today is dominated by a hilltop fortress (see Figure 9.5) that was used to defend the city. Other locational factors included access to water and food.

Rivers and cities

Rivers were important trade routes, and many great cities developed from small settlements along rivers as trade grew. Cairo, in Egypt, developed along a river; the cities of New Orleans and Philadelphia in the United States of America developed where ocean and rivers meet. Other cities developed where two or more rivers meet, as in the case of St Louis, in the USA, and Koblenz, in Germany. Rotterdam is one of the largest ports in the world. It lies on the North Sea coast of the Netherlands, at the mouth of the Rhine River, one of the major trade routes of Europe.

9.5 Salzburg—Austria's fourth-largest city—dates from about 15 BC, when the Romans merged several small villages to form a settlement known as Juvavum. The fortress of Festung Hohensalzburg was built in 1077 on the mountain that dominates the city.



Industrial cities

Industrial cities developed where there was ready access to the raw materials they used in the production process. Also important was a cheap supply of power. Figure 9.6 shows the strong link between coal—a source of power—and the location of Britain's most important industrial cities.

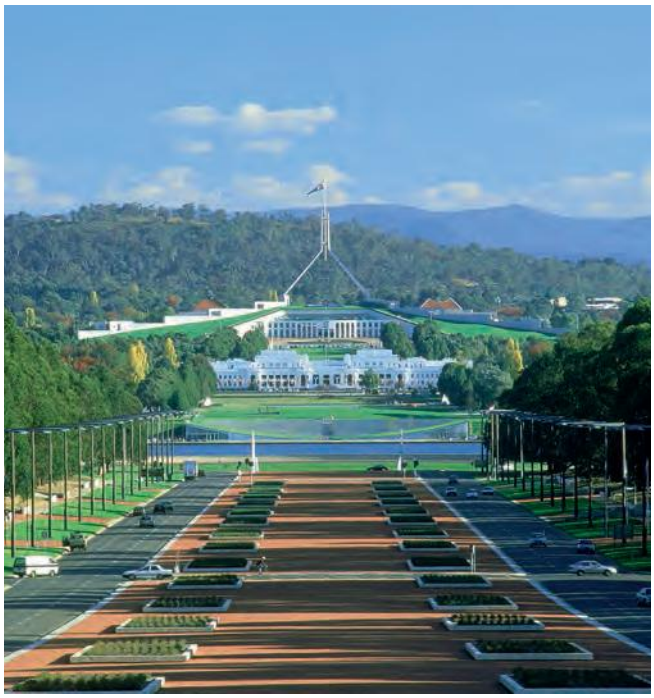


Source: Goods and Not So Goods website

9.6 The location of coalfields, industrial cities and port cities in Britain in the eighteenth and nineteenth centuries

Planned cities

There are very few fully planned cities. Canberra (see Figure 9.7), Washington, DC, and Brasilia are examples of planned cities. Many Australian towns and cities have been greatly influenced by particular urban architects. Adelaide, for example, was designed by Colonel William Light; Canberra, Griffith and the nearby town of Leeton were designed by American architect Walter Burley Griffin.



9.7 Canberra's design is based on Walter Burley Griffin's winning entry in the Federal Capital design competition of 1911.

ACTIVITIES

9.2

Knowledge and understanding

1 Outline how the locational factors of towns and cities have changed over time.

Applying and analysing

2 Read this unit carefully, studying Figures 9.5 and 9.7, and copy and complete the following table.

City	Advantages of its location	History	Features visible in the image
Salzburg			
Canberra			

3 Study Figure 9.6. Describe the distribution of industrial cities and coalfields in Britain.

Investigating

4 a Select a city and use the internet to investigate the factors responsible for its location. Present your findings to the rest of the class in an oral presentation.

b As a class, discuss the locational factors the cities investigated in part **a** have in common.

9.3 Urban or rural

There are advantages and disadvantages to any of the places in which people choose to live. In this unit we focus on urban areas and rural and remote communities.

Urban areas

Most Australians now live in large cities, usually near the coast. Because of their large populations, cities are able to provide a wide variety of services. For example, the largest hospitals are all located in big cities because that is where the need is greatest. Large cities also provide a range of entertainments and recreational activities not found in smaller centres. Urban areas also have better employment opportunities. This is one of the key advantages of living in an urban area.

Some Australians dislike living in cities, however, and **tree changes** and sea changes have become popular forms of escape.

Overcrowding is one of the main disadvantages of city living. A large population means that there is higher demand for housing, and this causes prices to rise. Traffic and public transport congestion are other problems. Heavy traffic also leads to increased air pollution. Other concerns include a perception that crime is more common in cities.

Rural and remote areas

The environment is one of the key advantages of living in rural and remote areas. There are fewer people, cars and factories. As a result, rural areas tend to be cleaner. Fewer people means more space. The demand for housing is often lower, resulting in cheaper house prices and more affordable rent.

As the distance from the city increases and areas become more remote, populations shrink and access to services declines. This is the key disadvantage of living in rural and remote areas. Australians living in very remote regions, such as far northern Western Australia, may have to travel hundreds of kilometres to the nearest shop. Health care can be so far away that doctors fly to their patients (see Figure 9.8)!

9.8 People living in remote Australia live so far from health services that they rely on the Royal Flying Doctor Service for their health care.



WHEN THE TREE-CHANGE DREAM TURNS TO DUST

Peter Munro

CAROLINE Harlow knew that relocating from the city to the country 18 months ago would be life-changing. But she didn't realise just how different the lifestyle would be.

Her first trip to town ended abruptly when the supermarket closed at midday on a Saturday. There was no public transport to speak of and a lack of doctors.

…

Increasing numbers of Melburnians are fleeing the stressful grind of the city for what they dream will be a peaceful country retreat. But tree changes do not live up to the harsh reality of life in rural Victoria, a new study has found.

In fact, 90 per cent of those surveyed say they are so disenchanted they plan to move on—to another town, the coast or back to the city—within five years.

Most say they are stressed by high living costs, poor work opportunities, a lack of services and the effects of drought. Many feel unwelcome and isolated.

…

Only 2 per cent researched their new locale before relocating from the city and as a result, there were 'deep chasms' between city residents' expectations of country life and their experience.

'People bought the dream about the idealistic country life, then they moved there and were confronted by the reality: poor health care, poor road quality, fewer work opportunities, expensive food, lack of entertainment, obesity, lack of ethnic diversity, difficulty making friends, conservatism and narrow-mindedness,' says Charles Sturt University researcher Dr Angela Ragusa.

…

Tree changers were mainly stressed urbanites with a romantic view that life in the country would offer a better lifestyle. Many subsequently discovered living costs were higher than expected, complaining of a lack of cheap rental housing, overpriced properties and expensive food and petrol. One disgruntled man said his 'cost of living is considerably higher in the country … because you've got transport in and out to cope with.'

Source: *The Age*, 19 April 2009

ACTIVITIES

Knowledge and understanding

1 Outline the advantages of living in large cities and other urban areas.
2 Identify the disadvantages of city living.
3 Describe what attracts people to a rural lifestyle.

Applying and analysing

4 Think about the location in which you live. Is it urban, rural or remote? List the advantages and disadvantages that you feel there are in living where you do.
5 Read the newspaper article 'When the tree-change dream turns to dust', then complete the following tasks.
   a Outline the disadvantages Caroline Harlow encountered when she moved from Melbourne to a rural area.
   b Describe the factors that attract people such as Caroline Harlow to life in rural areas.
   c What types of things to do you think people should check before they decide to move to a new area?

9.4 Urban housing densities

Australian urban areas are often classified according to their housing density (the number of dwellings per unit of land). Housing density can be described as being low, medium or high. Compared with other cities in the world, Australian cities have quite low housing densities, but this is beginning to change.

Low-density housing

The term 'low-density housing' refers to single-storey or two-storey houses that are detached—not attached to another house. Such houses have a front yard and a back yard. The low housing densities in Australian cities reflect Australians' preference for suburban living.

From the 1950s, private car ownership made it possible for many people to live some distance away from where they worked. As a result, many people moved from the crowded, older suburbs of the inner city to the new, low-density suburbs. These new suburbs were not well provided with public transport because people could drive their cars. Australia's suburbs are now dominated by low-density housing.

Building new suburbs is expensive because of all the infrastructure that is needed, such as roads, sewers, electricity poles, gas lines, schools, shops, parks and community services. Over time, the average size of a house block has decreased and the houses have become larger. The number of houses in low-density suburban areas ranges from eight to fifteen per hectare.



9.9 Medium-density housing Docklands, Melbourne

Medium-density housing

'Medium-density housing' is the term used to describe residential developments in which more people live than in low-density housing. Medium-density developments typically feature between twenty-five and forty-five dwellings per hectare, but can hold up to eighty dwellings. Housing types typical of medium-density developments include semi-attached and attached (multi-unit) housing units (townhouses, villas and three-storey walk-up apartments). Many **master-planned housing estates** now feature a mix of medium-density housing types, such as those in Figure 9.9.

In response to increasing populations and the high cost of creating new suburbs, governments have encouraged the construction of medium-density housing, especially near major transport interchanges. Governments sometimes rezone land so that housing can be built on land that used to have a different function. This policy is known as **urban consolidation**, and aims to increase population densities in existing urban areas. In this way, governments hope to slow the rate of **urban sprawl** (the outward growth of suburbs).

Urban consolidation is not always a popular idea. Urban consoliation involves the demolition of existing low-density housing in established residential suburbs, and its replacement with medium-density dwellings. Many people complain that this alters the look and feel of the neighbourhood.

Medium-density housing has existed for many years in Australian cities. Before the introduction of cars, most suburbs were dominated by housing of a similar density to modern medium-density housing. The rows of terrace houses found in the inner suburbs of cities such as Sydney and Melbourne are an example of this.

Master-planned estates

Master-planned housing estates are large-scale, integrated housing developments undertaken by a single developer. The physical and social infrastructure of the estate is planned by the developer. Master-planned estates include housing, shops, schools and community facilities. They are usually located on a city's urban–rural fringe (where a city's edge meets the country), but they are increasingly found on sizeable urban renewal sites.

High-density housing

There is no clear definition of high-density housing. It is generally thought, however, to refer to more than sixty or eighty dwellings per hectare and a height of five or more storeys. Australian cities now feature many such buildings (see Figure 9.11). Apartment living is popular with 'empty-nesters'—older people whose children have left home—and couples without children.



9.11 High-density housing: apartment blocks in Brisbane, Queensland

SPOTLIGHT

Australia's suburban McMansions

The term 'McMansion' was first used in the United States of America in response to the increasing size of new homes there. Over time, the typical Australian home has grown, too, from one with three bedrooms, one bathroom and separate living areas, to an open-plan, four-bedroom home with multiple bathrooms, including an ensuite. Popular extras, such as rumpus and media rooms, walk-in wardrobes and kitchen pantries, add to the overall size of modern homes. The average floor area of a newly built Australian home is 227.6 square metres. This is an increase of 40 per cent on the average in 1985 of 162.2 square metres. The average new home built in Australia (see Figure 9.10) is 10 per cent bigger than one built in the United States and 9 per cent bigger than in New Zealand. On average, our homes are the biggest in the world.



9.10 Low-density suburban housing: Australian new homes are, on average, the world's largest.

ACTIVITIES

Knowledge and understanding

1. Define 'housing density'.
2. Explain how increased car ownership led to the growth of low-density suburbs.
3. Distinguish between low-, medium- and high-density housing.
4. Outline how governments promote urban consolidation.
5. Explain what a master-planned estate is.

Applying and analysing

6. Copy and complete the following table, listing the advantages and disadvantages of each type of housing.

	Advantages	Disadvantages
Low-density		
Medium-density		
High-density		

9.5 Transport and cities

Traffic congestion affects the liveability of a city. In many cities around the world, the number of cars is increasing and traffic congestion is getting worse. One solution to traffic congestion is to encourage people to cycle, walk or use public transport.

Population densities

Table 9.12 shows that the world's most densely settled cities are found in South and East Asia. European cities also have high population densities. Australian cities (and many of those in North America) have low population densities. This is because much of the growth of these cities occurred in the years after World War II, when immigration rates were high and private car ownership was becoming more common.

Density and sustainability

It is generally thought that high-density urban areas are more sustainable than low-density, car-dependent cities. As a general rule, the lower the urban density, the greater the amount of energy consumed (see Figure 9.13). The main reason for this is that high-density cities have a greater reliance on public transport. Low-density cities often do not have the public transport infrastructure needed to move large numbers of people. Residents must rely on their cars.

Urban population density is only one factor influencing the type of transport that people use. People living in cities with a concentration of economic activity in the central business district (CBD) are more likely to use public transport, ride bicycles or walk to work. In cities where economic activities are spread across the urban area, people are more likely to drive to work.

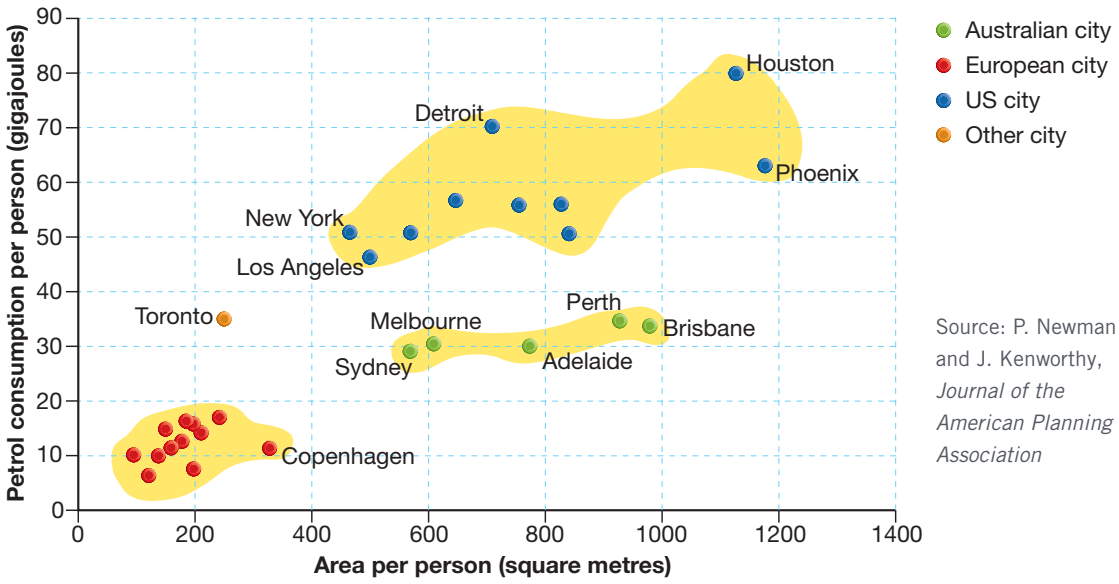
In Australia, the growth in the CBD-based financial services sector has led to a small but significant increase in public transport use. As well, more people are walking or cycling to work. This trend is reinforced by the growing preference for inner-city living.

9.12 Population densities of selected cities, 2012

City	Country	Population (million)	Area (km²)	Population density (per km²)
Asia				
Jakarta	Indonesia	24.8	2 784	9 480
Shanghai	China	20.9	3 497	6 000
Karachi	Pakistan	20.7	803	25 800
Mumbai	India	16.9	546	30 900
Dhaka	Bangladesh	15.4	347	44 400
Europe				
Moscow	Russia	15.5	4 403	3 500
Paris	France	10.8	2 845	3 800
London	UK	8.7	1 623	5 300
North America				
New York	USA	20.5	11 642	1 800
Los Angeles	USA	14.9	6 299	2 400
Chicago	USA	8.1	6 856	1 300
Toronto	Canada	6.1	2 287	2 700
San Francisco	USA	5.9	2 797	2 100
Australia				
Sydney	Australia	3.8	1 788	2 100
Melbourne	Australia	3.5	2 152	1 600
Brisbane	Australia	1.8	1 826	1 000
Perth	Australia	1.3	1 035	1 300
Adelaide	Australia	1.1	755	1 400
Canberra	Australia	0.4	329	1 100

Source: Demographia World Urban Areas, 2012

9.13 Relationship between urban population density and petrol consumption



Source: P. Newman and J. Kenworthy, *Journal of the American Planning Association*

Car ownership

Car ownership is a good indicator of transport use in cities. In Australia, only about 13 per cent of city-based households do not have a car, while nearly 50 per cent have two or more cars. London has an urban density up to five times greater than the densities of Australian cities. In London, 43 per cent of households don't have a car. Rather than drive to work, most Londoners either walk, cycle or take public transport. In Shanghai, China, only 18 per cent of households have cars.

'Smart growth' strategies

The 'smart growth' initiative in North America is an approach to designing neighbourhoods. The initiative focuses on three areas:

- building facilities that encourage people to walk
- building bicycle lanes
- building mixed-use buildings that include shops and housing.

In Europe, the terms 'compact city' and 'urban intensification' are used to describe similar planning models.

DID YOU KNOW?

In Sydney, of those households closest to the CBD, 30 per cent don't own a car.

ACTIVITIES

Knowledge and understanding

1. State where the world's most densely settled cities are located.
2. Explain why European cities have population densities greater than those found in North America and Australia.
3. State why high-density cities are generally considered more sustainable than low-density cities.
4. Explain how the distribution of economic activity affects the sustainability of cities.
5. Outline the relationship between car ownership and urban population density.
6. Outline the aims of 'smart growth' strategies.

Geographical skills

7. Study Figure 9.13. Write a paragraph comparing Australian cities with cities in Europe and the United States of America.

9.6 Urban consolidation

Since the 1990s, governments in Australia have attempted to encourage more people to live in established suburbs. Urban consolidation is designed to increase population densities in existing urban areas, and to limit the loss of surrounding rural areas to urban sprawl.

Growth of urban sprawl

The **suburbanisation** of Australian cities really began with the introduction of trams and the development of suburban rail networks. New suburbs developed along railway lines. The railways were the dominant influence on city development from the 1860s until about 1920.

The arrival of the car meant that people had more choices of where to live and were no longer restricted to living near railway lines. This affected cities in two ways: spaces between major transport corridors were filled (people did not need to live close to public transport, so areas once empty of houses began to be developed); and urban areas grew outwards, a process often referred to as 'urban sprawl' (see Figure 9.14). Urban sprawl is very costly. New suburbs need expensive infrastructure: utilities such as electricity, water and sewerage; schools and hospitals; commercial centres; roads and public transport.

9.14 Urban sprawl increases the demand for expensive new infrastructure.



Urban consolidation

To slow the rate of urban sprawl, governments have introduced policies and programs to promote urban consolidation. Urban consolidation involves the construction of medium-density to high-density housing in already built-up areas in the inner and middle ring of suburbs (see Figure 9.15). It also increases the range of housing types available.

The signs of urban consolidation can be seen throughout Australia's cities. In more popular locations, where land is often much more expensive, multistorey apartment buildings are constructed. In inner-city locations, old industrial sites and land occupied by old port facilities are being redeveloped into high-density residential and commercial neighbourhoods.

Land-use zoning

The main way in which governments encourage urban consolidation is through their control of the planning process. Governments identify neighbourhoods that are close to major transport nodes, and change the land-use zoning rules in these areas to favour medium-density and high-density housing. Developers then buy up low-density housing or industrial/commercial sites and construct higher density housing units.

The urban consolidation debate

Policies promoting urban consolidation are often debated, especially by the residents of neighbourhoods that are affected. While those in favour of such policies see urban consolidation as a way of slowing urban sprawl, and of making greater use of existing infrastructure, those opposed see it as a threat to the character and liveability of existing neighbourhoods. See Table 9.16.





9.15 An artist's impression of medium-density urban consolidation in Maribyrnong, Victoria

9.16 The case for and against urban consolidation

The case for	The case against
• Urban consolidation reduces our reliance on cars. This improves air quality and reduces greenhouse gas emissions. It also reduces the congestion, noise and accidents associated with cars in urban areas. • Slowing urban sprawl protects agricultural land on the outskirts of cities. • Low-density sprawl is very expensive, so urban consolidation reduces infrastructure costs. • The social isolation and inequality experienced by those living in sprawling suburbia is reduced. In the outer suburbs there are limited local services and few transport alternatives to the car. The elderly, women and young teenagers are particularly disadvantaged. • The priority given to private transport and private low-density housing in sprawling suburbia often results in neglect of public transport and public spaces, particularly in the inner city.	• The impacts of urban sprawl have already been reduced as building blocks have become smaller. • The claim that existing inner-city infrastructure is not being used to capacity is exaggerated. • Increasing population density in already crowded areas reduces the liveability of neighbourhoods. Traffic congestion increases and parking becomes more difficult. • Existing facilities such as sporting fields, schools, hospitals and public transport interchanges struggle to cope with the increased population density. • 'We have lost our privacy. Our backyard is now overlooked by a five-storey apartment building. The building blocks out the sun in winter.' • 'The heritage streetscapes of our neighbourhood are being destroyed. Beautiful old homes have been bulldozed to make way for apartment buildings.'

ACTIVITIES

Knowledge and understanding

1 Outline how changes in transport affected Australian cities.
2 Define 'urban sprawl' and 'urban consolidation'.
3 What are the main arguments against allowing our cities to continue to spread outwards?

Applying and analysing

4 Study Figures 9.14 and 9.15. Describe the contrast you see between the two images.
5 Why do governments promote urban consolidation?
6 Write a short paragraph in response to the following statement: 'The advantages of urban consolidation outweigh the disadvantages.'

9.7 High-density cities

The world's population is becoming increasingly concentrated in large cities where population density is high. While this trend presents great challenges, it also brings a number of benefits. It is contributing to a reduction in poverty and human suffering; and, importantly, it will help slow, and perhaps reverse, population growth.

The big shift

By the end of 2025, 60 per cent of the world's population will live in cities; by the end of 2050, the figure will be more than 70 per cent; and by 2100, it will be at least 75 per cent. Between now and 2050, the world's cities will absorb an additional 3.1 billion people. By 2030, the urban population of Asia and Africa will have doubled since 2000.

Advantages

There are a range of economic, social and environmental advantages associated with the rise of the high-density city. Cities are centres of economic opportunity and employment. Many of those people moving to China's rapidly growing industrial cities (see Figure 9.17), for example, are attracted by the prospect of gaining employment.



9.17 Chongqing, a city of more than 29 million people, serves as the economic centre of the upstream Yangzi area. It is south-western China's major manufacturing centre and a major transportation hub. Every day, more than more than 1400 people move into the city.

The social benefits of urban living are also significant. City dwellers, on average, live longer than people in rural areas. They also have lower infant mortality rates, lower fertility rates, and better access to medical care, family planning, education and social services. The health benefits, however, are not evenly spread: the rich do better than the urban poor.

Cities also have environmental benefits. Concentrating people in cities helps to preserve biodiversity by reducing the stress on wildlife habitats. High-density living can also save energy if residents rely less on cars and more on energy-efficient public transport, walking and bicycling. It is also easier to run large-scale recycling programs in high-density cities.

Implications for world population growth

When people move to the city from rural areas, they tend to have fewer children, by at least one child per family. In most cases, the average family size in cities is below the global **replacement rate** of 2.1 children. So, at some point this century, **urbanisation** may be responsible for the reverse in growth of the world's population.

Disadvantages

Because of their demand for resources, cities have huge **ecological footprints**. While cities cover just 2 per cent of the earth's land surface, they consume about 75 per cent of its resources and produce about 75 per cent of carbon dioxide emissions. Large areas of land must be used to provide city dwellers with food, water, energy, minerals and other resources.

High population densities also create a range of environmental challenges. Waterways become polluted by industrial waste and stormwater run-off. Industries and automobiles pollute the air. Household wastes need to be collected and disposed of in landfills.

Rapid growth in city populations also places great demands on existing infrastructure. People newly arrived in the city need housing, schools for their children and medical facilities. They also need a way of getting around, or transport.

Worldwide, more than a billion people live in crowded slums or squatter settlements. In sub-Saharan Africa, seven out of every ten people live in such conditions. Asia's largest slum is Dharavi, in Mumbai, India. Dharavi houses 600 000 people. The residents of such settlements lack access to electricity, sanitation and a clean source of water. Getting an education and accessing health care can also be difficult.

Implications for rural populations

As a result of urbanisation, the population of the world's rural areas will stop growing by the end of this decade. By 2050, the world's rural population will have declined by 600 million. India's rural population, for example, is expected to peak in 2025 at 909 million people and then decline to 743 million by 2050.

Those people who choose to remain in rural areas will benefit from the flow of money, knowledge and education from the cities back to the villages. They will, however, struggle to carry on traditional forms of agriculture. In the Philippines, for example, ancient rice terraces are falling into disrepair as young people move to the cities in search of work.

The future

In the Western world, fewer than 5 per cent of people are employed in agriculture, yet they are able to produce more than enough food to feed their countries' urban populations.

ACTIVITIES

Knowledge and understanding

1. State the economic advantages of urbanisation.
2. Explain the relationship between urbanisation and world population growth.
3. Describe what is expected to happen to rural populations.

Applying and analysing

4. List the advantages and disadvantages of the shift to high-density urban living. Construct a mind map highlighting the key points raised.
5. Write a short response to the following statement: 'The environmental benefits of high-density cities outweigh the costs.'

9.8 Case study: Bern, Switzerland

Bern, the capital of Switzerland, has for a number of years been voted one of the most liveable cities in the world. Two other Swiss cities, Zürich and Geneva, are also often on lists of the world's most liveable cities.

World Heritage treasure

Bern was made the capital of the newly formed Swiss **Confederation** in 1848. The city's selection was a political **compromise** between the large German-speaking city of Zürich and French-speaking Geneva. In this respect it is similar to Canberra. Canberra's site was selected as a compromise, roughly halfway between the two rival cities of Sydney and Melbourne. Bern's population of just over 130 000 is about half the size of Canberra's.

Bern is famous for being a World Heritage site. With its medieval buildings, a beautiful fifteenth-century cathedral known as the Münster, and cobblestoned streets, the Old Town of Bern was declared a World Heritage cultural site in 1983. This historic architecture gives the city a unique character and attracts thousands of visitors each year. Bern is described as having a very 'human scale'. This means that the city's buildings are relatively small and do not tower over or dominate people (see Figure 9.18). Instead, the small scale of the buildings creates a sense of openness, allows sunshine in and gives the city a welcoming atmosphere.

Bern's liveability

Bern is a very compact city, meaning that all the city's facilities are close together. The city's compact size is one of the main reasons why it is such a liveable place. Bern's population enjoy short travel times, and many use bicycles to travel around the city.

The Swiss are also well served by an excellent train system. Fast, reliable trains link all the country's major cities. These trains extend into Bern's suburbs, so even residents who live in outlying villages are just a few minutes away from the city centre by train. Trams also service the city and its inner suburbs (see Figure 9.19).

9.18 The medieval Old Town of Bern was declared a World Heritage cultural site in 1983.





9.19 The residents of Bern are well served by an excellent public transport system.

Bern's location is another factor that makes Bern a livable city. The people of Bern can enjoy the open spaces that go with a rural lifestyle while still having access to all the services and amenities of a large city.

Switzerland is a very wealthy country, and the people of Bern enjoy a very high standard of living. The unemployment rate in Bern is among the lowest in any European city. The types of jobs available are also an important factor. A very high proportion of the jobs in Bern are highly skilled, particularly in government and in the finance and insurance industries. These highly skilled jobs are also highly paid. This, in turn, allows more services and facilities to be provided. This can be seen in the city's vibrant cafe and shopping culture.

All these factors combine to make Bern one of the most liveable cities in the world. However, it is also one of the most expensive. For example, a takeaway hamburger meal costs the equivalent of A$14. Real estate is more expensive than in other parts of Europe because of the city's popularity, and other consumer items are also more expensive.

ACTIVITIES

Knowledge and understanding

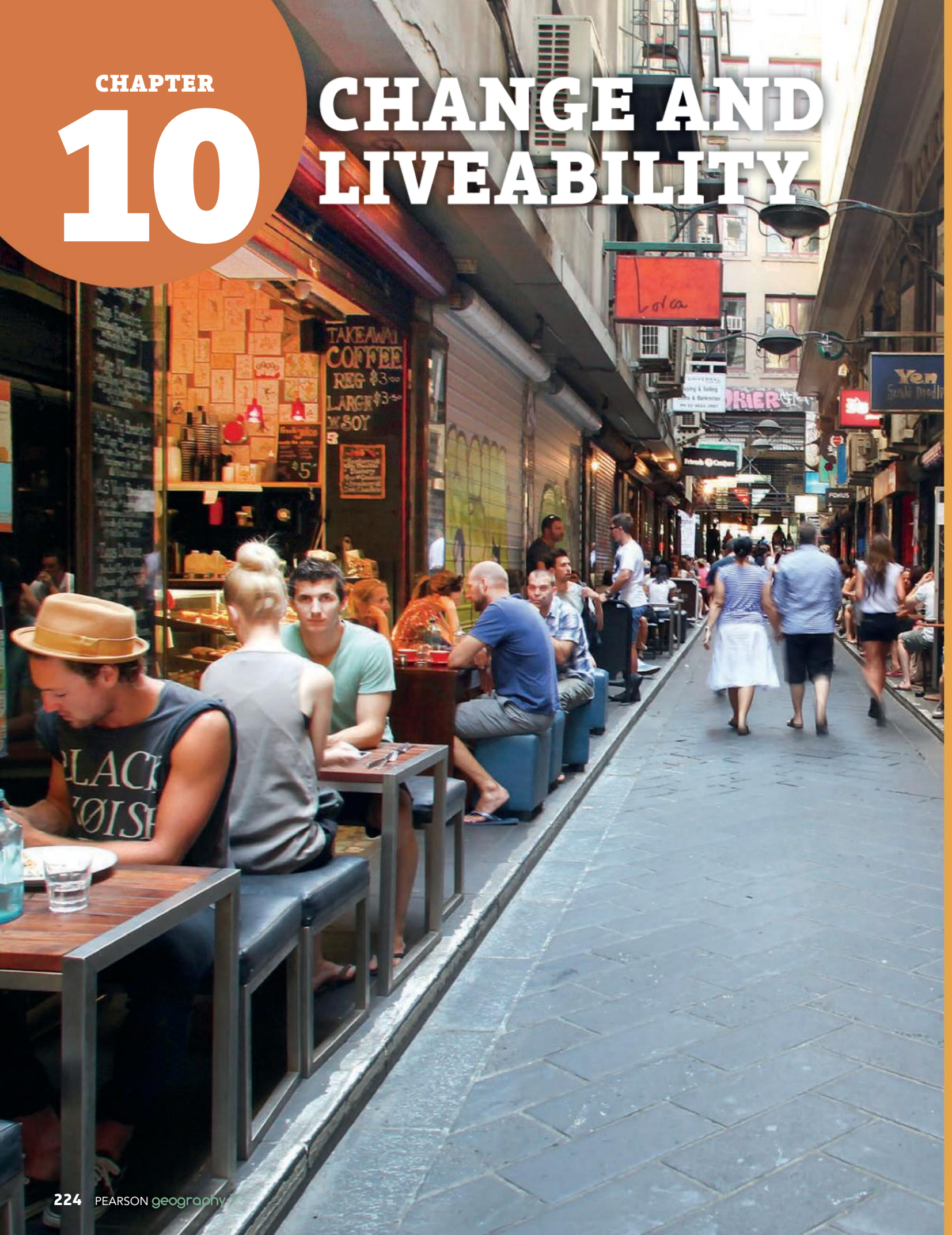
1 What do Bern and Canberra have in common?
2 Outline why Bern is described as having a 'human scale'.
3 Explain why Bern is a liveable city.

Applying and analysing

4 Imagine you have been employed by the City of Bern to encourage well-qualified professionals to move to the city. Design an advertising campaign for the benefits of living in Bern. You may wish to design a website or print advertisement, or write a script for a radio or television commercial.
5 Consider the factors that make Bern a liveable city. Now think about the suburb or town in which you live. What features does your suburb or town have that make it liveable? What would you change about your town or suburb to make it more liveable? Record your thoughts on a mind map.

CHAPTER

10 CHANGE AND LIVEABILITY



Geographers are interested in how places change. These changes occur in two ways: first, over time, and second, over space. For example, the town or suburb in which you live may have seen old buildings demolished and new ones constructed, or the ethnic mix may have changed as some people leave the area and others arrive. This is change over time.

In Geography we are especially interested in where change occurs. For example, a large manufacturer may close in one part of the city while new enterprises open in a high-tech business park. Change does not happen to just one part of the city but occurs unevenly across the entire city. This is change over space.

In this chapter, we study the factors causing change in Australian and selected European communities. Of particular interest are the changing demographic character of places and how we compare communities.

KEY IDEAS

- To understand how places differ
- To identify the factors causing change in Australian places
- To recognise how the distribution of Australia's population is changing
- To recognise how selected European communities are changing

10.0 Centre Place, Melbourne CBD

GLOSSARY

baby boomer	a person born between 1946 and 1964, during the 'baby boom' that followed the end of World War II
broadacre	a style of farming in which large areas of land are farmed to grow one crop or raise one type of animal, leading to greater efficiency
digital revolution	changes brought about by computing and communication technology
ecologically sustainable	meeting the needs of people today while conserving ecosystems for the benefit of future generations.
emigration	leaving the country of your birth to live somewhere else
extensive grazing	a system of livestock grazing in areas of medium to low rainfall, in which no irrigation is used
fibre-optic	using glass or plastic optical fibres, bundled in cables, to transmit images and data
fossil fuels	energy sources, such as coal, oil and gas, that are produced within the earth from the remains of living things
global warming	an increase in the world's average surface temperature
globalisation	the increasingly global relationships of culture, people and economic activity
immigration	coming to live permanently in a country that is not your place of birth
lifestyle	the manner in which a person or group lives
manufacturing	the making of products using raw materials
multicultural society	a community made up of people from different cultural backgrounds
natural increase	the difference between the death rate and birth rate of a population
net migration	the difference between the number of people entering a country permanently and the number leaving
outsourcing	contracting out a business-related activity
reserves	a store or supply of a resource that has not yet been used
royalty	a payment made, often calculated as a percentage of the proceeds, for the right to mine a resource on public land
wetlands	areas of land covered by water for all or part of the time

10.1 Change in Australian communities

Australian communities experience constant change—in the way we do business, earn a living, interact with the world, organise our social life, communicate with our friends and identify and form communities.

Globalisation

Barriers that once separated countries, such as distance, transport and communication costs, are being broken down. Technological advances have reduced the cost of producing goods and services, and increased the ease with which people, information, goods and services can move between countries. Globalisation is causing change in Australian communities and neighbourhoods.

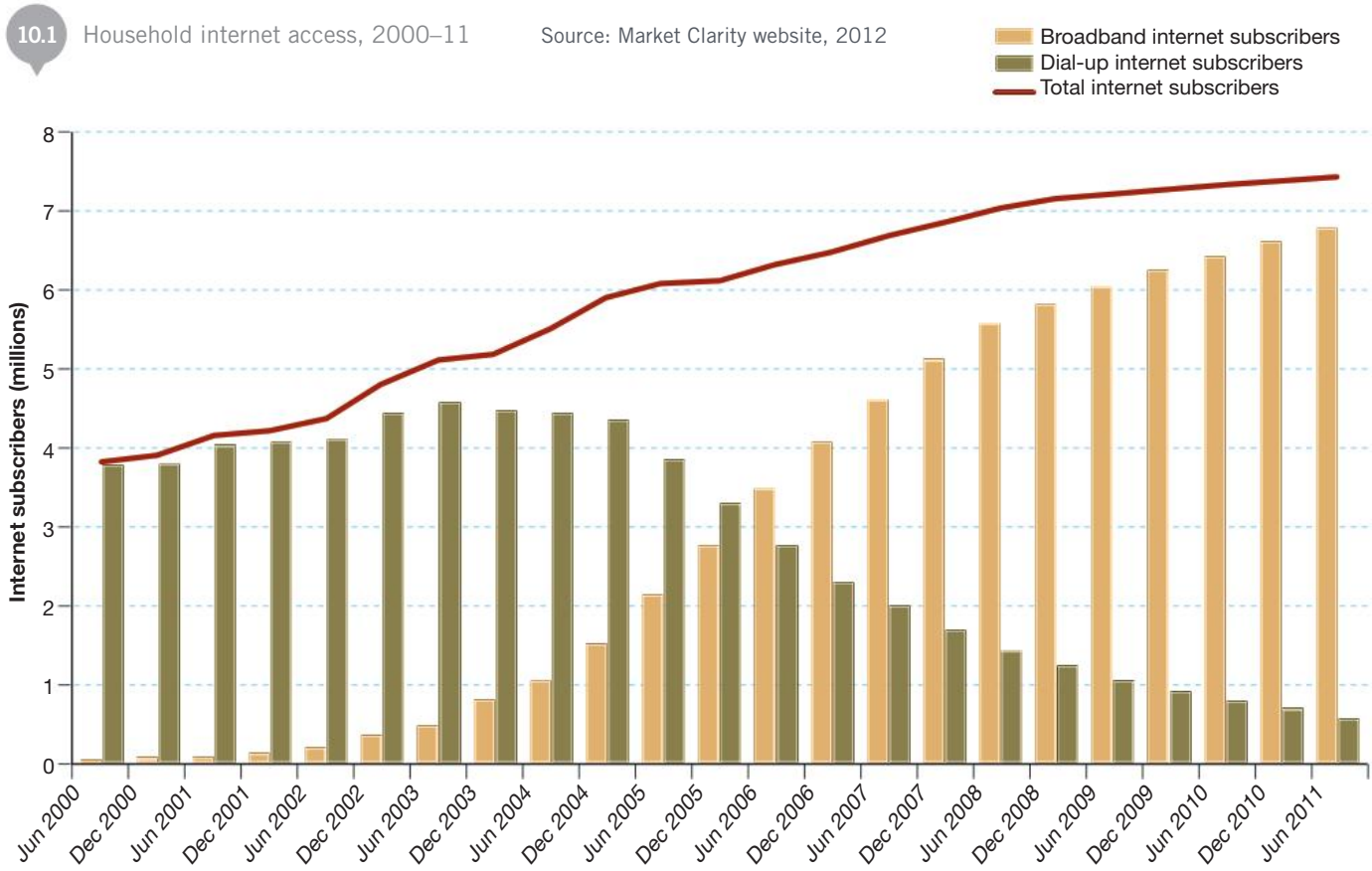
New technologies

Technological advances in telecommunications, computers and transport have changed the ways people interact. People are now much more mobile and information is more accessible.

Telecommunications

Advanced technology now makes it possible for people to communicate with others in their community or neighbourhood without leaving home. Figure 10.1 shows the increasing use of the internet and the changing way in which people are accessing it in Australia. Internet use is expected to change again once the National Broadband Network (NBN) is established throughout Australia. The NBN's **fibre-optic** network is expected to operate up to forty times faster than ADSL broadband.

10.1 Household internet access, 2000–11 Source: Market Clarity website, 2012



10.2 Trends in Australian employment, 1986–2011. Over the same period, the total number of people in employment increased from 5 586 300 to 9 260 000.

Employment category	Percentage of total workforce, 1986	Percentage of total workforce, 2011	Percentage change in number of employees, 1986–2011
Agriculture, forestry and fishing	7.6	3.5	–22.6
Mining	1.8	2.6	+138.9
Manufacturing	19.2	10.3	–11.7
Construction	9.0	11.3	+107.5
Retail trade	13.6	13.2	+60.4
Accommodation and food services	6.4	8.4	+117.6
Financial and insurance services	5.4	4.7	+42.4
Professional, scientific and technical services	5.4	9.4	+187.4
Public administration and safety	7.2	8.0	+84.9
Education and training	8.6	9.3	+78.0
Health care and social assistance	10.4	14.6	+131.3
Other services	5.5	4.9	+48.2

Source: Australian Bureau of Statistics

Mobile technology

Wireless communications systems and mobile devices such as smartphones, tablets and wireless modems make it possible to access and distribute large amounts of information over the internet without relying on a connection to a physical network.

Transport

Advances in shipping and cargo-handling technologies have enabled the volume of world trade to increase substantially. Developments in aeroplane technology have greatly reduced the cost and time involved in travel. As a result, there has been an increase in international tourism and in the movement of people to other countries in search of work and services, such as education and health care.

Outcomes of change

The overall effect of change for Australian communities and neighbourhoods is that the Australian economy has become more integrated and interconnected with the global economy. Changes to the types of work that are available, and to wages and job security, all have an impact on people's lives and the liveability of Australian towns and cities.

Technology and work

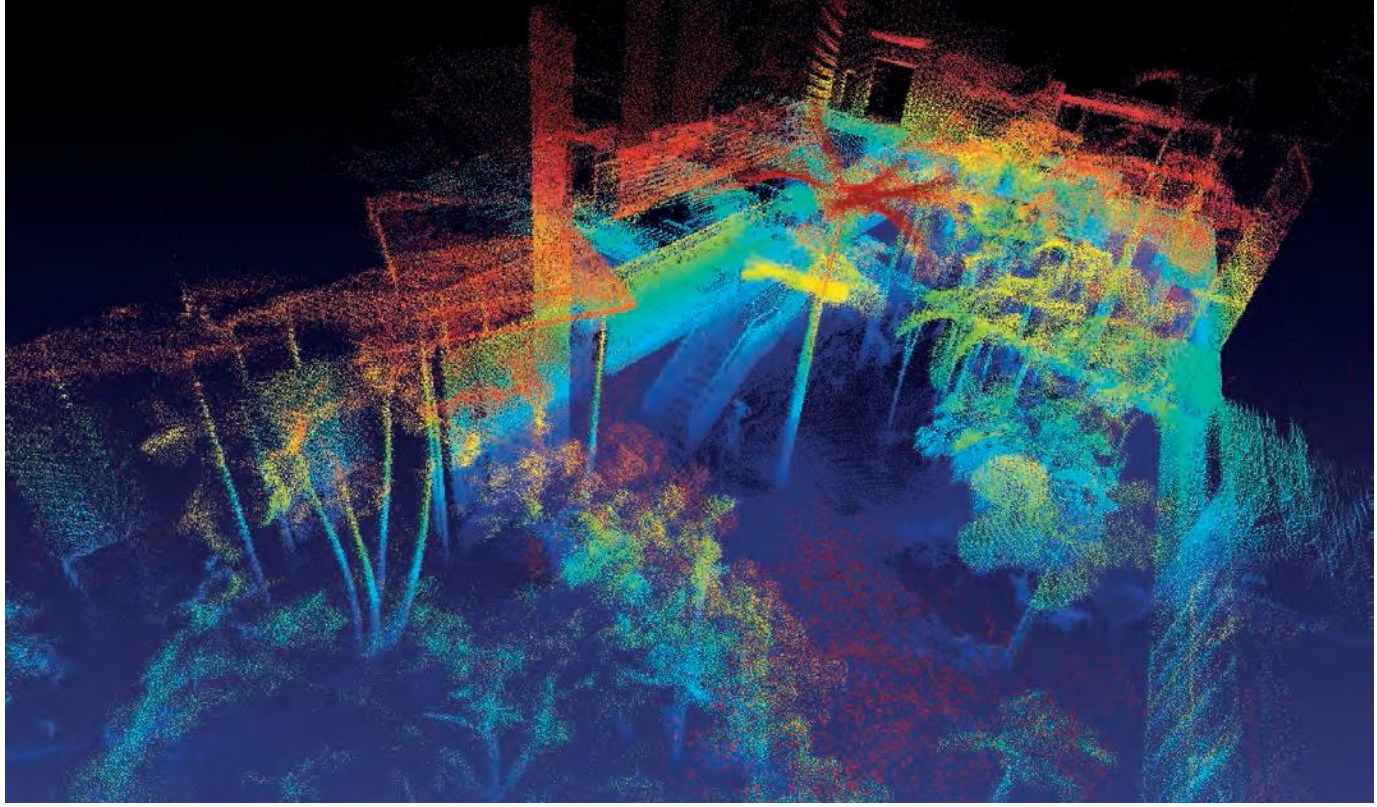
The technological changes described above have helped to transform the workplace in the following ways.

- Computers have changed the way information is stored, processed and transferred. These changes are most apparent in the banking and finance sectors and in all forms of administration.
- Robotics perform a wide range of complex assembly-line tasks that were once carried out by unskilled and semiskilled workers.
- Employment in some industries has declined and new types of jobs have been created, such as designing, building, operating and servicing the new technology.

Table 10.2 shows the change, or trend, in employment in different sectors of the workforce in Australia since 1986.

Costs of change

Change is never without social and economic costs. The growth of the service sector has created thousands of new jobs, particularly for women and teenagers. However, many of these jobs are casual or part-time jobs, with low wages and few benefits. As a result, many families are unable to achieve the lifestyle they would like to have. One in every five Australian households struggles to pay its bills.



10.3 A 3-D point cloud map generated by CSIRO's laser mapping system, Zebedee

Technological advances and economic changes have disadvantaged some workers. Workers who lose their jobs do not always find it easy to learn new skills. As a result, there is a growing gap between people who have well-paid jobs (many of which are in the high-tech, information-based sectors of the economy) and people with low-skilled, low-paid jobs. One example of a high-tech employer is the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which developed a handheld unit that produces 3-D maps such as the one shown in Figure 10.3.

Globalisation of culture

The media has become an important influence in shaping individual, community and national identities. A small number of media companies control most of what audiences watch and listen to. Rupert Murdoch's News Corporation, for example, can reach two-thirds of the world's population through its ownership of BSkyB (Europe), Fox (North America) and Star TV (Asia).

We now talk of the 'globalisation of culture'—the process whereby cultures of all types become more interrelated and interdependent. Critics say that a more accurate name for this process would be the 'Americanisation of global culture'. They point out that 75 per cent of all television programs shown around the world are produced in the United States of America. They fear that globalisation will result in a loss of cultural diversity.

Australian content

In order to promote Australian content on free-to-air television, the Australian Communications and Media Authority requires all commercial stations to broadcast a certain amount of Australian programming. Australian programming may include drama, documentary and children's programs.

Demographic changes

Demography is the study of statistics that describe the way a society is made up. The way Australian society is made up is changing in three important respects.

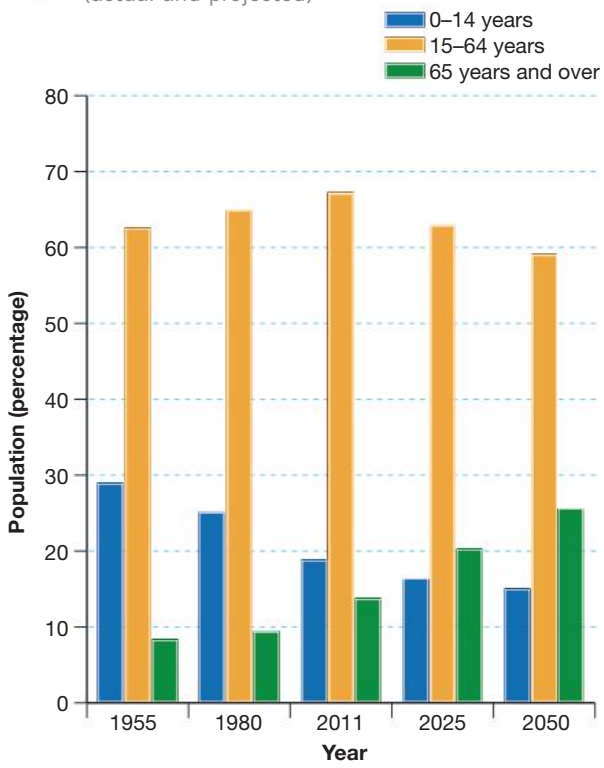
Ageing population

Australia has an ageing population. This means that the percentage of people over the age of 65 is increasing (see Figure 10.4). Retirees often form communities based on shared social interests. With plenty of spare time, they may join leisure-related clubs or become active in community-based organisations. In some cases, retirees form communities based on shared space. Retirement villages and resort settlements, such as Port Macquarie in New South Wales, are examples of this.

Family structure

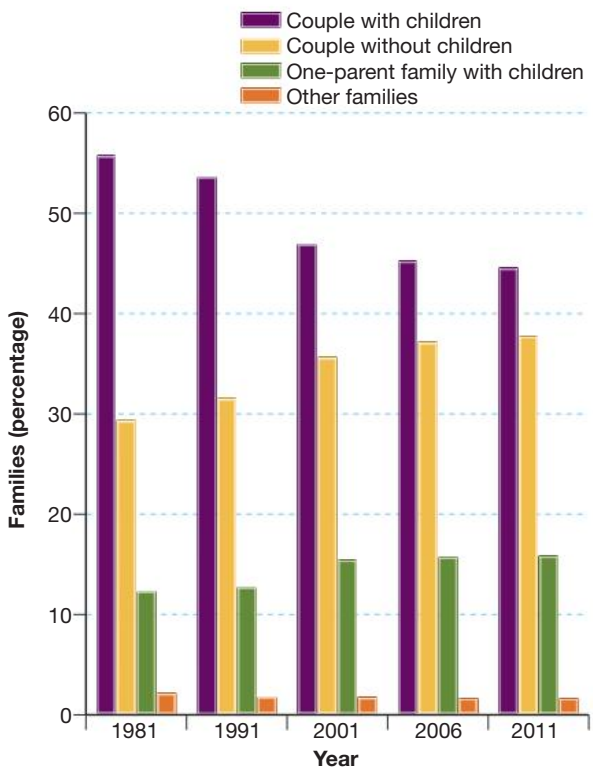
Figure 10.5 illustrates the changing structure of the Australian family. The traditional family unit (the couple with children) is in decline, while the proportion of the population made up of couple-only family units and one-parent families with children is on the increase.

10.4 Age structure of the Australian population (actual and projected)



Source: Australian Bureau of Statistics

10.5 Family structures in Australia, 1981–2011



Source: Australian Bureau of Statistics

Cultural diversity

Immigration and tourism have exposed Australian communities to different cultures. These have enriched communities and transformed entire neighbourhoods. For example, the Melbourne suburb of Carlton is closely associated with the city's Italian community.

Some of the most obvious impacts of cultural integration can be seen in the music we listen to, the television programs and movies we watch, the food we eat, the clothes we wear and the sports we play and watch.

ACTIVITIES

10.1

Knowledge and understanding

1 Describe the impact that the technological and telecommunications revolution is having on Australian communities.
2 Explain why the increasing power of global media networks is of concern to some people.
3 Explain what is meant by the term 'globalisation of culture'. Why is it sometimes referred to as the 'Americanisation' of global culture?

Applying and analysing

4 a List all the ways in which you have used technology in the last 24 hours.
  b Describe the types of material you have accessed—music, television, video, social networking sites etc.—and (if possible) the country where the material originated.
  c How has technology influenced the way you communicate?
5 List the country of origin of the television programs you watched in the last 24 hours. What proportion of these came from the United States of America?

Geographical skills

6 Study Figure 10.1. Using data from the graph outline the trends in household broadband and internet use between 2000 and 2011.
7 Study Table 10.2. Name the sectors of employment that have declined in the period 1986–2011, both as a percentage of the workforce and in terms of total employment.
8 Study Figure 10.4. Describe the trend apparent in the structure of Australia's population.
9 Study Figure 10.5. Using data from the graph, describe the changing nature of Australian families in the period between 1981 and 2011.

10.2 Australia's population

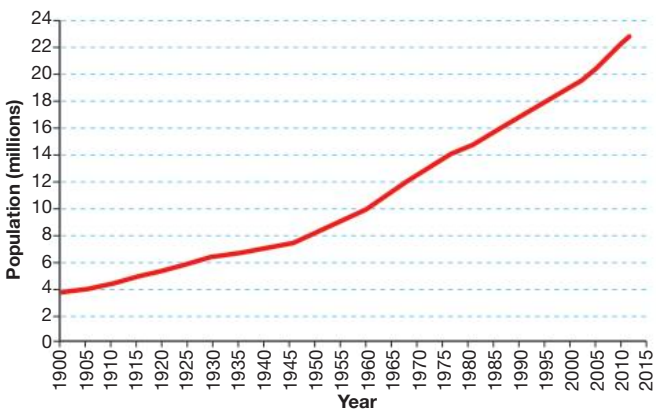
In April 2013, Australia's population reached 23 million. This is nearly three times the population back in 1950 (8.2 million) and five times the population in 1900 (3.7 million). Population growth has an impact on Australia's liveability.

Growth since 1901

Figure 10.6 shows the growth of the Australian population since Federation in 1901. Figure 10.7 shows the contribution made by the two parts of population growth: **natural increase** and **net migration**.

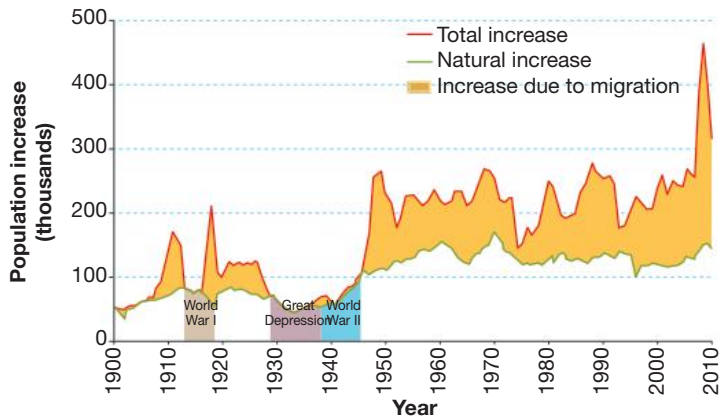
Natural increase is the difference between the birth rate and the death rate. Net migration is the difference between the number of permanent departures from Australia and the number of people arriving to live in Australia permanently.

10.6 Australian population growth, 1901–2012



Source: Australian Bureau of Statistics

10.7 Components of Australia's population growth, 1901–2010



Source: Australian Bureau of Statistics

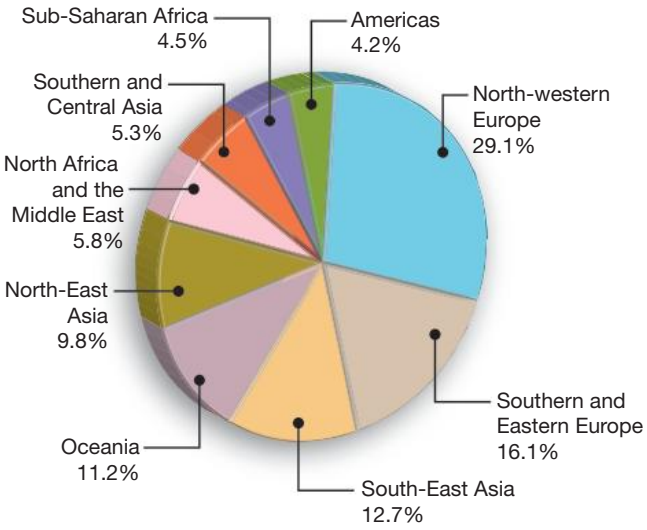


10.8 A family of British immigrants arrives in Sydney in 1952.

Growth after 1945

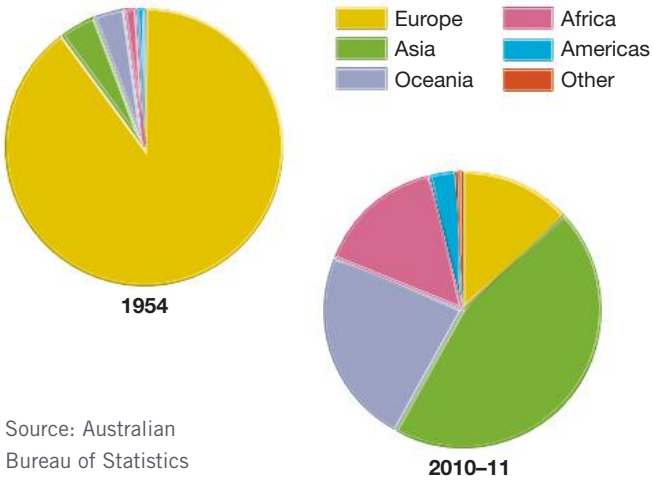
A significant share of Australia's population growth has come from **immigration**. Since World War II (1939–45), more than seven million people have migrated to Australia (see Figure 10.8). The outcome of this process has been the development of a **multicultural society**. At present, more than one in every four Australians is a first-generation settler. Figure 10.9 shows the birthplaces of all Australians who were born overseas. The source of these immigrants has changed over time. Figure 10.10 shows where new immigrants came from in 1954 and in 2010–11. New migrants to Australia are encouraged to become Australian citizens, as the family shown in Figure 10.11 did.

10.9 Birthplaces of overseas-born Australians, 2010



Source: Australian Bureau of Statistics

10.10 Source of new immigrants, 1954 and 2010–11



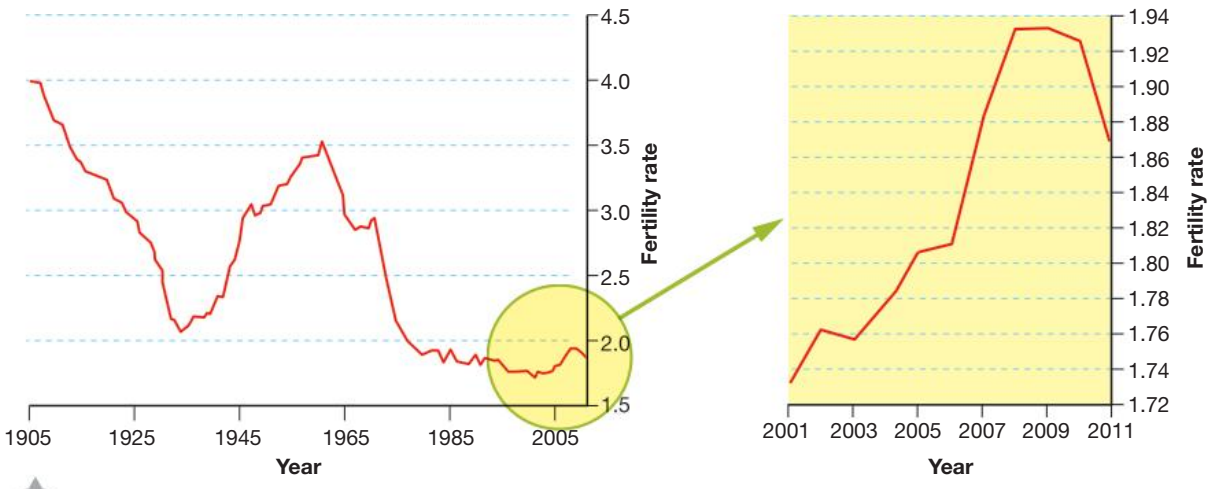
Source: Australian Bureau of Statistics

10.11 An Australian citizenship ceremony, 2012



Fertility rates

The number of children that women in Australia are having has decreased since 1905, as Figure 10.12 shows.



10.12 Fertility rate in Australia 1905–2011. The declining trend in fertility has been reversed in recent years but the fertility rate remains at relatively low levels.

Source: Australian Bureau of Statistics

SPOTLIGHT

Australia's ageing population

One of the most significant changes to Australia's population since 1901 has been the increase in the average age.



10.13 Australia's ageing population engages with new technology.

The reasons for this ageing of the population are:

- increasing life expectancy—Australians are living longer than ever before. The average life expectancy is now 83.9 years for women and 79.3 years for men (see Table 10.14)
- declining birth rates—lower fertility rates (the average number of children for each woman) have resulted in a decrease in the proportion of young people in the population
- changes in Australia's immigration program—in the 1950s and 1960s, Australia operated a large-scale immigration program. The majority of immigrants were young people of working age. Because of their age, many of them had children. In the late 1980s and 1990s, the immigration program was significantly reduced and many of those who did arrive now came from an older age group. In the late 2000s, the immigration program was expanded to record levels to meet the nation's skills shortage. Priority was given to people with employment skills in areas in which demand exceeded supply.

10.14 Life expectancy in Australia

Year of birth	Age in years (males)	Age in years (females)
1870	46.5	49.6
1901	55.2	58.8
1946	66.1	70.6
1986	72.8	79.1
2005	78.5	83.3
2010	79.3	83.9

Source: Australian Bureau of Statistics

Future population growth

Opinions about the ideal future size of Australia's population vary significantly. Some economists and politicians believe that Australia could support a population of 25–30 million. They argue that population growth will result in economic growth and that technology will be able to overcome the environmental problems created by any increase in population.

In contrast, some scientists and ecologists argue that a population closer to 8–10 million would be more **ecologically sustainable**. They believe that population growth will only worsen the problems of resource depletion, water availability and quality, land degradation, pollution and habitat loss.

Australia has little chance of changing its population growth rate by natural means (that is, changes in birth and death rates) in the near future, but it can decide on the number of immigrants allowed to enter the country. Without an immigration intake Australia's population would grow very slowly and might even start to decline. Economists argue that this would limit Australia's economic potential and result in a decline in living standards.

ACTIVITIES

10.2

Knowledge and understanding

1 State the number by which Australia's population increased over the course of the twentieth century.
2 Identify the two components of population growth. Define each one.
3 State the number of immigrants who have settled in Australia since World War II.
4 State the proportion of Australia's population who are either first-generation or second-generation settlers.

Applying and analysing

5 Explain why Australia's population is said to be ageing. What problems might this create for planners?
6 Explain why some economists and politicians argue for continued population growth.
7 Outline why some scientists and ecologists have called for a limit on Australia's population growth.
8 Identify the main means by which Australia's population growth can be controlled.

Geographical skills

9 Study Figure 10.6. Estimate the year in which Australia's population reached:
   a 5 million **b** 10 million **c** 20 million.
10 Study Figure 10.7, then answer the following questions.
   a In which year did the rate of natural increase peak?
   b What impact did the world wars and the Great Depression have on population growth? What was affected most: natural increase or immigration?
   c Explain why there was a sharp increase in population growth in 1918 and again in 1946.
   d Estimate the contribution made by immigration to total population growth in 2007.
   e What has been the general trend in the rate of natural increase since 1970?
   f Working in groups, suggest reasons for the trends evident in part **a** and part **b**.
11 Study Figure 10.12. What has been the general trend in fertility since the early 1960s? Suggest reasons for this trend.
12 Study Figure 10.9, then complete the following tasks.
   a Estimate the percentage of overseas-born Australians who were born in Europe (that is, North-western, Southern and Eastern Europe).
   b Estimate the percentage of overseas-born Australians who were born in Asia (that is, South-East Asia, North-east Asia and Southern Asia).
   c Calculate the number of overseas-born Australians who were born in Europe.
   d Calculate the number of overseas-born Australians who were born in Asia.
13 Study Figure 10.10, then complete the following tasks.
   a Estimate the percentage of immigrants from Europe in 1954 and in 2010–11.
   b Estimate the percentage of immigrants from Asia in 1954 and in 2010–11.
   c Write a report outlining how the source of immigrants has changed during this time.

Investigating

14 It is the 2040s and Australia's population has reached 30 million. As a class, brainstorm the benefits and disadvantages associated with a population of this size.

10.3 Geoskills: Population pyramids

A population pyramid is a special type of bar graph used to show the age and sex structure of a population. We can compare it with the population pyramids of other populations, and with those of the same population over time.

What a population pyramid tells us

A population pyramid shows the age groups of a population and shows either the actual number, or the proportion of the population, in each age group for both males and females. Each population pyramid represents 100 per cent of a particular population.

The shape of the population pyramid is important because it tells us a lot about the population. For example:

- If the base of the pyramid is wide, then there are more people in the younger age groups and the population is said to be 'young'.
- If the upper part is relatively wide, then the population is said to be 'old' or 'ageing'.

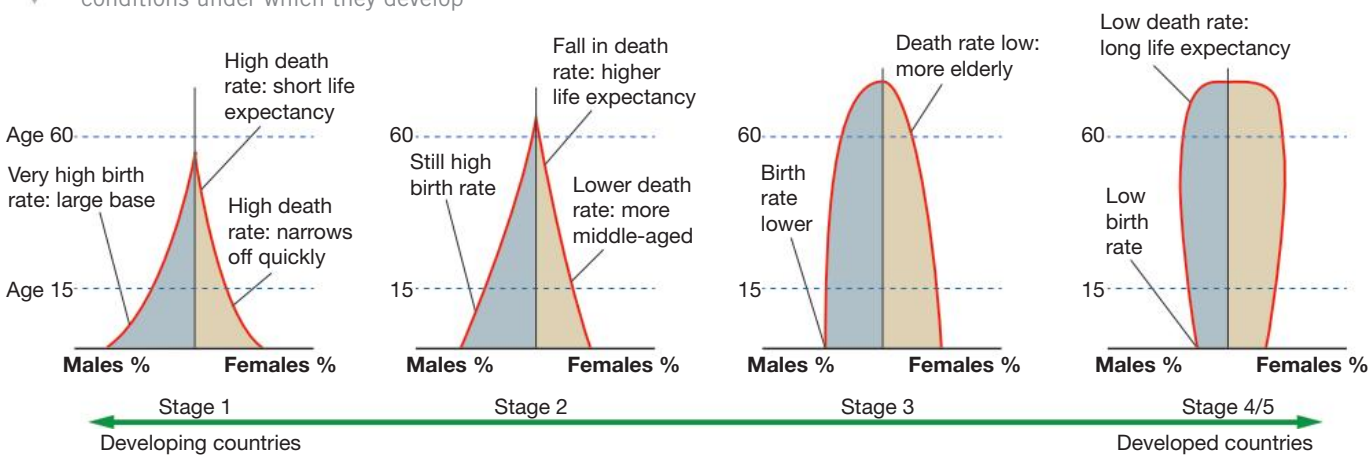
Events such as war, famine, disease or large-scale **emigration** may explain why there are fewer people than you might expect in a particular age group.

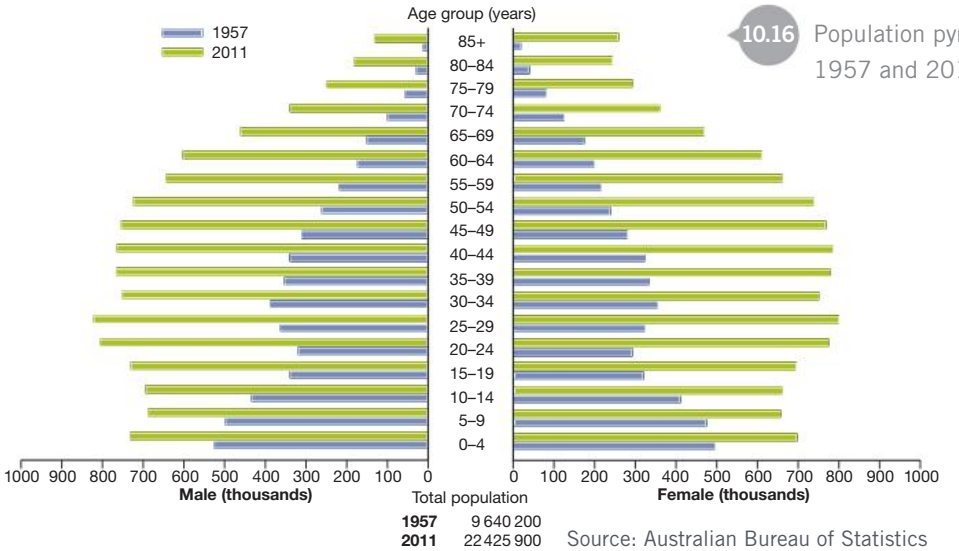
The impact of a baby boom and/or immigration may explain why there are more people in a particular age group.

Figure 10.15 shows a series of pyramid shapes with an explanation of conditions under which such population structures develop.

Populations are often divided into broader groups based on their level of independence. The dependent parts of the population are usually defined as the age groups 14 years and under, and those 65 years and over. The changing proportion of the population in each age group provides us with information about future population trends. If the proportion and the actual size of the population 65 years and over is growing, the population is said to be ageing. If the proportion and the actual size of the population 14 years and under are decreasing, we can conclude that the birth rate is declining.

10.15 Common population pyramid shapes and the conditions under which they develop

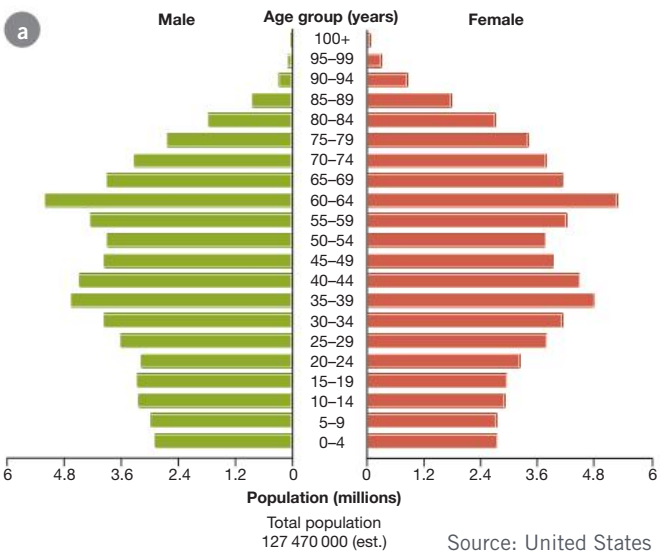




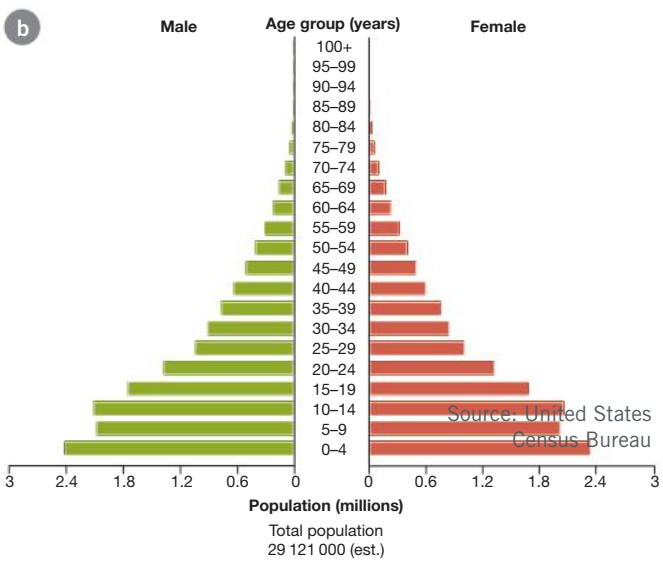
10.16 Population pyramid for Australia, 1957 and 2011

Source: Australian Bureau of Statistics

10.17 Population pyramids for (a) Japan in 2011 and (b) Afghanistan in 2010



Source: United States Census Bureau



Source: United States Census Bureau

ACTIVITIES

Geographical skills

1 Study Figure 10.16, then complete the following tasks.
   - **a** Estimate the percentage of the population under the age of 15 years in 1957 and 2011.
   - **b** Estimate the percentage of the population over the age of 65 years in 1957 and 2011.
   - **c** Using the data from Figures 10.15 and 10.16 and the information in the text, write an explanation of the trends observed.
   - **d** In groups, list and discuss the likely impact of the trends observed in Figure 10.16 on the future of childcare, education, the age pension and aged care.

2 **a** Study Figures 10.15 and 10.17, then copy and complete the following table in your workbook.

	Japan, 2011	Afghanistan, 2010
Population age (young, old or ageing)		
Stage of development		
Percentage of the population under 15 years of age		
Percentage of the population over 65 years of age		

   b What different issues may Japan and Afghanistan experience in the future?

10.4 Economic activity and population distribution

Australians live in many different geographical locations, ranging from large coastal cities to isolated outback homesteads. Why people choose to live in different locations is a result of many factors.

Where we live

Because of central Australia's harsh climate, scarce water resources and poor soils, few people live there. People have preferred to live in the milder climate of the east, and the better watered areas, which can support bigger populations. The east is also where the majority of Australia's jobs are located. Current trends in population distribution reflect the importance of economic factors in determining where people choose to live.

Building the pattern

The concentration of people near the coast can be traced back to the earliest European settlements. For the first 100 years, coastal shipping was the main form of communication because land routes were difficult. When roads were built, they simply reinforced the dominance of coastal cities.

Growth of coastal cities

With the country's reliance on trade, most of the large financial institutions established themselves in coastal cities and **manufacturing** grew, providing jobs for migrants as they arrived. Economic activity soon became concentrated in existing coastal city centres.

The pattern of land use

Australia's population distribution reflects the pattern of land use. Features of the pattern are listed below.

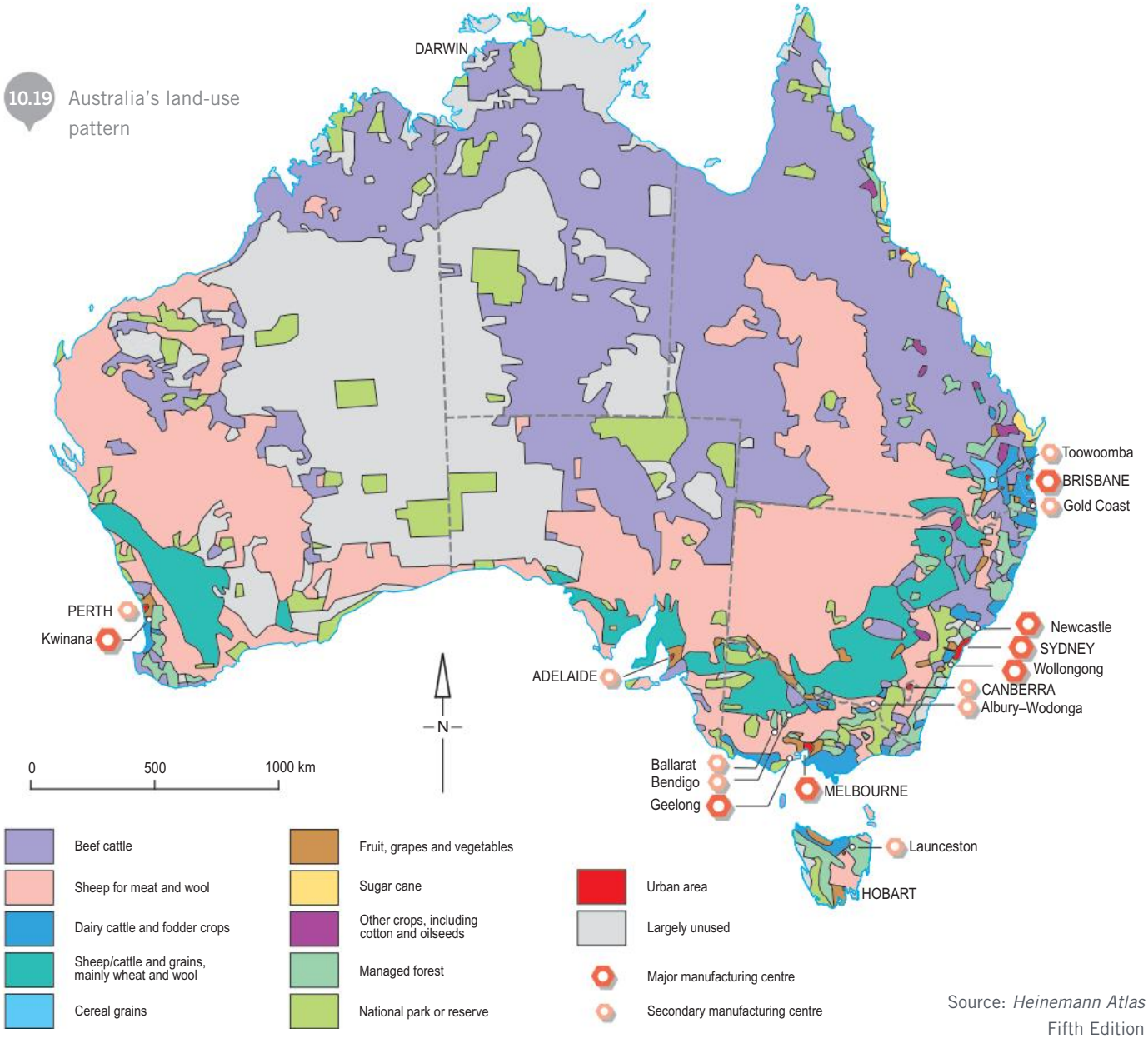
- The deserts of the mid-western section of the continent are largely uninhabited. The lack of water means that 25 per cent of Australia cannot support agriculture.
- Large areas of land are used for **extensive grazing**. In the tropical north, cattle are run on enormous properties averaging 100 000 hectares, and sheep are grazed on the semi-arid country to the south. Such grazing occupies 60 per cent of the continent. This land suffers from a shortage of water, so the population density is low (see Figure 10.18).

10.18 The population density is low in the vast grazing areas of Australia.



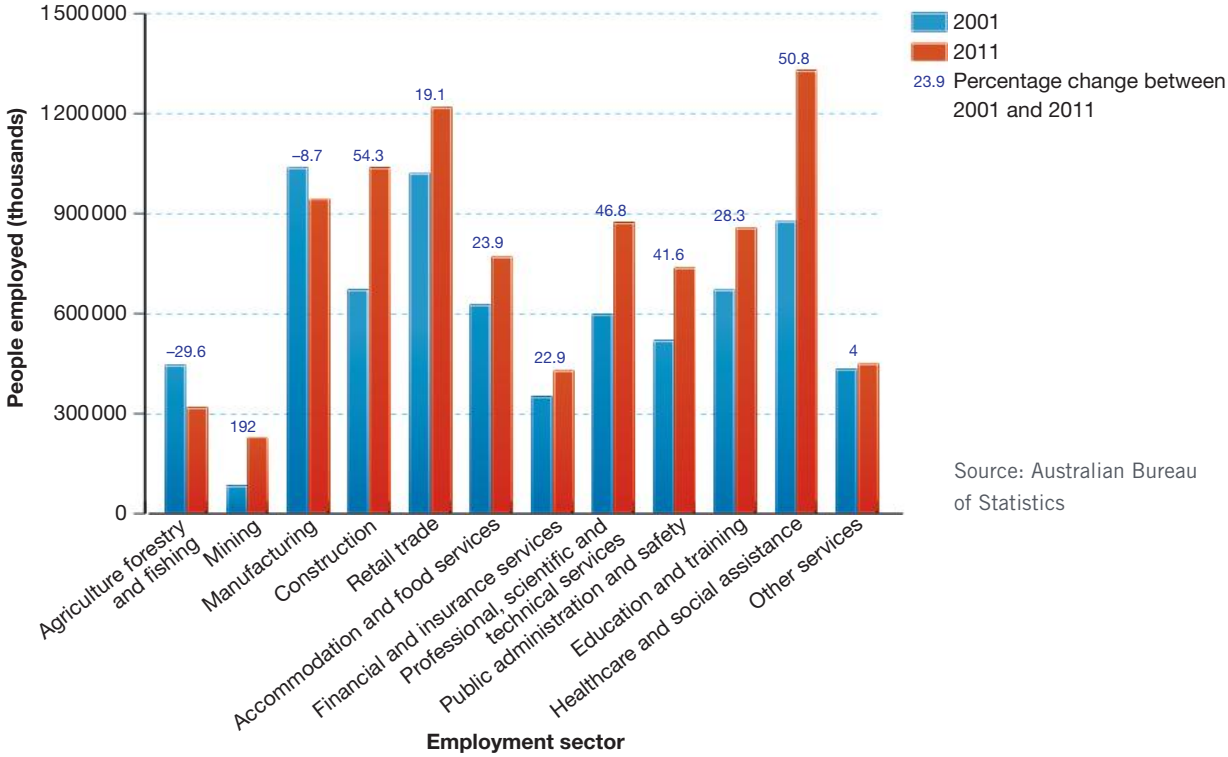
- The better watered areas of the east, south-east and south-west, which occupy the remaining 15 per cent of the continent, support most of the country's economic activity. They have generally reliable water supplies and fertile soils. These support mixed crop and livestock farming—commonly, of wheat and sheep. More intensive forms of agriculture, such as dairying, occur along the coast. Most of the urban–industrial growth is found here as well. This is where most Australians have chosen to live (see Figure 10.19).
- Mining is the only important land use whose location is not related to the availability of water resources. Mining occurs wherever mineral deposits are found—often, in remote areas.

10.19 Australia's land-use pattern



Source: *Heinemann Atlas* Fifth Edition

10.20 Structure of the Australian workforce, 2001–11. Far-reaching changes in the structure of the workforce influence the decisions people make about where to live.



Source: Australian Bureau of Statistics

Economic activities

In recent decades, economic factors have become increasingly important in people's decisions about where to live. This is a trend that is associated in large part with Australia's increasing engagement with the global economy.

New technologies and Australia's integration into the global economy have resulted in a change in the type of economic activity undertaken. Where manufacturing once accounted for nearly 30 per cent of employment, it has now shrunk to only 9 per cent. Most work is now in the service sector, in areas such as information and communications technologies, business services, health, hospitality and tourism (see Figure 10.20). These industries continue to be based in urban centres.

Trade has always been important for Australia's prosperity. Agricultural products such as wool and wheat once dominated Australia's exports, but now minerals are our most valuable export. The rapid economic growth of China and its demand for coal and iron ore have resulted in a mining boom in Australia. Australia is also a major exporter of services. The most valuable of these are education and tourism.

Recent trends

Where a person decides to live depends on the opportunities there are for them to work and the lifestyle they want. Some new general trends are:

- a declining number of people living in rural areas
- an increasing number of people moving to live near the coast
- an increasing number of people working in the mining industry.

Mining boom

In the past, mining booms led to the rapid growth of towns in regions where the minerals were found. This, however, was expensive. Mining companies generally took responsibility for building the infrastructure needed to support the mining workforce. Today, it is not uncommon for the majority of the workforce to live in major urban centres such as Perth, and to fly in and out of the mining centre for work. While working, they live in special facilities used to accommodate workers temporarily.

In 2010–11, Western Australia recorded a population increase of 2.4 per cent. The population of Perth (see Figure 10.21) is expected to increase by more than a third within the next 20 years.



10.21 Perth's rapid population growth has been driven by economic change in the shape of Australia's mining boom. The mining boom is, in turn, a product of the rapid economic growth taking place in China.

ACTIVITIES

10.4

Knowledge and understanding

1 Explain why early European settlement occurred on the coast.
2 Explain how the availability of water determines land use.
3 Describe the distribution of Australia's population.
4 Outline the changing patterns of Australia's population distribution.

Geographical skills

5 Study Figure 10.18 and identify the evidence that the land is used for grazing. Account for the absence of any stock in the photograph.
6 Study Figure 10.19, then complete the following tasks.
   a Construct a table with three columns. Give the columns the following headings: 'Extensive grazing', 'Mixed crop and livestock farming' and 'Intensive agriculture'. Refer to the map's key and place each of the first eight types of land use represented into one of the above three categories.
   b Identify Australia's major and secondary manufacturing areas.
7 Study Figure 10.20. Identify the sectors of employment that have shown an increase in percentage terms since 2001. What does this trend mean for the distribution of Australia's population?
8 Study Figure 10.20. Identify the four sectors of employment that have shown the greatest percentage increase since 2001. Where are the majority of these jobs located? What does this trend mean for the future distribution of Australia's population?

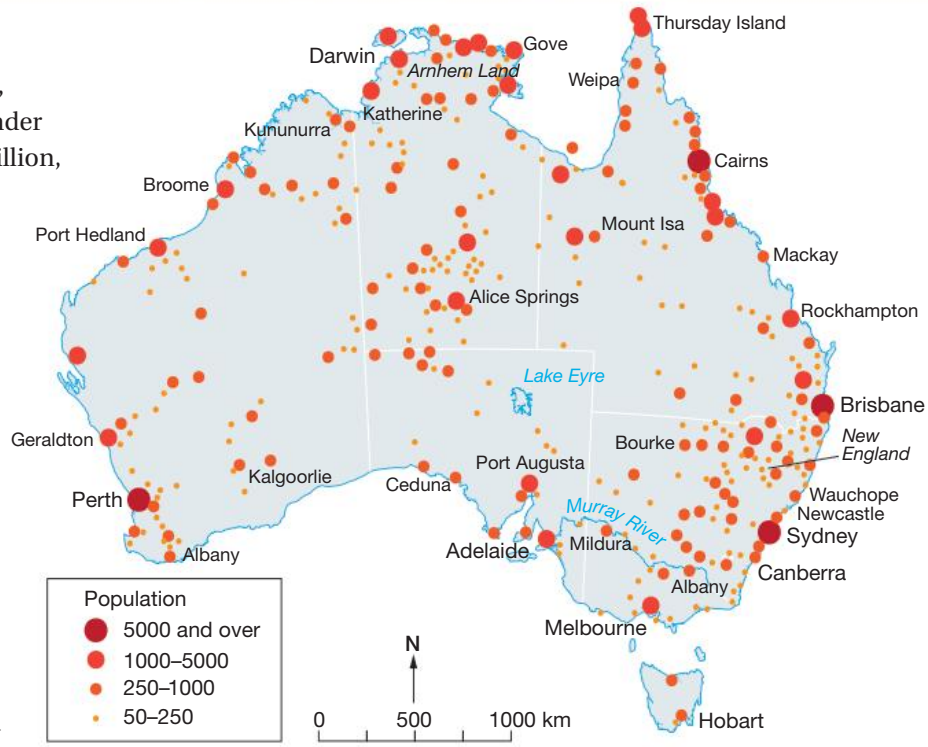
10.5 Changing distribution of Australia's population

The distribution of Australia's population is changing. Economic change, the ageing of the population and the lifestyle choices individuals make are the main causes of this change. Over time, these changes have important implications, especially in terms of the infrastructure required to meet people's needs.

Pre-1788

When the British First Fleet arrived in 1788, Australia's Aboriginal and Torres Strait Islander population may have been as many as 1 million, split into 250 to 300 language groups or nations. Within each nation there existed several clans, which had from as few as five or six to as many as thirty or forty members. Each nation had its own language and territory. While most parts of the continent were occupied, population densities were greater in those areas where water and food were more widely available. The number of people that different types of environments could support is shown in Table 10.22.

The distribution of Australia's Aboriginal and Torres Strait Islander population today is shown in Figure 10.23. Twenty-six per cent of Indigenous Australians live in semi-remote and remote areas, whereas just 1.7 per cent of the total population live in these areas.



Source: Australian Bureau of Statistics

10.23 Distribution of Australia's Aboriginal and Torres Strait Islander population

10.22 The productivity of the environment determined the population density of Aboriginal people in an area.

Environment	Location	Population density
Monsoonal	Arnhem Land (Gidjingali)	1 person/1.25 km^2
	Arnhem Land (Wanindiljaugwa)	1 person/8 km^2
Desert	Central Australia (Walbiri)	1 person/90 km^2
	Central Australia (Aranda)	1 person/32 km^2
Better watered area	Sydney	2–4 people/1 km^2
	Murray River	2–2.5 people/1 km^2
	Lake Eyre	1 person/4 km^2
High tableland	New England	1 person/56 km^2

Source: W. Hanley & M. Cooper (eds), *Man and the Australian Environment*, McGraw Hill, Sydney, 1986

Post-1788

In the years following European settlement, settlers spread out from the newly established colonial townships of Sydney (established 1788), Hobart (1804), Perth (1829), Brisbane (1825), Melbourne (1835) and Adelaide (1836). Because the colonists' agricultural knowledge was largely limited to European land-use practices, the early pioneering settlers first occupied those parts of Australia where the climate was most like that found in England. This helps to explain the concentration of people in Australia's south-east, where rainfall is more reliable and less seasonal.

Post-2010

Figure 10.24 shows the uneven distribution of the Australian population. Eighty per cent of people live in a narrow coastal strip, stretching from Brisbane to Adelaide, that represents just 3 per cent of the continent's land area. A zone of moderate population density stretches from the Darling Downs in southern Queensland, through the central west of New South Wales and across Victoria. The remaining 81 per cent of the continent contains just 3 per cent of the population.

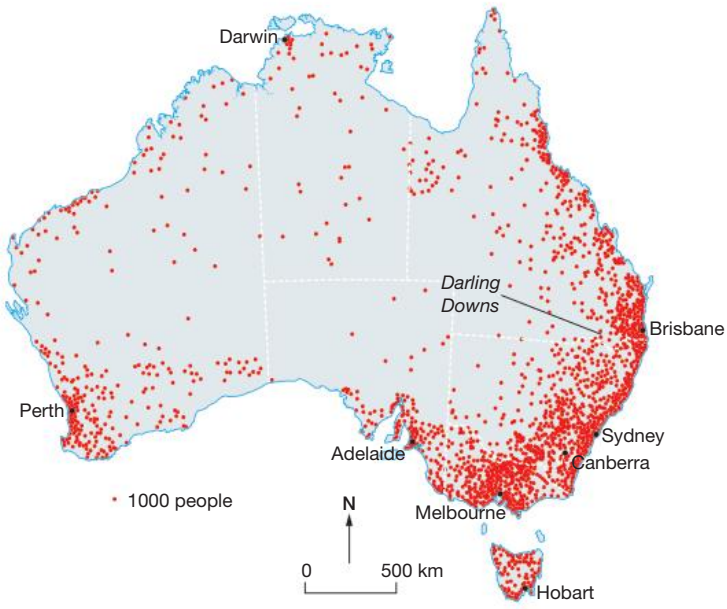
Each of these zones is associated with different land uses. The closely settled coastal strip contains almost all the big cities and most of the large-scale industry and business. The moderately settled zone is dominated by agriculture and some small-scale industry. The sparsely settled zone is dominated by extensive grazing and scattered mining activities.

Australia's overall population density (that is, the number of people per square kilometre) is 2.9 people per square kilometre. This is the lowest of any of the continents, except for Antarctica. The highest population densities are found in the south-east corner of the continent.

More than 80 per cent of the population (or 17.1 million people) live in cities and towns. This is why Australia is often described as the most urbanised society on earth. Fifty-two per cent of the total population (11.8 million) live in Brisbane, Sydney, Melbourne and Adelaide.

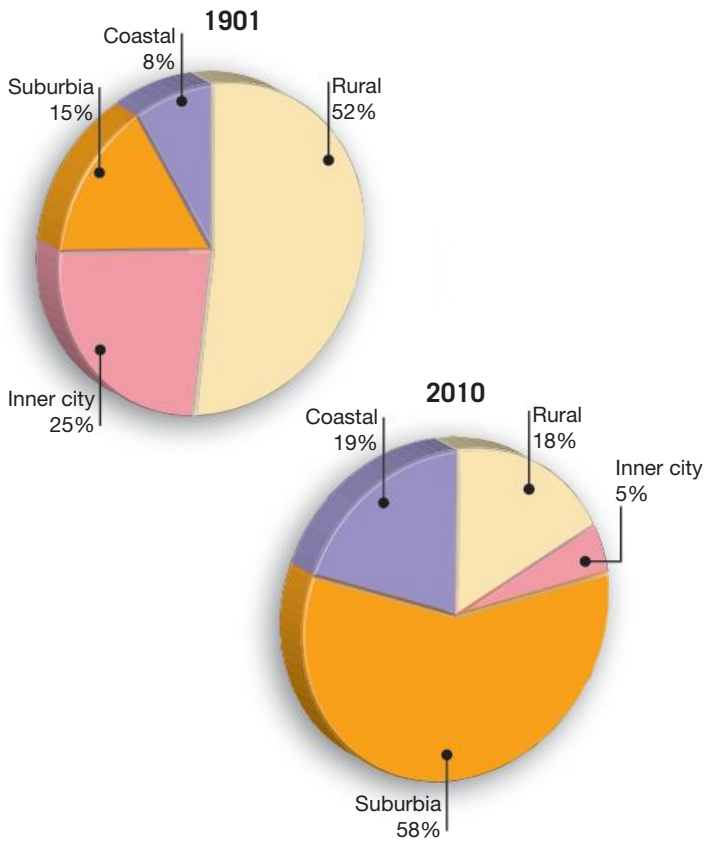
The distribution of Australia's population is changing. The most important of these changes are shown in Figure 10.25.

10.24 Distribution of the Australian population. Each dot represents 1000 people.



Source: Australian Bureau of Statistics

10.25 Distribution of the Australian population, 1901 and 2010



Recent changes

Australia's population distribution has changed and will continue to change. Recent changes can be observed in Figure 10.26.

Moving from the city

During the latter half of the twentieth century, Australians left the inner city for the suburban lifestyle. This has been called the 'flight to the suburbs'.

Moving to the city

Since the mid-1990s the number of people choosing to live in the inner suburbs of all Australia's large cities has increased. Attracted by the benefits of inner-city living, these people (mainly the young and older 'empty nesters') have increased the demand for new apartments within walking distance of the CBD or major public transport centres.

Also occurring is urban infill. This is the development of land in already-developed suburbs. Townhouses or small apartment blocks are built on land that once was vacant or used for non-residential purposes or had few houses. Infill development is becoming more common on transport corridors, near major commercial centres and in suburbs where there are older houses on large blocks of land.

Moving interstate

The number of people living in the Australian Capital Territory, Victoria, Western Australia and Queensland has increased faster than the national average, while the number living in New South Wales and the Northern Territory has also increased, but more slowly than the national average (see Table 10.28). The drawcards in Queensland's south-east include jobs, climate and lifestyle.

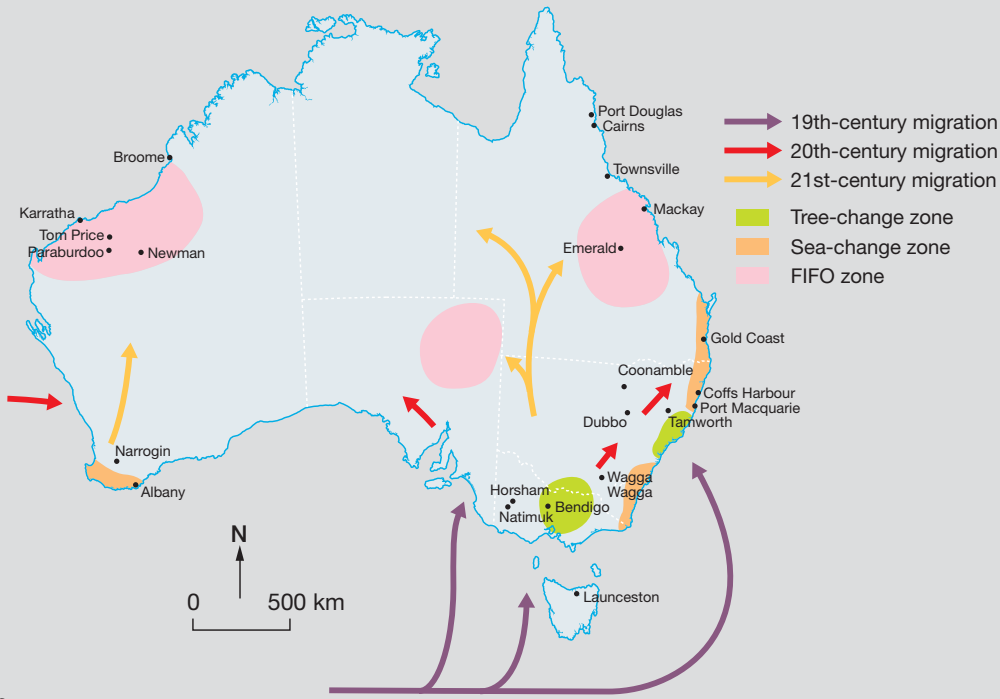
New arrivals, old choices

In 2010–11, overseas migration added 50 200 to the population of New South Wales, followed by Victoria

10.26 Key features of Australia's changing population distribution

New frontiers

Australia's mining boom is attracting people to those parts of Australia where minerals are found and where the great mining developments are taking place. The use of 'fly-in, fly-out' and 'drive-in, drive-out' labour means that the growth of communities in remote parts of Australia may not be as great as that experienced in earlier mining booms.



Let's head to the beach

Towns right along the coast have grown as retirees, families and singles seeking a lifestyle change move from the capital cities and the bush to beach-side communities. Queensland's Gold Coast has been the most popular destination for Australians on the move for 20 years. The Gold Coast barely existed in 1945. By 2000, it had 404 000 residents. By 2010, the population had grown to 540 000.

Regional centres back in vogue

Cities such as Dubbo, Tamworth and Wagga Wagga in NSW, Horsham in Victoria, as well as Narrogin in Western Australia, have grown in recent years, soaking up service providers and people from smaller, surrounding rural communities.

The bush bleeds

The share of the population living in rural areas is declining. As a result, many small rural communities are struggling to survive.

(45 700) and Queensland (31 300). The Northern Territory received just 630 people. Sydney is using immigrants to replace departing residents.

More migrants come to Australia from New Zealand than from anywhere else (see Figure 10.27). There are approximately 570 000 New Zealanders living in Australia. New Zealanders who move to Australia are generally young, and they come to Australia for work opportunities that are not available in New Zealand. They choose locations throughout Australia in which to live and work. New Zealanders do not require a work visa to work in Australia thanks to agreements between the two countries. Australians are also able to move to New Zealand to work without a visa, but the number of people who do so is very small.

State/Territory	Population growth (%)	
	2010–11	2011–12
Western Australia	2.4	3.4
Australian Capital Territory	1.9	2.0
Queensland	1.7	2.0
Victoria	1.5	1.7
New South Wales	1.1	1.2
South Australia	0.8	1.0
Tasmania	0.5	0.1
Northern Territory	0.4	1.8
Australia	**1.4**	**1.9**

Source: Australian Bureau of Statistics

10.28 Population change by state and territory, 2010–11



10.27 The New Zealand netball team, the Silver Ferns, have over half a million supporters to call on when they play the Australian netball team in Australia.

ACTIVITIES

Knowledge and understanding

1. Outline the distribution of Australia's population before 1788.
2. Describe the distribution of Australia's Aboriginal and Torres Strait Islander population today.
3. Describe the distribution of European settlers in the early post-1788 period. Why was settlement largely confined to the south-east corner of the continent?
4. Explain the relationship between land use and population density.
5. State why Australia is often described as the most urbanised society on earth.

Geographical skills

6. Study Figures 10.23 and 10.24. Describe how the distribution of the Aboriginal and Torres Strait Islander population differs from that of the Australian population as a whole.
7. Study Figure 10.25. Describe how the distribution of Australia's population changed between 1901 and 2010.
8. Study Figure 10.26. Write an extended response outlining the recent changes in the distribution in Australia's population. Identify the population movements associated with:
   a. economic factors
   b. lifestyle factors.

10.6 Australians and the coast

More than 86 per cent of the Australian population live within 50 kilometres of the sea. In recent decades, the shift of people to the coast has increased substantially. The implications of this trend are significant, and some parts of the Australian coastline are under pressure and must be managed carefully.



10.29 Time at the beach has long been important to Australians.

Growth along the coast

Holidays at the beach have long been part of Australia's national identity (see Figure 10.29). Increasingly, however, people are choosing not just to holiday on the coast, but to move there to live. This phenomenon is known as a 'sea change'. It is now occurring on such a scale that long stretches of coastline have become built-up areas and are emerging as major population centres.

Much of the coastal population growth has been concentrated within a 3-kilometre-wide coastal strip, as waterfont properties are highly valued. This is affecting every state, with the most rapid growth being in New South Wales, south-eastern Queensland, south of Perth in Western Australia, and along the Bass and Surf Coasts in Victoria. About 20 per cent of Australians now live in coastal towns and cities outside state capitals.

Young families on the move

Since 2000, there has been an increase in the number of younger people, many of them with families, moving to coastal communities. They are seeking cheaper homes, with the added attraction of a more enjoyable **lifestyle** away from the congestion of big cities. The highest rates of growth have occurred in areas close to the state capitals, where people are able to commute on a daily basis.

Retirement of baby boomers

Baby boomers are those people born in Australia between 1946 and 1964. As they retire, many baby boomers are choosing to sell their family homes in suburbia and seek lifestyle locations by the sea (see Table 10.30). People are continuing to turn their backs on the stresses associated with city living, and are adopting a more relaxed lifestyle.

10.30 Estimated growth of baby boomer populations in coastal towns, 2007–21.

Coastal town	Projected growth in population of baby boomers, 2007–21
Hervey Bay (Qld)	8500
Mandurah (WA)	7900
Mornington Peninsula Shire (Vic.)	6500
Tweed Heads (NSW)	5400
Victor Harbor (SA)	2400

Environmental impacts

The much-loved Australian coast is feeling the pressure of population growth, and conflicts have arisen between developers and those concerned about the environment. Protective sand dunes are bulldozed and **wetlands** are destroyed for residential and commercial developments. Local waterways can become polluted as the existing stormwater and sewerage systems become overloaded.

The sea change challenge

The rapid growth of population has created challenges for coastal councils. Many do not have sufficient financial resources to build the necessary infrastructure (roads, and water and sewerage systems). In 2004, the National Sea Change Taskforce was established. Its purpose is to provide leadership in responding to this population growth and, in particular, to give support and guidance to councils responsible for managing the growth in a sustainable manner. The challenge is to plan for growth without destroying the environmental attractions that brought people to the area in the first place.

ACTIVITIES

10.3

Knowledge and understanding

1 Define 'sea change' and describe where it is happening in Australia.
2 Explain why so many people are keen to move to the coast.
3 Outline the environmental impacts of coastal development.

Applying and analysing

4 Respond to the following statement with arguments for and against: 'Future coastal development should be limited as it is too damaging to the environment.'

Investigating

5 Study the data in Table 10.30 and research the five towns that are the most popular with baby boomers. In small groups, prepare a map or wall display of Australia that locates each of these centres, with text boxes showing the attractions of each one and a column graph of expected population increase.

10.7 Case study: Gerringong

Gerringong is a popular coastal town located on New South Wales's south coast. The area has golden beaches, rugged sea cliffs and rolling green hills that sit under the Illawarra escarpment to the west. While the beaches and sun attract many tourists in summer, Gerringong is a vibrant, close-knit community for those who have chosen to live there.

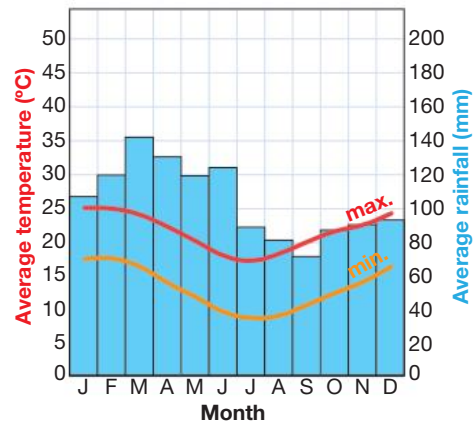
A coastal environment

People are attracted to Gerringong (see Figure 10.31) by the region's environment. The mountains come close to the sea, and the rolling hills that connect them to the coast are always green (see Figure 10.33)—a result of a temperate climate and good rainfall (see Figure 10.32). The fertile, red soil that has formed on top of the underlying basalt rock supports lush vegetation.



10.31 South coast, New South Wales

10.32 Climate graph for Gerringong, New South Wales



Gerringong's history

Aboriginal history

This area was rich in the resources sought by Aboriginal people as they moved along the coast over many thousands of years. Family groups of the local Wodi-Wodi People camped here. They also had tracks along the top of the escarpment to the west of the coastal plain, and hunted the plentiful wallabies of the rainforest.

The ocean provided a ready supply of pipi, fish and oysters. Fresh water was available in the creeks that ran into Werri Lagoon. Ochre (a pigment extracted from clay and used for ceremonial purposes) was found throughout the area.

European history

European colonists first explored this part of the New South Wales coast during the drought of 1813. Cattle were unloaded onto the area's beaches from open boats so they could find feed. As the colony grew, the resource most sought after was timber, especially the highly valued red cedar.



10.33 Oblique aerial photograph of Gerringong. Prominent landforms that are visible in the photograph include Werri Beach, Werri Lagoon (foreground) and some of the headlands that jut out into the sea.

Cedar cutters moved into the rainforests along the escarpment and, by the 1820s, the area became a major supplier for Sydney. Early government surveyors selected the sites of harbours and townships, and Gerringong became a gazetted township in 1829.

Once the land was cleared and the fertility of the soil discovered, dairying became a flourishing industry. A boat harbour at Gerringong was used to transport both the cedar and dairy products to Sydney. Once the supply of cedar was used up, dairying became the most important industry and the town grew to provide services.

DID YOU KNOW?

The name of the town of Gerringong is derived from an Aboriginal word meaning 'a fearful place'.

While Gerringong has long been a valued holiday destination, tourism has expanded rapidly in recent decades as developers have invested in new housing and tourist accommodation—some of which has been built on former dairying farms. As a result, Gerringong's population has expanded to 3500 over the last 20 years.

SPOTLIGHT

Retiring to Gerringong

'My wife and I work and live in Sydney, but I spent my teenage years in the Shoalhaven district and grew to love the Illawarra region as well. We brought our children to the Gerringong district on family holidays from their early years, and we purchased a property in which we intend to live when our Sydney working days are over. It is a family haven and a place we all love, even though the children are now all adults. Members of our extended family and friends also come here. We have made many friends within the local community and attend the Anglican church here when we can. People know each other in the town and you hear warm greetings whenever you are shopping or walking.

'The area has a mix of farming, tourism and support services as well as a town in which many people who commute to Wollongong (and even southern Sydney) live. The population grows rapidly in summer, and on holiday weekends, as it is a comfortable two-hour drive from central Sydney. There are regular train services to Gerringong on the Sydney network. Recreational activities include surfing, boating, fishing, bushwalking in nearby parks, whale watching, sports and community activities.

'There is a modern government primary school, and there are government and non-government schools in Kiama, Nowra and Shellharbour. Medical and legal practices are in town. Local shopping is fine for the basics and the larger centres nearby provide all the major shopping and entertainment activities. The population is not large, and therefore a number of specialty businesses have started and failed over the years. The locals love their Rugby League team, the Gerringong Lions, but all sports for men and women are enthusiastically participated in.

'The scenery is spectacular as the town sits on the coast with a background of the Illawarra escarpment. Saddleback Mountain towers to the north and is often shrouded in cloud. We feel this beautiful place is a true family home.'

Dr Timothy Wright

Sense of community

The residents of Gerringong enjoy living in a close, supportive community. They are involved in numerous organisations that draw them together. The Gerringong Surf and Lifesaving Club provides a voluntary service for beachgoers by setting up a patrolled area at weekends and on public holidays. The club encourages children to join, and the Nippers (junior lifesavers) can be seen on the beach most Sunday mornings during the summer (see Figure 10.34). In winter, the town gets behind the local Rugby League team, the Gerringong Lions, which is coached by Michael Cronin, a noted international player. When the Lions reach a grand final, most of the town turns up to cheer them on. Other community organisations include church groups of various denominations.

10.34 Nippers learning, gaining confidence and having fun in a safe beach environment in Gerringong



SPOTLIGHT

Gerringong through my eyes

'Children from Gerringong attend the local primary school and then Kiama High School. Students at Kiama High have the option of doing surfing for sport. Students and teachers meet at the beach at 6 a.m. and surf until around 7.15 a.m. These students are then allowed to leave school early that afternoon, while others do sports such as fishing, golf, lawn bowls and weights.

'Gerringong has a large Rugby League playing community. On Monday afternoons, many of the town's families and teenagers gather at the main oval for a friendly touch competition. It is a very social occasion, and is a major meeting for many residents.'

Josh Gorrie, aged 16

10.35 Population pyramid for Gerringong

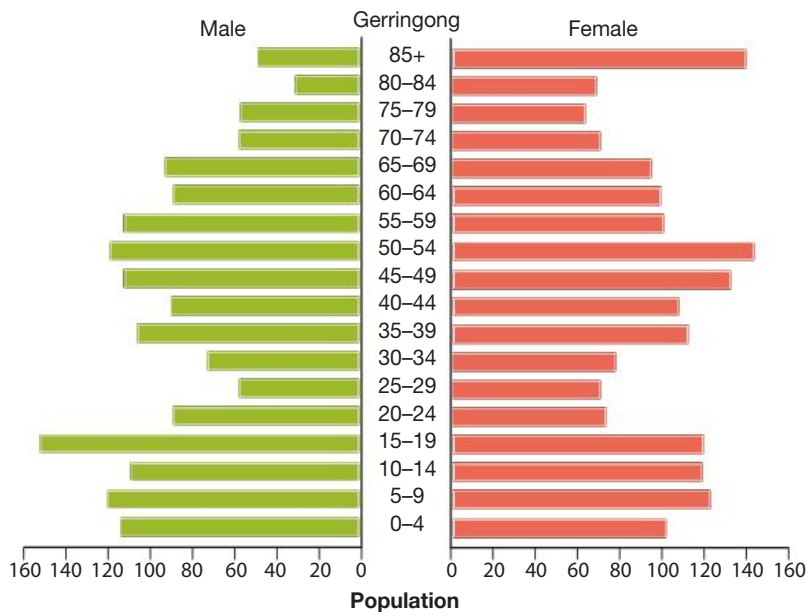


Figure 10.35 outlines the population profile for Gerringong. People of all ages are offered many opportunities to be part of the community. Young musicians have the opportunity to perform at regular concerts organised by the Gerringong Music Club.

Gerringong also appeals to retirees. For those who are active, there is much to do: surfing, fishing, bushwalking and cycling. It is an especially scenic area that inspires artists who have studios in the town. The less mobile aged people who live in the Mayflower retirement village are also made to feel very special. Each year, just before Christmas, the local Rotary Club organises a street parade, and players from the Gerringong Lions push the aged residents down the street in wheelchairs. People in Gerringong actively work together to protect their beaches. Figure 10.36 shows a group of volunteers removing weeds and planting vegetation to protect the sand dunes and beach.

DID YOU KNOW?

Gerringong Surf and Lifesaving Club's annual Captain Christie Ocean Swim is based on a local legend. The story goes that, in 1882, a sailor challenged Captain William Christie to swim from Gerringong Boat Harbour around the rocky headland to Werri Beach. The captain rose to the challenge and won a bottle of whisky for his efforts.



10.36 Members of the Gerringong community actively come together to protect their beaches. Werri Beach Dunecare is a project in which volunteers remove weeds and plant new vegetation around Werri Lagoon.

ACTIVITIES

Knowledge and understanding

1. Explain why people choose to live in Gerringong.
2. What is the meaning of the town's name?
3. Describe the resources of this coastal environment that have been used by Aboriginal people and by Europeans.
4. Explain why Gerringong has developed such a strong sense of community.
5. Outline the reasons why Gerringong appeals both to young people and to those considering retirement.

Geographical skills

6. Study Figure 10.32, then complete the following tasks.
   a. Calculate the mean annual temperature range.
   b. Describe and account for Gerringong's high annual rainfall and the distribution of this rainfall.
7. Using Figure 10.33, draw an annotated photo sketch of Gerringong.

Investigating

8. Using the internet, write a brief description of the accomplishments of three of the following people who have lived in Gerringong: Michael Cronin, Rod Wishart, Sally Fitzgibbons, Dean Bowen and Jack Druce.
9. Access the website of the Gerringong Surf and Lifesaving Club. Write a paragraph outlining why the club would appeal to young people living in Gerringong.

10.8 Impacts of technology

Advances in technology have transformed the world repeatedly throughout history. In recent times, the rate of technological change has increased significantly. Indeed, everything is faster these days. It is difficult to imagine a world without the internet, mobile phones, laptops, the iPod and the iPad, Facebook and wireless technologies.

Technology in the workplace

Businesses are often keen to use technologies that make them more productive and profitable. Unfortunately, doing so can also mean that some of their employees may lose their jobs. This can force those people to move to where work is available. For others, however, new technologies mean that they are not tied to a particular location or place to perform their work, and are free to move to where the lifestyle is more appealing.

Sectors affected

There has been a significant decline in Australia's rural population since at least the 1980s. Farms have been amalgamated (combined and made bigger) and mechanised. The increased use of machinery means that fewer farmhands are needed to work the land. Where casual labour was once used to harvest crops, mechanical harvesters are now common. This has severely affected the small towns that rely on the farm sector for their economic wellbeing. Added to this, people are using the internet much more to do their shopping and banking online, resulting in the closure of local businesses and bank branches. Technology also provides farmers with information to help them make better decisions. Up-to-date weather and climate data is accessed online. This can then be combined with data gathered in the field, as shown in Figure 10.37, and analysed to help farmers decide when to plant their crops.

Even those working in city-based factories, or in the service industries, can find that their jobs disappear, mainly because of **globalisation**. Corporations make decisions based on costs, and it is often cheaper to move their manufacturing operations to countries where wages are lower. In 2009, for example, Pacific Brands, the maker of Bonds clothing, sacked 1850 Australian workers after **outsourcing** its production to China.

The **digital revolution** and the development of the internet have made it easier for companies to shift their information technology services overseas. Examples of major Australian companies sending work offshore to places such as India are Telstra, Optus, Coles Myer and Westpac.

DID YOU KNOW?

In 1787–88, Captain Arthur Phillip's First Fleet took 8 months to sail from England to Sydney. Today, a Qantas A380 makes the journey in less than 23 hours.



10.37 Technology helps farmers to make their farming practices more efficient and more profitable.

Increased job flexibility

The introduction of new technologies does not always destroy jobs. Think of all the jobs created by the computer and mobile phone industries, and in online retailing. More importantly, the new information and communication technologies make it possible for people to live in their preferred location and still conduct business (often via the internet).

Commuters

Freeways and express trains have reduced travel times. This has led to an increase in the number of workers choosing to commute, on a daily basis, often over long distances, to jobs in metropolitan areas. Travel times in big cities are increasing, and governments are trying to find ways to reduce traffic congestion.

Fly-in, fly-out workers

Long-distance commuting has become more common in the mining boom states of Western Australia and Queensland. Fly-in, fly-out (FIFO) mining operations are those where food and accommodation (in a building known as a donga) are provided for workers at or near the mine site. Rather than live in the local community, the miners live on site for a rostered period of time and then return home. In Paraburdoo, WA, FIFO workers operate on a cycle of six days on, six days off.

Telecommuters

Improvements in telecommunications mean that people are free to move even further away in pursuit of their preferred lifestyle, and yet can still conduct business, be educated (through a School of the Air) and have their healthcare needs attended to—all over the internet. The National Broadband Network (NBN) will provide faster internet times. The NBN will connect up to 90 per cent of homes and workplaces with broadband data transfer speeds of up to 100 megabits per second—allowing for quicker, cheaper downloads. This is enough to support the use of high-definition videoconferencing by businesses, and for enhanced education and health applications. At a cost of $35.9 billion, it will be one of Australia's greatest ever infrastructure projects.

In the very near future, it will be possible for people to live in the spectacular Australian Alps and run businesses in Sydney, Melbourne or elsewhere while spending their days on the ski slopes. Someone with a business idea in Tarcoola, Charleville or Boggabilla will be able to market their product or service to a worldwide market.

SPOTLIGHT

My Family stick figures

We have all probably seen My Family window stickers. You might even have them on your family's car.

The Gold Coast–based Sticker Family business has sold more than two million stick figures—which include 'Father cooking', 'Mother with football', plus grandparents, children and pets—since 2009.

My Family stickers started when Phil Barham, a chiropractor, saw something similar while in California on a business trip. Back at home, he teamed up with Monica Liebenow, a graphic artist, who started doodling stick figures with a distinctive Australian flavour. At first, the pair sold the stickers at markets and fetes. Today, they sell them to a worldwide market through the Sticker Family website.

ACTIVITIES

Knowledge and understanding

1. Identify the new technologies and explain how they have affected people's choices of where to live.
2. Define the term 'FIFO workers'.
3. Describe the National Broadband Network and outline its potential to influence people's decisions about where to live.

Applying and analysing

4. Prepare some questions to ask a parent, a grandparent or an elderly person about how different their life was without all the modern technological devices we now have. Based on their answers, prepare an oral report.
5. Write a paragraph about how your life would change if all computers and telecommunications ceased operating for a day.

Investigating

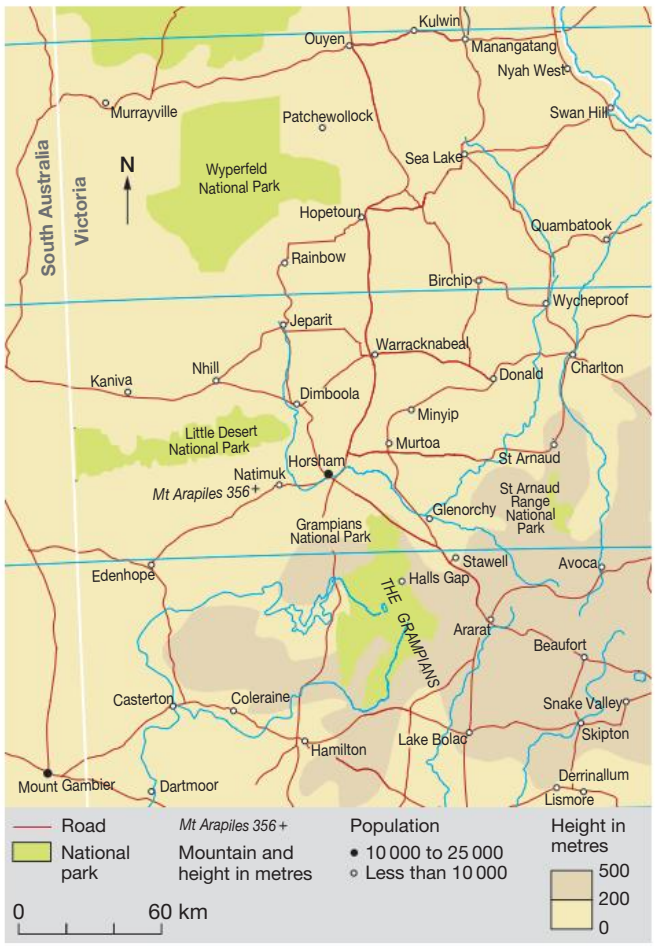
6. Find an example of an online enterprise. Where is it based? What locational factors did the operators of the business take into account when they established the enterprise?

10.9 Case study: Natimuk

Natimuk is a small rural town located in the heart of the Wimmera agricultural region of western Victoria. It provides goods and services for the surrounding wheat-growing and sheep-grazing district. Some 10 kilometres to the west of the town is Mt Arapiles, one of Australia's best rock-climbing locations.

An inland environment

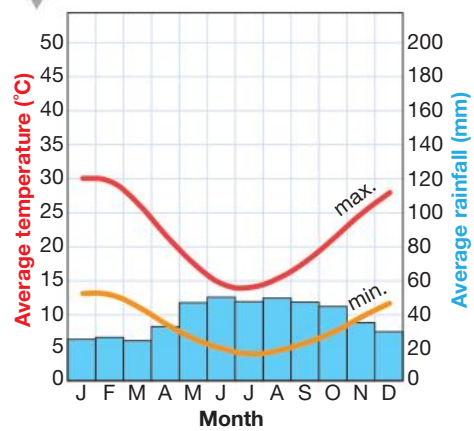
Most of the Wimmera near Natimuk is very flat (see Figure 10.38). Only Mt Arapiles—an abrupt sandstone outcrop rising up 356 metres—towers above the broad plains. A bushranger known as Captain Melville used Mt Arapiles to spot coaches travelling below, on the road from Melbourne to Adelaide, in the early days of settlement. Lake Natimuk, one of many lakes in the area, teems with fish and yabbies after prolonged rain, but it can completely dry up in a drought.



10.38 Natimuk and surrounding region

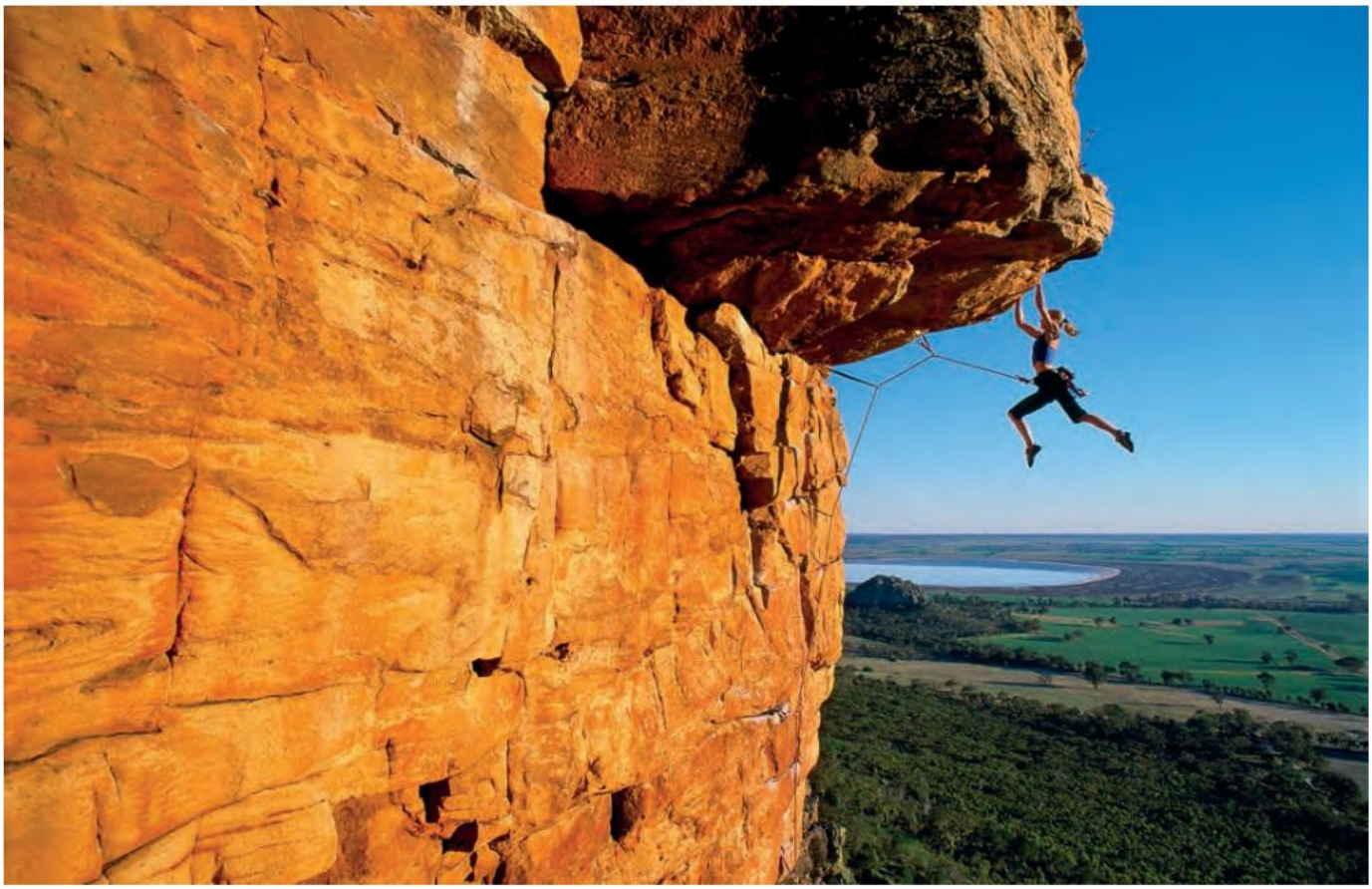
Natimuk experiences hot, dry summers, but the winters are cooler and wetter due to the cold fronts that sweep across the southern part of the Australian continent (see Figure 10.39). Rainfall is unreliable and droughts are common, leaving the land brown and bare for long periods.

10.39 Climate graph for Natimuk



Aboriginal history

The presence of Aboriginal people in the Wimmera is thought to date back tens of thousands of years. The Djurite Balug clan of the Jardwadjali People lived in the area around Mt Arapiles, hunting, fishing and gathering food and other resources. They quarried the hard rock of Mt Arapiles to make stone tools; a number of small quarries and other archaeological sites, including rock art sites, have been found there. Mitre Rock, just north of Mt Arapiles, is sometimes thought to have been sacred to the Djurite Balug, but it is likely that the entire mountain held special importance for them. Most of the original inhabitants had been displaced by the 1870s, when Natimuk was founded, but some of their descendants still live in the area.



10.40 Rock climbers from around the world visit Natimuk to climb on the faces and overhangs of nearby Mt Arapiles. Mitre Rock is visible beside Mitre Lake below.

European history

The first European visit to the region was that of the explorer Sir Thomas Mitchell in 1836. He climbed Mt Arapiles (by a less steep route than today's rock climbers; see Figure 10.40), and named it after a hill in Spain. From the summit, he noted in his journals the bark and grass shelters, coated with clay, built by the Djurite Balug people on the plains below.

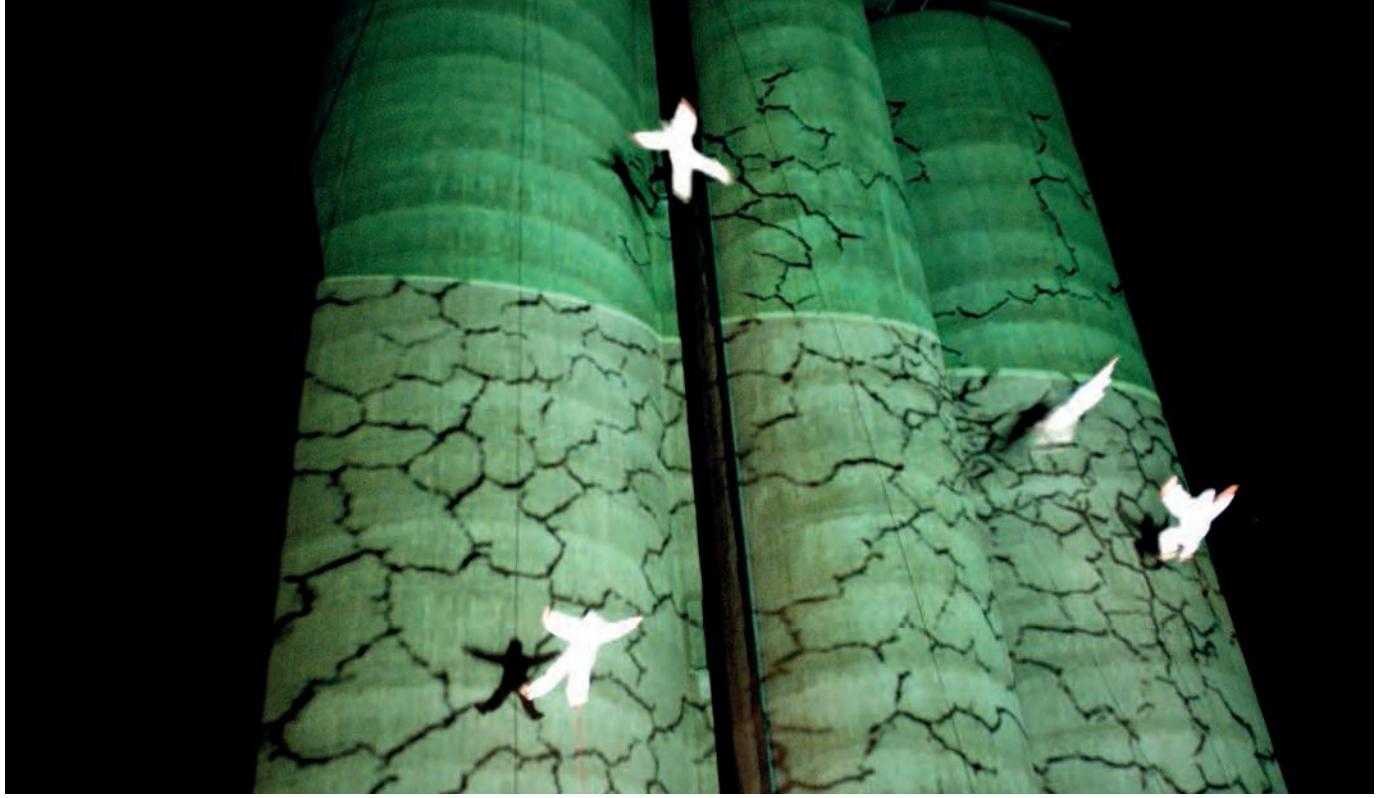
Early Victorian colonists quickly recognised the value of the pastures in the Wimmera region. By 1844, properties raising sheep were established. The town itself dates back to the 1870s, when it supported the vast sheep stations in the area. The post office opened in 1874 as Natimuk Creek, but was renamed Natimuk (minus the 'Creek') in 1884. It quickly grew to be one of the largest towns in the district, with over seventy shops and industries, including a flour mill and a steel foundry. By 1927, it had become one of the first Victorian towns to have its own electricity supply.

The Wimmera is a productive agricultural region where the land is used for **broadacre** cropping (mainly of wheat, canola and other grains and pulses) and grazing. Almost all towns rely heavily on primary production, and many of them are dominated by grain storage silos and flour mills.

DID YOU KNOW?

The name of the town of Natimuk is derived from an Aboriginal word meaning 'little lake', referring to the lake that lies to the north of the town.

Significantly, many of the smaller towns in the area are dying, just as they are across much of rural Australia. More advanced technologies and transport, and fewer people working the land, mean that these smaller towns struggle to survive. Regional centres are thriving. Nearby Horsham has, for example, grown more than Natimuk. Despite this trend, Natimuk has resisted the decline common in other Wimmera towns by developing its tourism industry. At the 2011 Census, Natimuk had a population of 659.

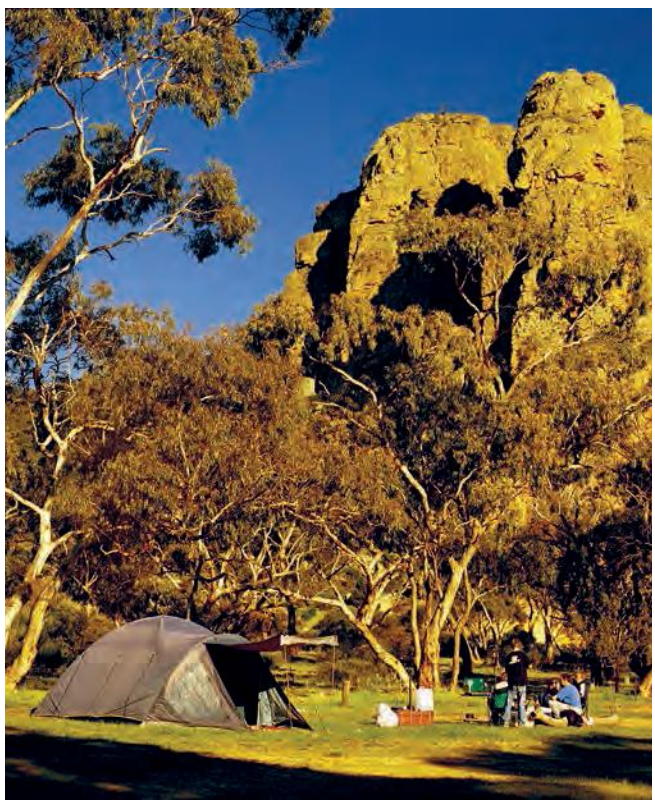


10.41 Performers at the Nati Frinj arts festival

Community actions

The residents of Natimuk are committed to action and progress. A Community Action Plan identifies the assets that are important to the town's future and undertakes to sustain and expand them.

10.42 Campers in Mount Arapiles–Tooan State Park, near Natimuk



Mt Arapiles offers first-class rock climbing that is considered by enthusiasts to be the best in Australia. The metamorphosed sandstone formation rises 356 metres and comprises many faces, gullies and outcrops. There are more than 2000 climbing routes, of varying degrees of difficulty, on its many features. Many climbers have made Natimuk their home so that they can live near Mt Arapiles. Some conduct climbing and abseiling courses there. The climbing at Mt Arapiles is so good that enthusiasts travel there from interstate and overseas. Many visiting climbers use the camping facilities at the base of Mt Arapiles, as shown in Figure 10.42.

Another attraction of Natimuk is its arts festival. The Nati Frinj, which is held every two years, is a weekend celebration of art, music, theatre, poetry and science. The Nati Frinj is a significant event that makes connections in the community and strengthens the town (see Figure 10.41).

Overcoming isolation

Advances in transport and communications technologies have reduced the isolation of living in Natimuk, over 300 kilometres from Melbourne, and elsewhere in rural Victoria. Physical distance is no longer the barrier it once was. A range of commercial and personal transactions that once required long journeys, or were slow because they depended on road or rail transport, can now be done over the internet. For the citizens of Natimuk, the global market

is theirs to access. Using e-commerce, they can buy books, music, clothing and electronic goods from all over Australia and overseas. They can pay bills and do their banking online. Farmers can immediately access expert technical support for any expensive machinery they import. Social networking websites such as Facebook and Twitter have transformed personal communications. The National Broadband Network will further enhance Natimuk's connectivity. It will open up new opportunities in areas such as education, health care and entertainment.

SPOTLIGHT

Natimuk through my eyes

'Natimuk has only one primary school, with a total of around fifty children. Secondary school students have to travel by bus to Horsham, which takes about 25 minutes. Horsham College, a government secondary school of over 1000 students, offers a diverse range of subjects. This is a huge advantage over other nearby country schools. School sports are at the beginning of the year, with swimming and athletics followed by cross-country running. Horsham College has a specialised volleyball program, and selected students represent the school regionally and nationally in volleyball, as well as in other sports such as tennis, badminton, netball and football.

'Life outside of school includes going to the local cafe, milk bar, skate park, BMX track and lake. After school has finished for the day, most kids go to the milk bar and hang around until tea time.

'Natimuk is an extremely close-knit town, and most people belong to the Natimuk Football Netball Club. On weekends, the whole town supports the football and netball teams, known as the Rams and the Ewes, and stays together for a meal every Saturday night at the football ground. The football and netball teams play in the Horsham District Football League, which takes in towns up to 100 kilometres away. This means early mornings for local kids playing footy and netball as they have to travel long distances for their junior matches. Natimuk also has tennis, bowls and gymnastics clubs. Other activities in the area include motorbike riding, trout fishing and swimming.

'After people finish their time at secondary college, most move away from Natimuk to cities such as Ballarat, Bendigo, Geelong and Melbourne to attend university. There are not many opportunities for employment in Natimuk, which means people not attending university leave the town to move to Horsham for other employment opportunities, such as beginning a trade.'

Luke Garwood

ACTIVITIES

Knowledge and understanding

1 Explain why people choose to live in Natimuk.
2 Outline how the town of Natimuk got its name.
3 Describe the resources of this environment that have been used by Aboriginal people and by Europeans.
4 Explain why Natimuk has continued to grow whereas other rural towns across Australia are declining.

Applying and analysing

5 Using the information in Units 10.7 and 10.9, write a comparison of life in Gerringong and Natimuk. Consider what the environments of both towns are like and how that affects the lifestyle of their residents.
6 Design a car bumper sticker promoting Natimuk. Use design or desktop publishing software for a professional finish.

Geographical skills

7 Study Figure 10.39, then complete the following tasks.
   a Identify the months that experience the highest temperature, and state that temperature.
   b Identify the months that experience the lowest temperature, and state that temperature.
   c Calculate the mean annual temperature range.
   d Explain why Natimuk has a larger temperature range than Gerringong (see also Figure 10.32).
8 Use Figure 10.40 to draw an annotated photo sketch of the part of Mt Arapiles shown in the photograph.

Investigating

9 Use the internet to collect synoptic charts for Australia that account for the dry summers and wet winters that Natimuk experiences.
10 Undertake internet research to write a brief description of Nati Frinj festivals that have been held in Natimuk.

10.10 Australia's mineral and energy resources

The rapid economic growth taking place in China and other parts of Asia has greatly increased the demand for Australia's mineral and energy resources. The price received for these resources has increased sharply, as global demand now outstrips supply.

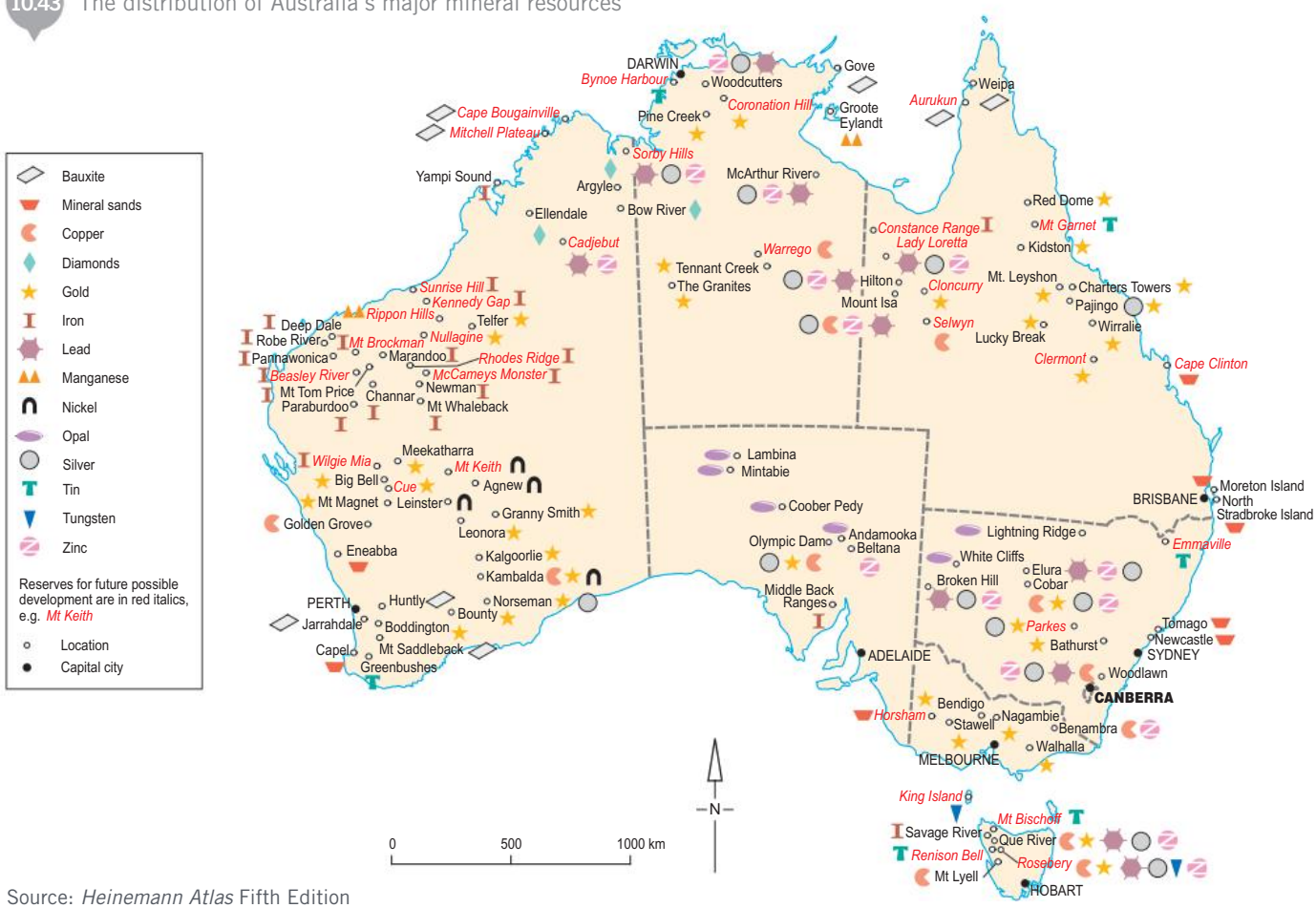
Export values

In 2011, the value of Australia's mining and energy exports totalled $190 billion. This represents 72 per cent of Australia's exports by value (up from 23 per cent a decade earlier). By contrast, agriculture accounts for 12 per cent, manufacturing 13 per cent and services 16 per cent. In 2011, Australia's most important non-renewable resource exports were iron ore ($59.3 billion), coal ($46.9 billion), petroleum ($11.8 billion) and natural gas ($11.1 billion).

Mineral resources

Australia is one of the world's major mineral producers. Iron ore, gold, and bauxite are our most important mineral exports. Other important minerals include copper, lead, zinc, diamonds and mineral sands. More than 80 per cent of Australia's minerals are exported. Figure 10.43 shows the distribution of Australia's major mineral resources. Western Australia and Queensland together account for more than 60 per cent of the total value of Australia's mineral exports.

10.43 The distribution of Australia's major mineral resources



Source: *Heinemann Atlas* Fifth Edition

Energy resources

Australia has vast **reserves** of coal and natural gas (see Figure 10.44). Known reserves of oil are more limited. The main deposits of black coal are found in the Sydney and Bowen basins. Two-thirds of the coal mined is exported, mainly to Japan, China, Korea, India and the countries of Western Europe.

Coal is the main fuel used to generate electricity in Australia. Most coal-fired thermal power stations, such as those in the Hunter Valley, New South Wales, are located close to coal mines. The electrical energy that the stations produce is transmitted by high-voltage power lines to the major urban centres. In Victoria, the power-generation industry relies on brown coal from the Latrobe Valley. Concerns about the relationship between the burning of **fossil fuels** and **global warming** have encouraged governments to consider the development of cleaner, alternative sources of electricity; for example, wind-generated power.

DID YOU KNOW?

BHP Billiton is a huge global mining, oil and gas company. Based in Melbourne, it is the largest miner, and the third-largest company of any kind, in the world.

10.44 The distribution of Australia's energy resources

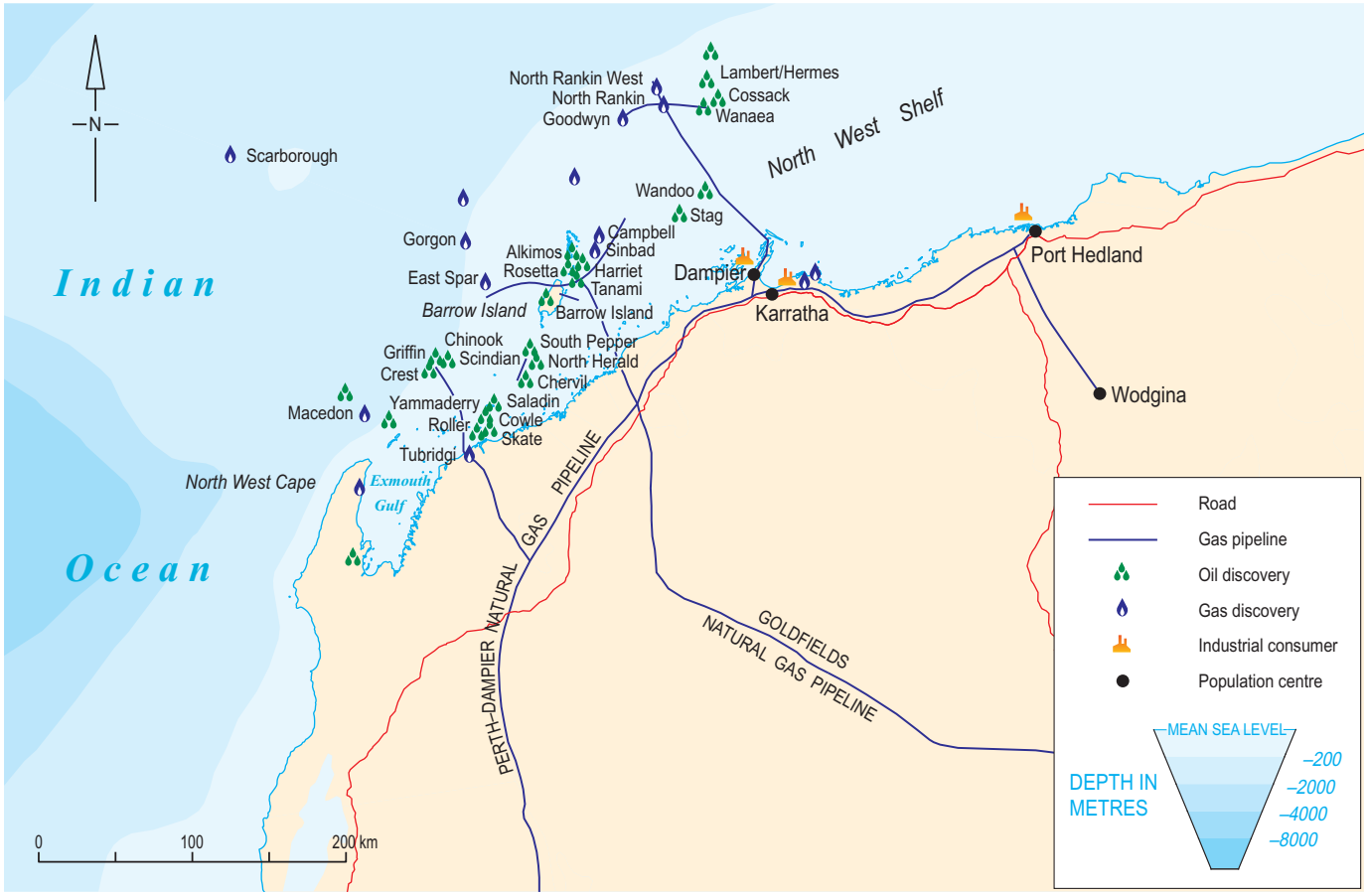


Source: *Heinemann Atlas* Fifth Edition

Gas fields

Australia's gas fields are located well away from the major urban centres. Because of this, long pipelines have had to be built to transport the gas to where it is needed. The south-east of Australia relies on the Cooper Basin gas fields. Gas from the North-West Shelf (see Figure 10.45) is exported to Japan in a liquefied form.

10.45 Natural gas production facilities in the North-West Shelf of Australia



Source: *Heinemann Atlas* Fifth Edition

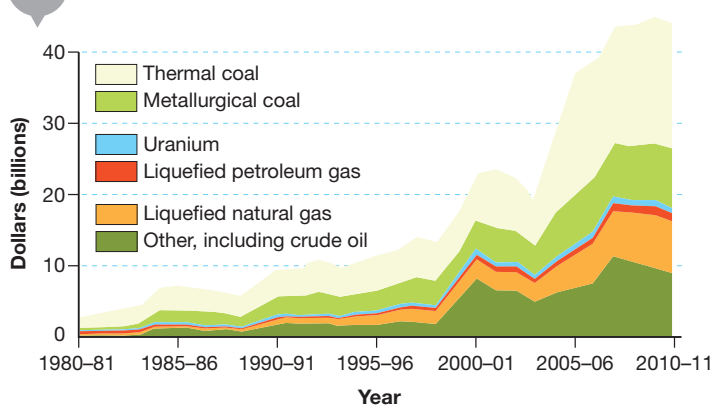
Skillsbuilder

Compound line graphs

Compound line graphs use a number of lines to show the total quantity and the relative size of the parts that comprise the total. The principal features of a compound line graph are as follows.

- The top line of the graph shows the total.
- Each line other than the top line represents one of the components that make up the total.
- The size of each component is shown by the gap between the line above and the line below.

10.46 Compound line graph of Australia's energy exports



Resource ownership

The Crown (in effect, the state governments) owns all minerals in Australia. State governments grant exploration licences to companies that are keen to locate non-renewable resources. If a resource is discovered, a government may give a company permission to mine the resource. In return, the company pays the state government money known as a **royalty**. The revenue from royalties is used to fund the activities of government for the benefit of all.

Landowners do not own the minerals under their property; the Crown owns them. This means that if a mining company finds a resource such as coal seam gas under your property, the company does not need your permission to mine the resource. It only needs a mining licence from the government.

Sharing the benefits of Australia's mining boom

To ensure that all Australians would benefit from the wealth generated by mining Australia's non-renewable natural resources (especially coal and iron ore), the Australian Government introduced the Minerals Resource Rent Tax in 2012. The revenue from the tax will be used to reduce the amount of tax companies and businesses pay, increase superannuation payments to working Australians and fund the building of infrastructure, such as railways, roads and schools.

ACTIVITIES

Knowledge and understanding

1 List the natural resources of which Australia is a major world producer.

2 State who owns the minerals found in the ground.

Applying and analysing

3 'Australia's non-renewable mineral and energy resources belong to all Australians, rather than to those who own the land under which they are found.' In your workbook, copy and complete the following table and write as many ideas as you can that support and disagree with this statement. Two examples have been done for you.

Support this statement	Disagree with this statement
• The resources are owned by all Australians, not by a company	• The mining companies pay to extract the resources

4 How can the benefits of Australia's mineral wealth be shared?

5 Once Australia's non-renewable resources are used up, the wealth they generate will decline. Write as many ways as you can think of in which the benefits of mining these resources might be protected for future generations.

Geographical skills

6 Study Figure 10.43, then complete the following tasks.

- **a** Name the mineral(s) mined at each of the following locations:
  - **i** Tom Price, Western Australia
  - **ii** Broken Hill, New South Wales
  - **iii** Mount Isa, Queensland
  - **iv** Coober Pedy, South Australia
  - **v** Weipa, Queensland
  - **vi** Kalgoorlie, Western Australia.
- **b** Name the locations where the following minerals are mined:
  - **i** diamonds
  - **ii** mineral sands
  - **iii** bauxite
  - **iv** opal.
- **c** Identify the region of Australia where most of the country's iron ore is mined.

7 Study Figure 10.44, then complete the following tasks.

- **a** Name the energy resource extracted at each of the following locations:
  - **i** Blackwater, Queensland
  - **ii** Muswellbrook, New South Wales
  - **iii** Latrobe Valley, Victoria
  - **iv** North Rankin, Western Australia.
- **b** Name the energy resources produced in the Gippsland Basin.
- **c** Name the locations in which uranium is mined.

10.11 Case study: Paraburdoo

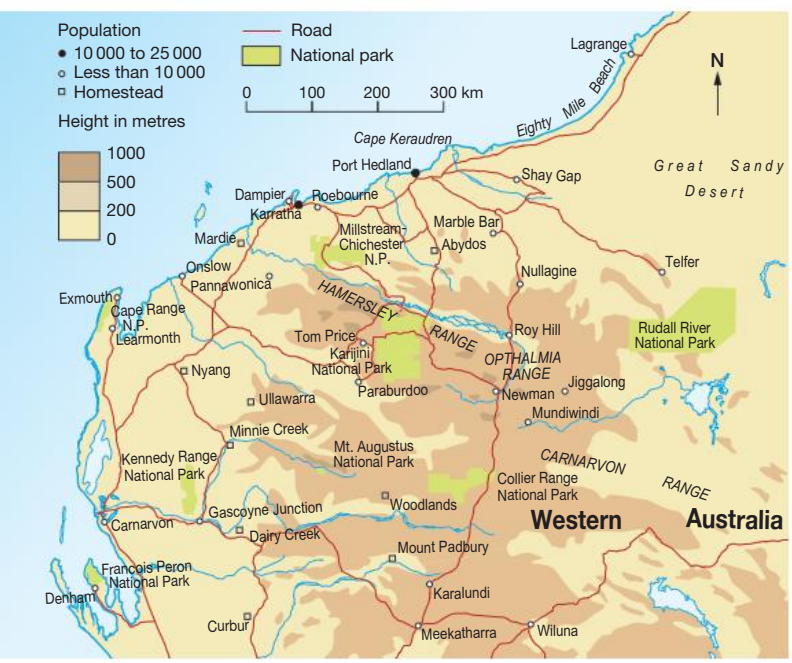
Paraburdoo is a mining town in the heart of the remote Pilbara region in the north-west of Western Australia. Paraburdoo was purpose-built in the early 1970s to support Western Australia's iron ore industry. Today, most of the town's residents still work in mining operations or supporting services.

The Pilbara environment

The Pilbara is a vast, dry and sparsely populated area, renowned for its scenic landscapes and red earth. The Pilbara covers 502 000 square kilometres (see Figure 10.47). It is rich with mineral deposits, especially iron ore. Western Australia contains the oldest known rock formations in the world. In fact, it is the immense age of the Australian continent that makes it so rich in minerals. The Pilbara is about 3.5 billion years old, and it is in rocks of this age that bands rich in iron ore are found between layers of other rocks.

Given its location, nearly 300 kilometres from the coast and 24 kilometres north of the Tropic of Capricorn, it is apparent why Paraburdoo has such a hot, dry climate.

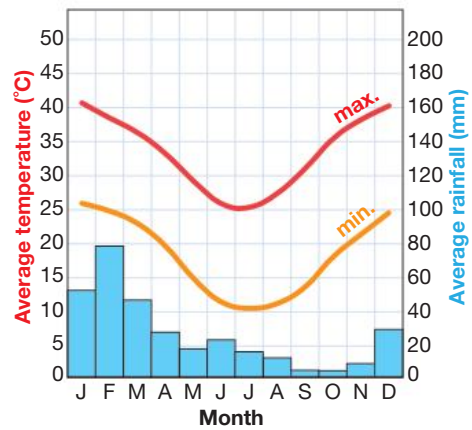
10.47 Paraburdoo is located in the Hamersley Range of Western Australia.



Source: *Heinemann Atlas* Fifth Edition

Extremely high temperatures can be reached: the highest recorded temperature is 48.9°C. The average annual rainfall is a low 310 mm (see Figure 10.48).

10.48 Climate graph for Paraburdoo



SPOTLIGHT

Paraburdoo through my eyes

'Living in a mining town is very different. The workers are young and wages are high, which is what attracts us, as we have to do without many things that are taken for granted elsewhere. Fresh food arrives on a truck only once a week. High school students have a long day, leaving at 6.45 a.m. to travel by bus to Tom Price. Tee-ball and motocross are popular with the children, but competition is limited.

'Families that move to Paraburdoo generally only stay for 5 years. There is a sense of isolation from living on the edge of a desert that we can only cope with for so long. Others are fly-in, fly-out workers.'

Rio Tinto truck driver



10.49 Mt Tom Price open-cut iron ore mine, Pilbara region

Aboriginal history

Aboriginal people have lived in, and managed, the environment of the Pilbara for over 30 000 years. Their survival depended on knowing where to find waterholes, and their movements followed the seasons as they gathered root vegetables, fruit, eggs and honey, and hunted kangaroos and reptiles.

The name of the town Paraburdoo is derived from an Aboriginal word, *pirupardu*, which can be translated as 'meat feathers'. This refers to the white cockatoos that live in the area, which were a ready supply of food for the Aboriginal people.

European history

Exploration for iron ore in the Pilbara (see Figure 10.49) began in the early 1960s, yielding promising results. Few people lived in the region, so the mining company Rio Tinto built whole towns for mineworkers and their families. Paraburdoo was one of the company towns purpose-built in 1970, and it grew very quickly. The population has since remained steady at between 2000 and 2500.

As the mining boom has accelerated, production has been expanded in response to the huge demand from China. In 2012, iron ore became Australia's biggest export.

DID YOU KNOW?

The film *Red Dog* was based on a dog commonly seen around the Pilbara. It relates miners' stories of the dog, which became a legend in the area (see Figure 10.50).



10.50 A Pilbara legend is portrayed in the movie *Red Dog*.

ACTIVITIES

Knowledge and understanding

1. Explain why people choose to live in Paraburdoo, but stay for only a few years.
2. Outline how the town of Paraburdoo got its name.
3. Describe how the resources of this environment have been used by Aboriginal people and by Europeans.

Applying and analysing

4. Write a personal account of how your life would change (if at all) should your family move to Paraburdoo.
5. Study Figure 10.48. Describe what it would be like working in the mining industry in the Pilbara during January and February.

Investigating

6. Undertake library or internet research to determine what iron ore is used for.
7. Undertake internet research to:
   - a explain why the climate in the Pilbara is so hot and dry
   - b investigate the legend associated with the movie *Red Dog*. Assess the accuracy of the movie's portrayal of the life of this dog in the Pilbara.
8. Access the website of the mining company Rio Tinto and prepare a short report on its history and its operations in the Pilbara.

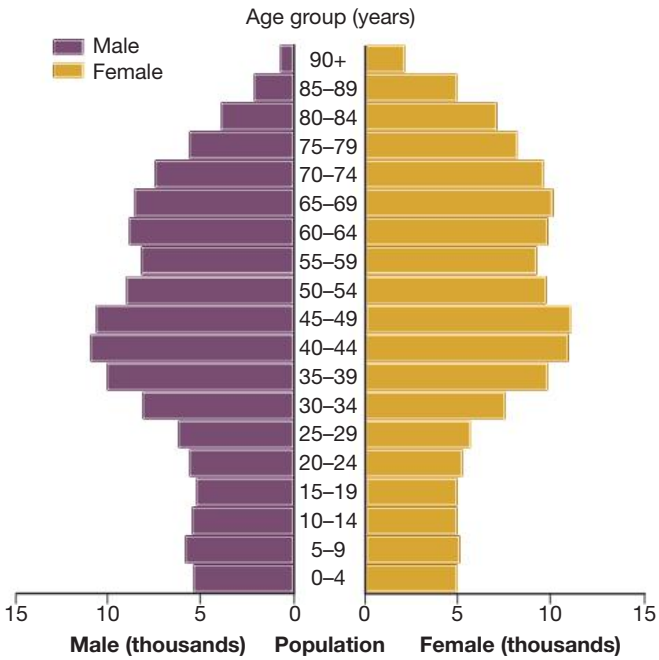
10.12 Case study: Venice, Italy

Venice, located in the north-east of Italy, is famous for its canals, architecture and artistic treasures. In 1987, the city and its lagoon were awarded World Heritage status.

Venice's ageing and declining population

The population of Venice has been steadily decreasing over the past 50 years. In the 1950s, the population was over 170 000; today, it is less than 70 000. The decline is due to the high cost of living, the low availability of affordable housing for residents and a massive increase in the number of tourists visiting the city. The city's population is ageing as the young move to the mainland in search of affordable housing, employment and a lifestyle more to their liking. Today, young people make up only a small proportion of Venice's population: just 14 per cent, compared with 18 per cent for all of Italy. A total of 25 per cent of the city's population is considered to be elderly, compared with 19 per cent for all of Italy (see Figure 10.51).

10.51 Population pyramid for Venice. Venice has an ageing population.



Impacts of tourism

Venice was built centuries ago on wooden piles driven into the mud of low-lying islands in the middle of a huge lagoon. Instead of roads and cars, canals and boats dominate the city, and its unique character makes it hugely popular with tourists. In 2007, more than 20 million tourists visited Venice, breaking all records for the tiny city. More recently, visitor numbers have declined, but they remain in excess of 12 million each year. Eighty per cent of tourists come from outside Italy. Many disembark from giant cruise ships that have begun to visit in increasing numbers during summer—the peak of the tourist season (see Figure 10.52).

At the present rate of decline, there will be no Venetians living in the city by the 2030s. As a result, Venice runs the risk of becoming little more than a historical theme park, where tourists visit and enjoy the sights while the 'locals' commute from the mainland to work in the city's tourist-based service industries, especially its hotels and restaurants.

Housing

One of the main reasons for the departure of so many Venetians has been the cost of housing. Real estate in Venice is now as expensive as in the most exclusive suburbs of New York and London. Most Venetians cannot afford to rent or buy such properties. A typical small apartment in the old quarter of Venice can cost the equivalent of $1.5–2 million. For this price Venetians get a very old home that requires a great deal of costly maintenance.



10.52 On any day in summer, up to 60 000 tourists crowd into Venice. Many of them arrive on large cruise ships.

Many Venetian palaces, apartment blocks and houses have been converted into hotels that cater for tourists. As a result, even though the population of Venice is declining, there is a massive shortage of long-term accommodation for locals. The demand among wealthy foreigners for Venetian holiday homes also pushes prices up.

Loss of services

The *vaporetti* are the boats that serve as buses on the city's canals. The *vaporetti* are crowded with tourists throughout summer, making it difficult for locals to get about. Shops that provide goods and services for the local population are also disappearing. Where once supermarkets and even cinemas were found, there are now souvenir shops and restaurants catering for the needs of tourists. Prices in the shops have also risen, as they are set for the tourist market rather than the local market.

While many Venetians fear that tourism may destroy their community and their way of life, they recognise that the industry is vital to their city's economic wellbeing. Some argue that Venice has always been a difficult city in which to live. For instance, Venetians have always had to rely on boats for transportation instead of cars and trains. People also point out that the city is old, and its buildings are difficult and expensive to maintain. All these factors encourage young Venetians to leave.

ACTIVITIES

Knowledge and understanding

1. Describe the attractions of Venice for tourists.
2. Outline the population changes taking place in Venice.
3. Explain the link between tourism and the demographic changes taking place in Venice.

Applying and analysing

4. Copy and complete the following table.

Tourism in Venice	
Advantages	**Disadvantages**

5. If you were the mayor of Venice, what would you do to balance the needs of the local people with the needs of tourists? Prepare a short report outlining your plan.
6. Investigate why local groups protest against visits to Venice by cruise ships. Prepare a short report that details your findings.

10.13 Case study: Costa del Sol, Spain

The Costa del Sol (meaning 'sunny coast') is found in the province of Málaga in the south of Spain. The Costa del Sol's location on the Mediterranean Sea and its warm and sunny climate have made it one of the most visited regions in Europe. Up to 30 million visitors flock there each year, and a large number of people have migrated to live permanently or bought holiday homes there.



10.53 Marbella, one of the main towns along the Costa del Sol, has been transformed from a fishing village into a huge urban centre catering for tourists.



10.54 The Costa del Sol. The warm, sunny climate of the Costa del Sol makes it a popular tourist destination and a place for migration.

Transformation

Half a century ago, the Costa del Sol (see Figure 10.54) was dominated by small, sleepy fishing villages that had remained unchanged for hundreds of years. The architecture was of a traditional style and the economy was based on agriculture. In the second half of the twentieth century, as tourism boomed, the Costa del Sol was transformed into a popular tourist destination. Thousands of Europeans headed there for a beach holiday, and previously small towns grew into large urban centres catering for the needs of tourists. Where small villages once stood, huge resorts have been constructed (see Figure 10.53), dramatically changing the character of the coast.

Sun-seeking migrants

Another significant change that has taken place has been an increase in the number of people migrating to the Costa del Sol from elsewhere in Europe, to live either permanently or for extended periods of the year. Recent estimates are that there are more than 700 000 British people living in Spain. The majority of these British migrants—or expatriates, as they are known—live on the Costa del Sol. This large number of British people living in the area has further changed the character of the coast and has had other impacts on local communities. The needs of expatriates are often quite different from those of local communities.

One of the main outcomes of this migration has been a dramatic increase in real estate prices. The large number of British people seeking to buy property along the coast and in inland towns pushed up prices, making it difficult for local people to remain in the area. Many of the migrants are retirees who have considerable wealth and are prepared to pay high prices to get the property they want. They also need to access different services. Retirees, for example, put a strain on local medical services.

There has been criticism from Spanish residents that British expatriates do not involve themselves in the local community, but instead try to bring their British lifestyle with them to Spain. In recent Spanish local elections, in some towns where more than half the population was made up of expatriates, only 12 per cent had registered to vote. Research by an English-language newspaper popular with British expatriates found that the majority of British people living permanently on the Costa del Sol spoke less than ten words of Spanish in a week (see Figure 10.55).



10.55 A 'British' cafe on the Costa del Sol, targeting British expatriates and tourists

SPAIN FINANCIAL CRISIS

Sun setting on expats' Costa dreams

It was sundowner time at the Cantina tapas bar in the picturesque village of Frigiliana, a few miles inland from the Costa del Sol town of Nerja.

Inside, local men were watching bullfighting on television and smoking cigars in quiet contravention of the smoking ban. Outside, expatriate Britons were discussing the vagaries of living in Spain.

Mark Jones, who runs his own gardening and pool maintenance company, had spent two days queuing at the local municipal office to renew his residence permit.

'I got there at 9 a.m. on the first day and my number was 26; by lunchtime they were only up to number 6, and they close at 2 p.m.' he complained.

'You have to renew every bit of paper here every few years but I can't afford two days off to queue in an office. There are no staff now because of the cuts, so it all takes longer. It's like everywhere: as soon as the recession hits, it's the immigrants who cop it worst.'

Conversation turned to a local couple, who are desperate to leave Spain but who can't because their house is still unsold after four years on the market—despite dropping the asking price from €1 million to €750 000.

Expats are finding life hard in a country where they once basked in a cheaper way of life. Around 1 million Britons spend part or all of the year in Spain, but thousands are now returning home—and more want to, but say they can't afford to because their property is no longer worth what they paid for it.

For the first time since 1998, Spain recorded a drop in foreign residents last year, according to newly released figures.

With its narrow cobbled streets, whitewashed houses and children riding horses down the main road, Frigiliana lives up to most tourists' idea of an authentic Spanish village.

But appearances can be deceptive. Out of its 3000-strong population, 1280 are foreign nationals, including 700 Britons, making the village one of the most expat-dominated in Spain. The school advertises itself as bilingual.

The British population is so large that the local council pays Kevin Wright, a former travel rep from Leicestershire who has lived in Spain for more than 20 years, to run a 'foreigners' department'.

He helps expats deal with everything from local business permits to burst pipes and land disputes with neighbours, and has noticed changes since the eurozone crisis began.

'Before, I was getting ten newbies a week moving here from the UK; now I get one,' he said. 'Some Brits have lived here for 20 years but now, families move out here, then six, eight months later pack up and go back because they can't find work, or didn't realise what the cost of living would be.'

Mr Wright says many Britons fail to learn Spanish or to assimilate, so that the community becomes dependent on itself—to its cost.

'People think they can set themselves up doing business to other Brits, like finance or house sales and rentals, or pool maintenance, gardening and cleaning.

'But the property market isn't there any more, and people have cut back and do their own maintenance, so there's less work.'

In a country fighting for its own survival, Spanish politicians are not unduly concerned with the plight of British residents, particularly when many are retired so do not actively contribute to the national economy.

Source: *The Telegraph*, 26 May 2012

Impacts of the economic crisis

The economy of Spain was one of those hardest hit by the economic downturn that followed the global financial crisis (GFC) and the European debt crisis. By 2012, more than 25 per cent of Spain's workforce were unemployed, and youth unemployment exceeded 50 per cent. One of the main impacts of the GFC, which badly affected expatriate communities along the Costa del Sol, was a dramatic decline in house prices, as shown in Figure 10.56. Some people have moved back to Britain. This increases the number of properties for sale and drives prices down even further. Some housing developments have been abandoned before they were completed (see Figure 10.57).

During the boom, property developers were keen to make money, and invested heavily (often using borrowed money) in the construction of resorts, apartment complexes and villas. Many of these now stand empty or unfinished. Abandoned building sites stand as a reminder of Europe's economic problems.

There has also been a growing backlash towards expatriate communities in Spain from local Spanish residents. They accuse the migrants of taking what little work there is and of failing to contribute to the local community.

10.56 Changes in house prices in Spain, 2002–12. The significant decline coincides with the start of the global financial crisis in 2008.



Source: Financial News website



10.57 An abandoned Spanish building site—a reminder of a boom gone bust

ACTIVITIES

10.5

Knowledge and understanding

1 Explain why the Costa del Sol has become a popular destination for tourists and migrants.
2 Describe the changes that have taken place on the Costa del Sol since the second half of the twentieth century.
3 Outline the criticisms some local people have of British expatriates.
4 Describe the impact of the global financial crisis on Spain.

Applying and analysing

5 How have tourism and migration affected the community of the Costa del Sol?
6 Read the article 'Spain financial crisis: Sun setting on expats' Costa dreams', then complete the following tasks.
   a Describe the impact of the global financial crisis on expatriates living in Spain.
   b Outline the criticisms Kevin Wright makes of British expatriates living in Frigiliana.
   c Why do you think expatriates are now finding it so hard to survive in Spain?

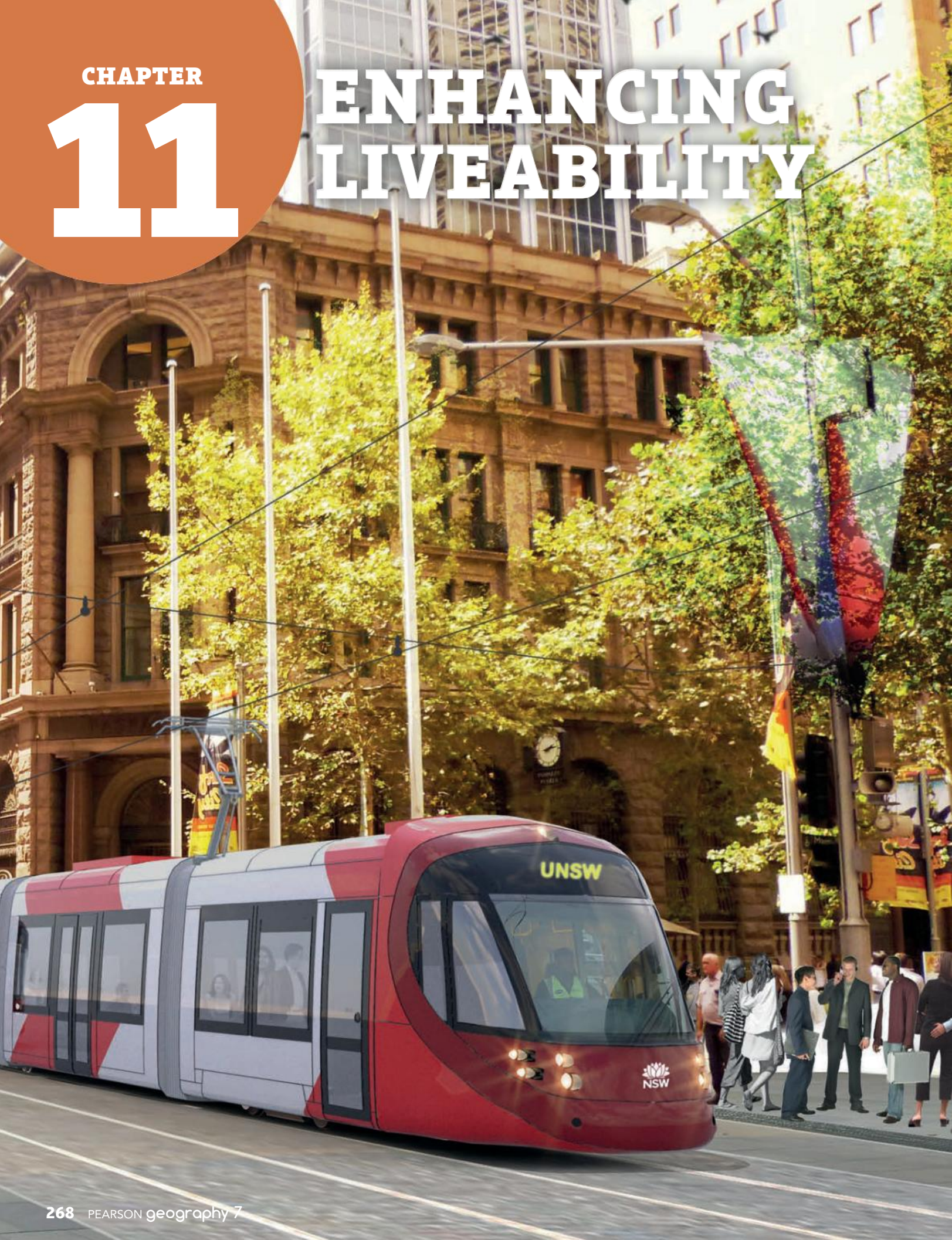
Geographical skills

7 Study Figure 10.54. Describe the location of the Costa del Sol.
8 Study Figures 10.56 and 10.57. Describe what has happened to house prices in Spain.

CHAPTER

11

ENHANCING LIVEABILITY



We now know that some places are perceived as being more liveable than others. We also know that liveability can be used as a measure of the quality of life, wellbeing and happiness experienced by people living in a neighbourhood or town. Enhancing the liveability of places is the role of governments, planners, groups and individuals. Plans and initiatives to enhance liveability may be local and small-scale; for example, a Neighbourhood Watch program or the establishment of a community garden. They may also be large-scale; for example, public transport infrastructure, urban renewal building projects or community services such as education, health care and recreational facilities.

In this chapter we focus on liveability and how it can be improved. Particular attention is given to improving the liveability of neighbourhoods for people with disabilities. We also look at a range of strategies that can be used to enhance liveability, in particular the liveability of the inner city, such as improving shopping centres, recreational spaces and schools. The English city of Manchester is examined as an example of a city that has been able to enhance its liveability.

KEY IDEAS

- To understand how the liveability of places can be enhanced, especially for people with disabilities
- To investigate the strategies used to enhance the liveability of inner-city neighbourhoods, shopping centres, recreational spaces and schools
- To be able to compare places using ABS data and fieldwork

GLOSSARY

accessibility	ease of entry, especially in the context of giving elderly people and those with disabilities easy access to places and services
assembly line	a system of manufacture in which workers perform specialised tasks one after another as the product being assembled passes down a line
Census	a detailed official description of a population, based on data from a questionnaire
community garden	a garden that is planted and tended by members of a community, who then share any produce and other benefits that result
container ship	a ship that carries cargo stacked on its deck in containers of a standard size and shape
disability	a physical or mental condition that can be either inherited or acquired and which leaves a person unable to do a normal activity that someone of the same age can do
gentrified	describes an inner-city neighbourhood where housing has been renovated by middle-class people new to the area
grey water	water generated from domestic activities such as laundry, dishwashing and bathing, which can be recycled
Industrial Revolution	the rapid development of industry in the early nineteenth century, brought about by the introduction of steam-driven machines
infrastructure	physical structures that allow a society to function, such as buildings, roads, water pipelines, sewers, electricity distribution systems, railways and airports
investor	a person or an organisation that provides finance for a project in the expectation of making a profit
supply chain	a system, typically made up of many steps, for transforming raw materials into finished products and delivering them to customers

11.0 Sydney is reintroducing trams to the city centre to improve liveability by reducing traffic congestion.

11.1 Methods of enhancing liveability

There are many ways in which the liveability of a city, suburb or town can be improved. Enhancing liveability benefits people who live in, work in or visit an area. It increases property values and business activity, and it can improve public health and safety.

How to improve liveability

Liveability is greatly influenced by the type and condition of public spaces—those places where people naturally interact with each other and their community. Public spaces include streets, parks, transportation terminals and other public facilities. These are affected by public policy and planning decisions.

Transport options

Liveability is improved when planners and governments develop safe, reliable and affordable transport choices that decrease people's dependence on cars. Other benefits of this include reduced traffice congestion, improved air quality, reduced greenhouse gas emissions and improvements in public health.

Affordable housing

Another way to enhance liveability is to expand the housing choices for people of all ages, incomes, and racial and ethnic backgrounds. Building medium- and high-density housing close to major transport and activity centres (see Figure 11.1) increases mobility and lowers the combined cost of housing and transportation.

11.1 The Elizabeth Quay redevelopment in Perth will feature an inlet surrounded by a landscaped promenade, new public spaces, shops, restaurants, entertainment venues, and new office and residential accommodation.



Social places
Facilities such as aquatic centres, libraries, indoor and outdoor sporting facilities, town squares, playgrounds and skate parks can all provide attractive public spaces where people can gather and interact.

Open space
Open space helps people to interact with the natural environment. Open spaces need to include both passive places, where people participate in recreational activities such as walking and picnicking, and active places, where people can participate in sport and children can play.

Biophysical environment
A place's impact on the environment can be reduced through energy efficiency and recycling programs. Degraded land can be rehabilitated by planting native vegetation, and rural landscapes can be protected by slowing the rate of urban sprawl. Vacant land near transport, activity and employment centres provides opportunities to promote urban consolidation.

Support for communities
Existing communities can be improved by investing in public transport-focused and mixed-use developments (for example, integrating residential and commercial places). The community can be involved in important planning decisions.

Facilities and activities
People's lives can be enriched by participating in cultural and community activities such as theatre groups, choirs, bands and orchestras.

Celebrating diversity
Celebrating the ethnic and cultural diversity of the community can enrich people's lives and promote social harmony and personal wellbeing. Examples of this approach include community festivals, celebrations and events.

Accessibility
All public and commercial spaces should be accessible to people with limited mobility, especially the elderly and those with disabilities.

Economic wellbeing
Promoting selected economic activities can create employment close to where people live. Providing the right educational opportunities develops the skills people need to gain secure, rewarding work.

Healthy lifestyles
Providing facilities and services such as sporting venues, fitness trails, medical services, clinics and hospitals promotes good health and personal wellbeing.

Coordinating government activities
Governments at different levels can build on the unique characteristics that define places by investing in healthy, safe and walkable neighbourhoods, whether they be rural, urban or suburban. Planning for the future can include, for example, increasing access to smart energy choices such as locally generated renewable energy.

Enhanced streetscapes
The liveability of places can be improved by enhancing streetscapes—the visual elements of a place's streets. These include the road, adjoining buildings, street furniture, fences, trees, nature strips and open spaces, all of which combine to form a street's character. Pedestrian-friendly streets create opportunities for people to meet and interact, helping to create community networks.

Calming traffic
Traffic calming involves the construction of roadway design features that lower vehicle speeds. This can reduce traffic volumes, noise and air pollution, and improve safety, especially for residents.

ACTIVITIES

11.1

Knowledge and understanding
1 List the benefits of affordable transport.
2 State the benefits of open spaces.

Applying and analysing
3 Individually rank the strategies for enhancing the liveability of places. Explain the reasons for your ranking.
4 Study Figure 11.1. Does the Elizabeth Quay redevelopment meet any of the strategies for improving liveability discussed in this unit? Explain your answer.
5 Select four of the strategies for improving liveability that you would implement in your suburb or town.
   a Explain why you chose those particular strategies.
   b Describe how these strategies would improve the liveability of your town or suburb.

11.2 Taking action

The liveability of places directly impacts on the people who live and work there, or choose to visit. While many aspects of liveability are determined by the planning decisions of governments, individuals and groups can take action to improve the liveability of their neighbourhood.

Enhancing public spaces

The liveability of a neighbourhood is largely determined by the condition of shared public spaces—the places where people interact with each other. These include streets, footpaths, parks, transport terminals and other public facilities. Even though state and local governments carry out the planning, construction and maintenance of these spaces, there is a growing trend for community-based groups to set up projects to improve public spaces.



11.2 Community garden, Docklands, Melbourne

'Farming (or gardening) the footpath' has been happening for some time in cities around the world. In programs of this kind, local residents plant fruit trees, vegetables and herbs, as well as flowers and native plants, on nature strips, next to the footpath (see Figure 11.2) and also in community gardens. Not only does this beautify neighbourhoods, it provides food for the residents. Residents are drawn closer together through their involvement in such projects, which have been especially popular with young people. There has been an increase in interest in Australian cities, with **community gardens** being established in many suburbs.

In Totnes, in the United Kingdom, volunteers have been planting young chestnut and walnut trees along streets and in parks and other green spaces since 2007. In time, these trees will be harvested and will provide an important food source for local communities. A similar project has been undertaken in Glandore, a suburb of Adelaide, where citrus trees have been planted along the nature strips, underneath taller eucalypts.

Protecting liveability

The responsibility for approving developments within neighbourhoods rests with government. Local residents, however, are able to influence decision-making processes by either supporting or opposing proposals. When development-related issues arise, activists have a range of strategies available to them to mobilise public opinion and influence decision-makers.

Assessing liveability

An individual's perception of the quality of their community is a combination of many factors that influence their day-to-day living. From their personal experiences they build a perception of their neighbourhood's worth. One way to assess liveability is to survey and score a neighbourhood or town (see Table 11.3).

11.3 Form for conducting a neighbourhood liveability survey

Criteria		Score				
		Poor				Good
Law and order	• Amount of petty crime	1	2	3	4	5
	• Amount of violent crime	1	2	3	4	5
	• Graffiti and vandalism	1	2	3	4	5
	• Personal safety	1	2	3	4	5
Economics	• Employment opportunities	1	2	3	4	5
	• Affordable housing	1	2	3	4	5
	• Access to consumer goods and services	1	2	3	4	5
Environment	• Humidity and temperature	1	2	3	4	5
	• Urban design	1	2	3	4	5
	• Architecture	1	2	3	4	5
	• Parks and gardens	1	2	3	4	5
	• Streetscapes	1	2	3	4	5
	• Maintenance of public spaces	1	2	3	4	5
Culture	• Community recreational facilities	1	2	3	4	5
	• Places of worship	1	2	3	4	5
	• Restaurants	1	2	3	4	5
	• Public libraries	1	2	3	4	5
	• Entertainment centres	1	2	3	4	5
Education	• Availability of private schools	1	2	3	4	5
	• Availability of public schools	1	2	3	4	5
	• Quality of educational institutions	1	2	3	4	5
Health care	• Quality of private health care	1	2	3	4	5
	• Quality of public health care	1	2	3	4	5
	• Aged care facilities	1	2	3	4	5
Infrastructure	• Quality of road network	1	2	3	4	5
	• Quality of public transport	1	2	3	4	5
	• Quality of telecommunications infrastructure	1	2	3	4	5
	• Availability of good-quality housing	1	2	3	4	5
	• Provision of utilities: water, electricity, sewerage	1	2	3	4	5
	• Cycle ways	1	2	3	4	5

ACTIVITIES

Knowledge and understanding

1 List the types of public spaces in which people interact with each other.
2 State the role of government in managing public spaces.
3 Describe the concept of 'farming the footpath'.

Applying and analysing

4 Rank your local neighbourhood on each of the criteria listed in Table 11.3, using the scale from 1 to 5. Tally the total score out of 150.
5 Repeat Activity 4 for a nearby neighbourhood. Develop a class ranking of neighbourhoods.

11.3 Liveability and disability

Many of Australia's suburbs lack infrastructure, including public transport, to provide access to employment, shops, schools, medical facilities and open spaces for people with disabilities. This leaves many people isolated, jobless and bored. Considerations of the liveability of neighbourhoods and towns do not always take note of the needs of people with disabilities.

Disability

A **disability** is any condition or impairment that restricts a person's lifestyle or everyday functioning compared with another person of the same age.

A disability may be associated with a person's ability to see, hear or speak, or it may affect their mobility or learning ability. One in five Australians has some form of disability, so it is important for the whole community that people with disabilities are supported and treated with respect and common courtesy.

Young people with disabilities want the same things that all young people want. They value friendships and enjoy going out and having fun. They play sport (see Figure 11.4) for the same reasons as everyone else: for pleasure and fitness, to learn new skills and for social contact. As well, they want to gain control over their lives and look forward to living as independent adults one day. However, some young people with disabilities, and those with special education needs, can become isolated and feel excluded from the general community. Sometimes this means that when they leave school they drift away from training, further education and employment.

It is very important to find effective ways to enhance liveability for young people with disabilities. Fundamental to this is increasing their independence. This can be assisted by:

- adjusting the physical environment so that all people can access everything that they need to, including toilets and entrances to shops, libraries, venues and clubs.
- providing affordable, reliable, safe and accessible transportation to allow all people to move about independently
- providing education opportunities in an inclusive environment where students are part of regular classes.



11.4 Many people with disabilities play sport.

SPOTLIGHT

Public transport accessibility

In response to the Commonwealth Disability Discrimination Act and Transport Standards legislation passed by parliaments, Australia's transport operators are increasing the **accessibility** of their services. Sydney's City Rail, for example, is committed to providing all passengers—including the elderly, people with disabilities and those travelling with prams, young children or luggage—with access to its services. All new stations and trains are accessible to people with disabilities. Features that enhance accessibility include ramps, lifts, tactile tiles on the edge of platforms, continuous handrails, accessible ticket counters and payphones, and audio and visual information services. New trains are equipped with wheelchair spaces, priority seats for elderly and less mobile passengers, accessible emergency help points, colour-contrasted doors and handrails, audio and visual destination information and accessible toilets.

11.5 Checklist for shopping complexes to assess suitability for people with disabilities

Criteria	Adequate	Inadequate. What improvements are needed?
Accessible car spaces near the entrance to the mall or close to the shopping centre		
Wheelchair ramps		
Handrails on all ramps and stairs		
Slip-resistant stairs		
Accessible toilet facilities with a grab rail next to the toilet and enough room to manoeuvre a wheelchair		
Taps and handbasins within reach of wheelchair-users		
Large signs		
Signs that use dark symbols (rather than writing) on a white background		
Braille on the buttons of lifts, and audible notification of levels for blind people		
ATMs with braille and audio		
Braille trails		
In cinemas, dedicated seats for blind people, with headphones that give audio descriptors for scenes where there is no dialogue		

ACTIVITIES

Knowledge and understanding

1 Define the term 'disability'.

Investigating

2 Your school is upgrading its facilities for students who use a wheelchair. Working in pairs, complete the following tasks.
   - **a** What physical changes, if any, would need to be made to your school to ensure that students who use a wheelchair have full access to all facilities?
   - **b** How could you ensure that all students with a disability feel included in your school community?
   - **c** What could your school community gain from including young people with disabilities?

3 Visit a local shopping complex. Working in pairs, complete the checklist in Table 11.5. Make a judgement on the suitability of the shopping complex for use by people with disabilities. Write a letter to the manager of the shopping complex, or to the local council, commending them for their efforts and/or making suggestions for improvement.

11.4 Better cities

At the heart of the modern city is the central business district, or CBD. Being at the core of cities, CBDs are important places for work. Many CBDs are now also becoming popular places to live. A key question is how the liveability of such places can be enhanced.



11.6 South Bank in Brisbane provides important recreational open space within the Brisbane CBD.

The need for open space

A city's main commercial and business-related functions and its major public institutions, such as town halls, libraries, museums and theatres, are located in its CBD. In modern cities, large buildings dominate the urban landscape, and there is little open space. This lack of open public spaces, such as plazas and parklands, is one of the criticisms of many CBDs around the world. Such places are important not just for environmental reasons but also as places for relaxation and recreation. In recent years, there has been a trend towards redesigning inner cities to make room for public spaces and to create green zones within the city.

South Bank in Brisbane (see Figure 11.6) is set along the south bank of the Brisbane River. This large complex contains parklands, riverside walking trails, restaurants and other recreational facilities. Sydney's recently announced Barangaroo redevelopment, along the eastern shore of Darling Harbour, also has large areas reserved for open public space.



11.7 The Trio apartment building in Sydney has one of the world's tallest vertical gardens.



11.8 One Central Park, Sydney, was designed by award-winning French architect Jean Nouvel. The tower's facade is clad in vertical gardens designed by French artist Patrick Blanc.

Greener buildings

Not only are CBDs being redesigned to make them better places in which to live and work; the buildings in them are being transformed. New technologies mean that buildings can be more environmentally friendly.

'Green' buildings are structures that are efficient in their use of energy and other resources. The greenest buildings are those that minimise energy and water use, protect the health of their occupants, improve the productivity of workers and reduce waste and pollution.

Among the greenest buildings are those with vertical gardens and roof gardens. Vertical gardens consist of special supporting frames, secured to the side of the building, that are planted with shrubs and other smaller plants. An automated watering system is installed to sustain plant life.

At a height of 33 metres, the vertical garden of the Trio apartment building in Sydney is among the world's tallest (see Figure 11.7). An even larger vertical garden is being constructed in the nearby Central Park development on the edge of Sydney's CBD (see Figure 11.8). In addition to contributing to the beauty of our CBDs, vertical gardens have important environmental benefits: the plants act as insulators, helping to reduce the amount of energy needed for cooling and heating.

Other strategies

Additional strategies to enhance the liveability of CBDs are:

- enhancing public spaces and streetscapes with quality paving and street furniture, plantings and outdoor dining options
- reducing traffic congestion by discouraging vehicle access, imposing parking restrictions, providing low-impact public transport options such as trams, developing pedestrian-only areas and constructing dedicated cycleways
- encouraging a range of after-dark activities in places such as cafes, restaurants, wine bars, theatres and other entertainment venues
- enhancing public safety by the use of surveillance cameras, street lighting and additional police patrols
- encouraging a mix of retailers, including convenience stores and supermarkets.

SPOTLIGHT

Melbourne's Pixel Building: Australia's most sustainable building?

The recently opened Pixel Building in Melbourne (see Figure 11.9) might look a little unusual, but it is has been labelled Australia's greenest building and one of the most environmentally sustainable structures in the world. The innovative building achieved the highest possible green rating and has received many architectural and environmental awards.

What makes the four-storey building so green is a combination of construction materials and design features. The building was built using a new type of concrete called Pixelcrete. Compared with standard concrete, the manufacture of Pixelcrete produces only about half the amount of carbon dioxide, a major cause of global warming. The roof is covered with native grasses, which help to insulate the building against summer heat and winter cold, thereby reducing energy use. Solar cells on the roof generate power.

Another energy-saving device is found in the windows, which have a special feature called 'night purging'. Concrete and glass absorb heat during the day and can retain heat overnight in an enclosed building. In the Pixel Building, computer technology is used to open the windows on cool nights, allowing air to flow through the building and cool the structure. Cooling the building at night in this way reduces the need for air conditioning during the day.

The building contains reed beds, through which **grey water** flows from showers, sinks and handbasins. These beds filter the water before it enters the stormwater system; they also act as a natural form of air conditioning. Sunshades on the windows help to reduce the amount of heat in summer and can be opened to allow natural light into the building, further reducing energy needs.

Other interesting features include vacuum toilets that minimise water use, and onsite water collection and storage that make the building 'water neutral'. This means that the building captures and stores the same amount of water as it uses.

11.9 The Pixel Building in Melbourne is one of the greenest buildings in the world.



SPOTLIGHT

Barangaroo parklands

Barangaroo is a large urban renewal project on the edge of Sydney's central business district. From as early as 1820, this part of Sydney served a variety of port-related functions. As well as wharves, there were boatbuilding and boat repair facilities. It continued to be an important waterfront area until the early part of the twenty-first century, when the container terminal on the site was moved to Port Botany.

An important part of the project is the development of Headland Park. This park will be revegetated with native plants, including more than 600 mature trees. The site will also include walking trails, cycle paths, a cove for small boats and tidal rock pools.

The park will enhance the liveability of Sydney by returning to public use parts of the harbour foreshore that have been off limits for more than a century. It will also provide an important recreational space for the residents and workers of the Barangaroo area (see Figure 11.10).

The park and the nearby area are named after Barangaroo, who was a powerful Aboriginal woman at the time of the first British settlement in Sydney. She commanded authority from the early colonists and fiercely maintained traditional customs.

11.10 The construction of Headland Park at Barangaroo is transforming a former dock, left, into public space, right.





ACTIVITIES

Knowledge and understanding

1. Outline the role and features of a typical CBD.
2. State the advantages of 'green' buildings.
3. Explain what a vertical garden is. What are the advantages of vertical gardens?
4. Describe the benefits of Headland Park at Barangaroo.

Applying and analysing

5. Write a report outlining the various ways in which the liveability of CBDs can be enhanced.
6. Develop a plan for an open public space in a CBD. Think carefully about the facilities and features you would like to include.

Investigating

7. In pairs, brainstorm a list of the ways in which the Barangaroo development enhances the liveability of Sydney. Record your findings in a table.
8. Investigate another example of a green building. What are its green features?

11.5 Better shopping centres

Suburban shopping malls have a significant impact on the environment. With their huge car parks, they encourage car use. They also consume vast amounts of energy on lighting and air conditioning to keep people comfortable. But shopping centres are changing.

Design of shopping centres

Because shopping centres have huge car parks, they encourage us to travel there by car rather than use public transport. They also consume vast amounts of energy. Think of the features of the typical large shopping mall. It has few, if any, windows, so a lot of artificial lighting is needed. It is climate controlled by huge air conditioners to keep people comfortable so that they will stay longer and spend more money.

Shopping centres are, however, beginning to change. Architects and designers are looking at ways to reduce the environmental impact of shopping complexes, and they are becoming more like traditional street-based shopping districts. Shops are laid out along open pedestrian malls. Because these areas are open, they do not need to be lit or air-conditioned, and this greatly reduces energy use.



11.11 Rouse Hill Town Centre, Sydney

The Rouse Hill Town Centre, in Sydney's north-west (see Figure 11.11), was constructed in the mid-2000s. It won architectural acclaim throughout the world for its innovative, energy-saving design. During its first full year of operation, the centre achieved an ecological footprint 32 per cent lower than that of a standard New South Wales regional shopping centre.

Shopping centres of the future

The Orion Springfield shopping centre in Ipswich, in south-east Queensland (see Figure 11.12), has been designed to minimise its environmental impact. It is considered the most environmentally friendly shopping centre in Australia and has attained a six-star rating, the highest level possible, from the Green Building Council of Australia.

Like the Rouse Hill development, Orion Springfield has open pedestrian malls that link low-rise shopping areas. Sun-shading devices such as trees, shade sails and verandahs reduce the energy needed for climate control. Special features reduce water usage. Huge water tanks capable of holding 780 000 litres collect rainwater. This is then mixed with recycled water to flush toilets, clean bins, fill the centre's water features and water its gardens.

Designers have even planned ahead for the centre's eventual demolition. The structure's steel frame has been designed for easy disassembly, allowing at least 95 per cent of the steel to be recycled.



11.12 Orion Springfield Shopping Centre in Ipswich, Queensland

Integrated centres

Another important trend is to build integrated commercial–residential complexes. One is the new Top Ryde City shopping and residential complex in suburban Sydney. This massive complex includes three department stores and more than 200 other retail outlets, restaurants, a large food court, cinemas and a public library. On top of the complex are three large, multistorey apartment buildings with resort-style facilities. Underneath is a bus transit hub. Residents claim that they rarely have to leave the complex. 'Everything you need is just downstairs', says one person who lives there.

Promoting sustainability

There are a variety of ways in which to reduce the environmental footprint of retail complexes. These include:

- design that takes into account the path of the sun and increases the effectiveness of sunshades and wall insulation
- double-glazing to reduce heat transfer
- high-efficiency air-conditioning systems
- energy-efficient lighting
- motion detectors for toilet and staircase lighting
- 'green roof' strategies such as solar panels and water-harvesting capabilities
- indoor gardens to reduce heat
- slow-down technologies for escalators and travellators
- recycling bins.

Traditional shopping strips

The liveability of neighbourhoods can be improved by upgrading existing local shopping strips. Many local shopping strips have adapted, and now thrive because they are more accessible and convenient than the big shopping centres. Some have become flourishing cafe and restaurant strips and make an important contribution to the night-life of communities.

ACTIVITIES

Knowledge and understanding

1. List the environmental impacts of shopping malls.
2. Explain how, and why, the design of shopping malls is changing.
3. Explain how traditional shopping strips have adapted to the competition from big shopping malls. How does this change enhance the liveability of neighbourhoods?

11.6 Better recreational spaces and schools

The liveability of communities and neighbourhoods can be improved by enhancing the quality of recreational spaces and schools.

Better recreational spaces

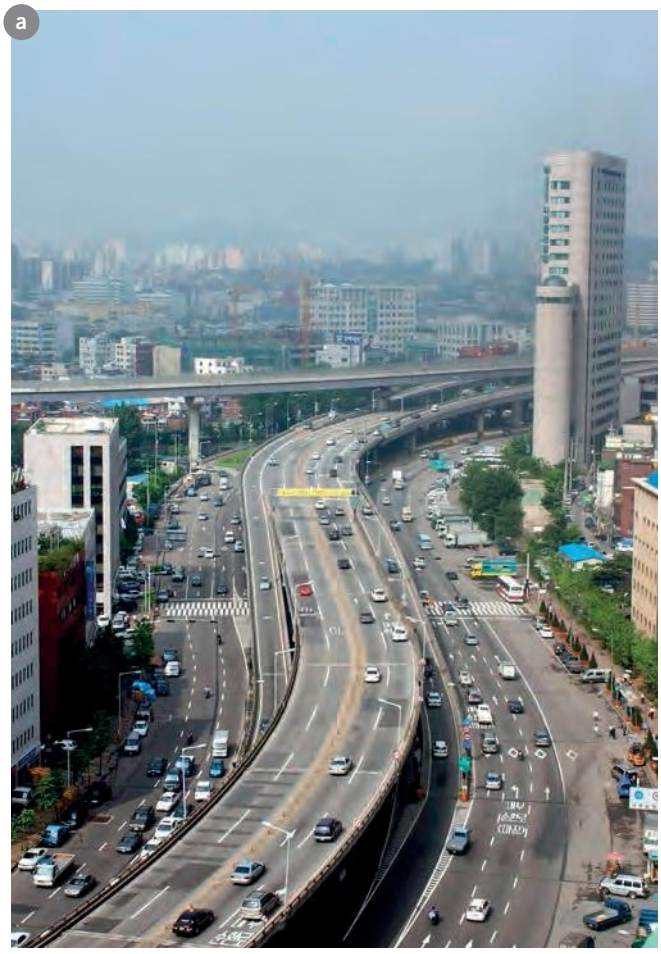
In densely populated cities, there will always be competing demands for the limited supply of land. As the world's population becomes increasingly urbanised, there is a growing demand for recreational spaces. It is important to ensure that our recreational spaces are well designed and that they meet the varied needs of the community. It is also important that government authorities insist on recreational space being part of all future developments.

Recreational spaces provide important health benefits by giving people somewhere to exercise and somewhere to relax. Benefits of this kind are sometimes referred to as 'wellness'. Fresh air itself has numerous health benefits. A recent study from California, in the United States of America, for example, found that the air outside was on average 25 to 62 per cent cleaner than the air people breathe inside buildings.

In Australia, one of the best examples of recreational spaces is the Geelong Youth Activities Area, shown in Figure 11.13. The area has won a number of design awards, including the 2010 Australia Award for Urban Design. It caters for many different activities. There are outdoor areas for large events such as music festivals, there are basketball courts and spaces for BMX and skateboarding, and there is wireless internet connection throughout. Importantly, young people were involved in the design of the area, and it is a place where activities popular among young people are not just tolerated, but promoted. For example, there are 'skateable' surfaces where skateboarding tricks are encouraged.

11.13 The award-winning Geelong Youth Activities Area provides a range of activities for the city's young people.







11.14 (a) Before 2002, a freeway ran through Seoul, South Korea, where once the Cheonggyecheon River had flowed.

(b) The Cheonggyecheon River redevelopment saw the freeway demolished, the river returned and parklands built.

Reclaiming recreational space

Two cities noted for their transformation of vacant land into parkland are Seoul and New York.

Seoul

Seoul, the capital of South Korea, has a population of more than 10 million people. This huge city has a reputation for heavy traffic and high pollution levels, and for being a 'concrete jungle'. In 2005, however, the city hit international headlines for an amazing parkland project.

Running through the centre of Seoul is the Cheonggyecheon River, whose name means 'clear valley stream'. By the 1970s, the river was heavily polluted, and run-down buildings were found along its concrete-lined channel. It was very far from being a clear valley stream. As the average wealth of South Koreans grew, so did the number of cars they owned. The Cheonggyecheon River was filled in and converted into a road. Later, a six-lane elevated freeway was constructed.

In 2002, Lee Myung-bak, who was mayor of Seoul at that time, announced an extraordinary plan to tear down the freeway and build a 12-kilometre-long park along the course of the old river. The freeway carried more than 160 000 cars a day and was considered crucial to Seoul's economy.

Within two years, the freeway was gone and so were the cars. The loss of the freeway forced people to rethink their travel habits. Public transport use increased. The Cheonggyecheon River was restored and began to flow again, and the people of Seoul were given a beautiful new park to enjoy. One amazing outcome of the project is that the average temperature around the park has fallen by up to 3 degrees Celsius. This is because the hard concrete surfaces that once absorbed heat have been replaced by grasses and water. The Seoul experience was so successful that similar projects are being planned in Shanghai, China.



11.15 High Line park in New York was built on an old elevated railway line. It shows how disused industrial land can be made into parkland.

New York

New York, in the USA, is famous, among other things, for its skyline and large Central Park. Since 2011, it has also become known as a city with an elevated park. The High Line linear park (see Figure 11.15), in the city's Meatpacking District, took the place of an elevated railway line that had been built in the 1920s but was no longer used. In 1999, plans were put forward to demolish the line. Instead, US$115 million was invested in converting the line into an elevated park. The park features lawns and forested areas. Economists estimate that the park has generated at least US$2 billion in investment in housing, commercial and retail projects in the newly revitalised district surrounding it.

Better schools

Until recently, the design of schools had not changed very much in hundreds of years. Most schools still have separate classrooms with desks in neat rows and a board at the front of the room. Learning is beginning to change, however, and the way we build schools is also beginning to change.

Today, there is much greater use of technology in classrooms. Even very young primary school students have access to computer-based learning. It is common for students to be working, not just with other students in their class, but with students on the other side of the world—for example, when doing maths problems on the internet.

To cater for this type of learning, different and more flexible learning spaces are important. The Hellerup School in Denmark is often described as the most innovative school in the world. Some of the features of the Hellerup School are now appearing in Australian schools, such as Dandenong High School in Victoria (see the Spotlight box 'Schools of the future').

SPOTLIGHT

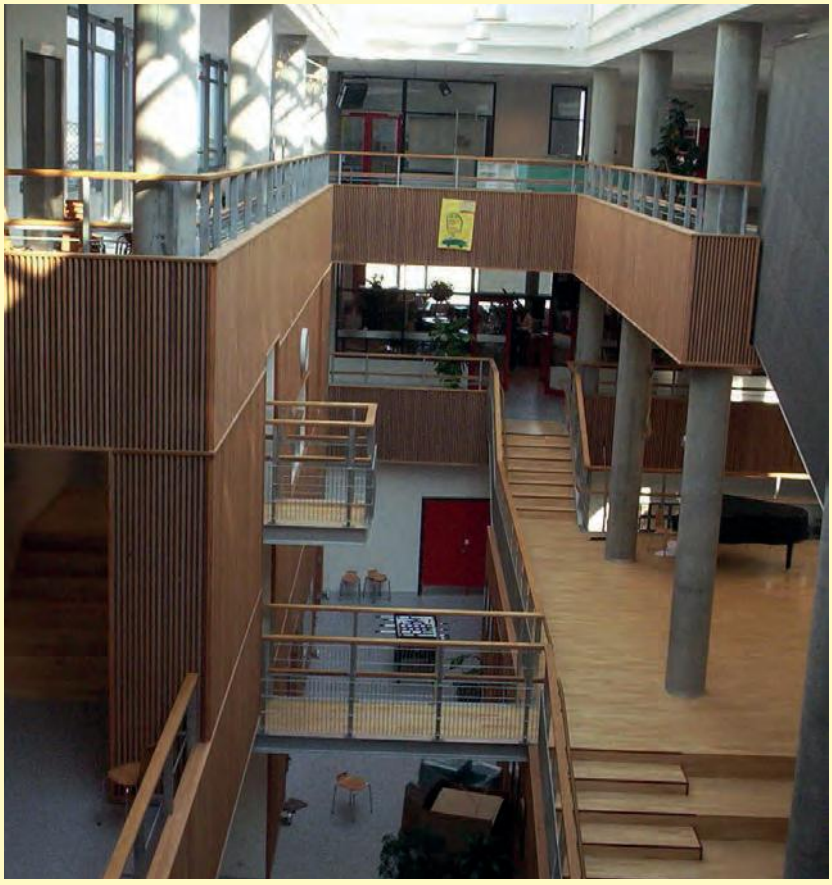
Schools of the future

At the Hellerup School, there are few classrooms. Instead, there are many rooms of different sizes that can be used for meetings between students and teachers. There are large open spaces where students can work by themselves or in small groups, as well as small rooms for quiet work.

Hellerup, and schools such as Dandenong High School in outer Melbourne, take a non-traditional approach to learning. As a result, they need buildings that serve different purposes and that are flexible. For example, a class may work together for part of a lesson and so need a larger space, then work in small groups on a research task and so need a different type of space.

In Dandenong, web-based learning programs such as Moodle help students to stay connected with teachers and peers. Students access these online resources through a range of technologies. At Hellerup, students are encouraged to use their smartphones as a way of communicating with teachers and also to help with research tasks.

11.16 Hellerup School in Denmark has adopted a different design approach.



ACTIVITIES

11.2

Knowledge and understanding

1. Explain why it is important that authorities insist on the provision of recreational spaces in new urban developments.
2. Describe the benefits of well-designed recreational spaces.
3. Discuss why the Geelong Youth Activities Area is considered to be well designed.
4. List the reasons why schools need to be redesigned.
5. Explain why flexible spaces are important in modern school design.

Applying and analysing

6. List ideas for transforming your local park or school playground into a better recreational space. Construct a sketch map showing the key features of your design. To accompany your map, prepare a short report outlining the key features and the reasons you have included them.
7. Read the text on reclaiming cities for parkland, then complete the following activities.
   - **a** Describe the impact of Seoul's growth on the Cheonggyecheon River.
   - **b** How has the river been transformed in recent years?
   - **c** Outline the redevelopment of the High Line park.
   - **d** What have been the benefits of the High Line park to the Meatpacking District?
   - **e** Why do you think the construction of the park has brought these benefits?
8. Write an extended response comparing the design of your school to that of Hellerup School.

11.7 Case study: Manchester, United Kingdom

Manchester, located in the north-west of England, was the world's first great industrial city. With its steam-powered cotton mills, Manchester became the centre of the new textile industry that signalled the start of the Industrial Revolution. Manchester declined as an industrial centre during the 1960s but recent large-scale urban renewal projects have brought new vitality to the city.

Industrial beginnings

For most of Manchester's history, the city relied heavily on industries attracted to the region by a ready supply of coal. The coal was used to produce the energy that drove the new steam-powered machines.

Cotton processing

The Flemish people who settled in the area in the fourteenth century established a weaving tradition in Manchester. So, when cotton became available from Britain's colonies in the eighteenth century, Manchester held an early advantage. The invention of steam-powered spinning machinery introduced mass production to the cotton industry. Manchester had access to the water and coal needed by the new large factories.

Astonishing growth

As the cotton industry boomed around the turn of the nineteenth century, Manchester began to grow rapidly. At its peak in 1853, the city had over 100 mills. It became the world's main centre for cotton processing and was at the very heart of the global cotton trade.

Building on its beginnings in cotton processing, Manchester went on to develop a wide range of industries. The engineering firms that made the machines for the cotton mills diversified into other metal products, and the chemical industries that made bleach and dye moved into other commodities. Other commercial interests in Manchester, such as banking and insurance, supported these industries.

Thousands of people, including many who were fleeing the potato famine in Ireland, came to Manchester looking for work. The mill workers were very poor, and they lived in a maze of damp, poorly lit and filthy dwellings in overcrowded slums.

The **Industrial Revolution** brought wealth to Manchester's merchants and factory owners, but a large part of the population lived in poverty and squalor.

The Manchester Ship Canal

In 1894, the merchants of Manchester built a canal linking the city to the Irish Sea. The canal enabled ocean-going ships to reach Manchester's docks, some 58 kilometres inland. This provided direct access to raw materials as well as to markets for manufactured products. It made Manchester more competitive by removing the need to transport goods to and from the Port of Liverpool.

On the banks of the canal at Trafford Park, the world's first planned industrial estate was established in 1896. In 1899, British Westinghouse became the earliest engineering company to locate there when it began building a factory to manufacture turbines and generators. In 1911, the American car manufacturer Ford opened a factory and introduced its pioneering **assembly-line** method of production.

Manchester's canal and rail links soon enabled the city to become a centre for the processing and distribution of food. In 1938, the Kellogg Company opened a major industrial complex at Trafford Park. Kellogg's Corn Flakes are still made there today.

Trafford Park expanded rapidly during World War I and World War II as factories converted to bomb and munitions production. The famous Spitfire fighter planes and Lancaster bombers with their Rolls-Royce Merlin engines were also made there. At its peak in 1945, Trafford Park employed 75 000 workers in the war effort. Employment held up well in the 1950s, but the 1960s brought the first factory closures. The changing use of the Manchester Ship Canal can be observed in Figures 11.17, 11.18 and 11.19.



11.17

Manchester Dock No. 9 in about 1900. The Manchester Ship Canal can be seen in the foreground of the picture, and Dock No. 9 is on the left.



11.18

Salford Quay 19 in 1971, showing the Manchester Ship Canal and the lower end of Manchester Dock No. 9 at top centre.



11.19

Salford Quays in 2012, showing the Manchester Ship Canal on the right of the picture and Manchester Dock No. 9 in the centre. Media City is in the foreground.

Industrial decline

During World War II, Manchester was bombed by the German air force, the Luftwaffe, and large parts of the city were destroyed. The postwar years became difficult for Manchester. The early source of the city's wealth was gone: the cotton exchange closed in 1968 as cotton trading declined. At the same time, heavy industry suffered an economic downturn, and companies closed their factories. Manchester lost 150 000 manufacturing jobs between 1961 and 1983.

In 1982, the Port of Manchester closed. The Manchester Ship Canal could not handle the new generation of large **container ships**. This led to a further drop in the city's fortunes.

Revitalisation

More recently, Manchester underwent extensive regeneration (urban renewal). This was spurred on by efforts to recover from an Irish Republican Army terrorist bomb attack in 1996, and was further aided by investments in **infrastructure** for the 2002 Commonwealth Games. Large sections of the city were either demolished and rebuilt, or **gentrified**, with former mills and warehouses being converted into apartments.

Trafford Park Development Corporation

The British government was involved in early efforts to assist Trafford Park, but these had only limited success because the transport infrastructure of the country's first industrial estate was outdated.
In 1987, the Trafford Park Development Corporation (TPDC) was established to promote the area. It completed an infrastructure program with upgraded highways and a bridge that linked Trafford Park to major motorways, making it more attractive to **investors**.

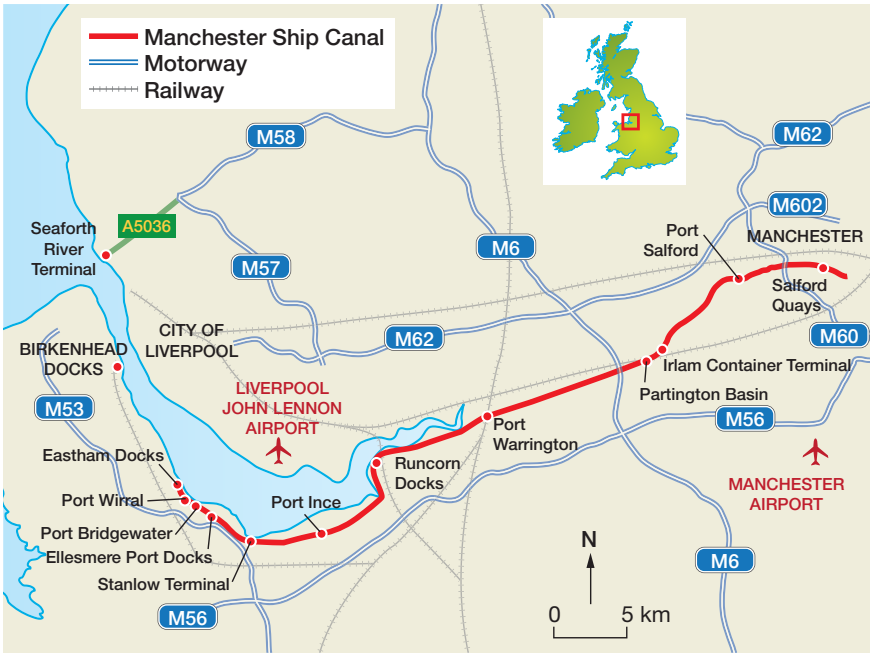
The TPDC was finally dissolved in 1998, having exceeded all its targets for reversing the decline and creating jobs. It had attracted 1000 companies and approximately $2.7 billion of private-sector investment, and created more than 28 000 new jobs. Trafford today has over 10 000 businesses, including international brands such as Adidas and L'Oréal. Modern high-tech industries and distribution operations have moved into Trafford in significant numbers. Photronics, the world's leading manufacturer of a key element in the production of electronics components, has built its new European headquarters in Trafford.

The Atlantic Gateway

The opening of the Manchester Ship Canal in 1894 and the subsequent loss of jobs in the Port of Liverpool led to increased rivalry between Manchester and Liverpool. The 2011 Atlantic Gateway strategy plans to establish a commercial corridor between the two cities. The strategy is backed by $80 billion of investment over 50 years. It is the largest development project in UK history.

The Atlantic Gateway will provide a central distribution base to improve **supply chains** for businesses across the north-west of the United Kingdom (see Figure 11.20). The Port of Liverpool will be redeveloped, as will the Manchester Ship Canal. It is planned that companies will move their freight on barges along the canal between the Port of Liverpool and the Manchester docks. This will lower costs, be better for the environment and take heavy trucks off the region's roads. A freight centre currently under construction on the banks of the canal in Manchester will be the key site for the distribution of goods.

11.20 The Atlantic Gateway strategy will provide the transport infrastructure needed to improve supply chains for businesses across the north-west of the UK.



Source: Mersey Ports Master Plan

Salford Quays

The site of the former Manchester Docks has become one of the largest urban regeneration projects in the UK. Salford Quays is now a prosperous quarter of the city. The most significant development is Media City UK, which is set to make Manchester a global hub for digitally driven industries. The aim is to make Manchester the creative capital of Europe. Already, Salford Quays is the new home of:

- the British Broadcasting Corporation (BBC), which moved five departments, including the BBC Children's division and BBC Sport, to Salford in 2011
- SIS Live, Europe's largest outside broadcast and satellite uplink provider
- one of the biggest high-definition media studios in Europe.

Salford Quays also has a thriving residential community, well served by hotels, coffee shops, recreation facilities and cultural attractions.

Manchester today

The city has become notable for its vibrant cultural and music scene; its creativity, media links and sporting connections; and its scientific and engineering output. Manchester is probably best known around the world for its Premier League football teams Manchester City and Manchester United. Manchester United is one of the most famous football clubs in the world and claims to have a fan base of more than 650 million people worldwide.

There is a sense of optimism associated with the revival of Manchester. There are still people living in poverty. However, for those who have chosen to live in the Manchester community, there are now more opportunities available. It became the UK's fastest growing major city in 2012.

DID YOU KNOW?

In Australia, New Zealand and South Africa, the term 'manchester' refers to household items such as sheets, pillowcases and towels.

ACTIVITIES

Knowledge and understanding

1 Explain why Manchester came to dominate the cotton industry.
2 Describe the types of industries that existed in Manchester in the nineteenth century.
3 Account for the decline in manufacturing in the postwar years.
4 Outline the efforts that have been made to revitalise Manchester in recent decades.

Applying and analysing

5 Demonstrate how the Media City UK development at Salford Quays is a premier location for media companies to relocate to. Include the following in your response:
   - the names of media companies already there
   - facilities
   - infrastructure.

Geographical skills

6 Study Figures 11.17, 11.18 and 11.19. Describe the changes that have taken place in the Salford Quays area of Manchester since 1900.
7 Study Figure 11.20, then answer the following questions.
   a Describe the transport infrastructure associated with the Atlantic Gateway strategy.
   b What is the distance travelled from the Seaforth River Terminal to Port Salford by:
      i canal
      ii road
      iii rail?
   c Do you think it would be quicker to move goods by canal, road or rail? Explain.
   d What are the benefits of moving goods by the canal?

11.8 Geoskills: Using ABS data to compare communities

The Australian Bureau of Statistics provides a number of databases that students can access, free of charge, to investigate and compare communities.

Online data tools

Census

Every five years, the Australian Bureau of Statistics (ABS) runs a **Census** of Population and Housing. All households must complete a Census form, which is a detailed questionnaire. The Census form asks questions about people, families and dwellings. Information gained from by the Census helps governments to plan for the future. Businesses use Census data to decide where to set up, expand or close down their operations.

The ABS makes Census data available via its extensive website (see Figure 11.21). Because the user can select the area they wish to investigate, the ABS site is ideal for studying the characteristics of communities. Geographers use this data to investigate spatial patterns of key demographic, social and economic factors. The data can also be used to compare one community with another and to reveal spatial differences or variations within communities.



11.21 Census home page

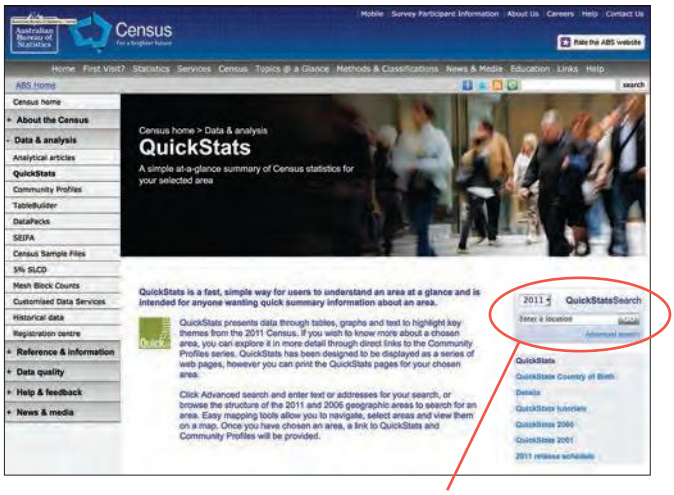
Accessing Census data

The best way to access Census data is to use QuickStats, shown in Figure 11.22.

QuickStats

QuickStats provides the user with a summary of key Census data for a chosen area, compared with data for the whole of Australia (see Figures 11.23 and 11.24). The data available includes:

- person characteristics
  - age
  - citizenship
  - number of people born overseas
  - country of birth
  - language spoken at home
  - marital status
  - labour force participation
  - occupation
  - industry of employment
  - income
- family characteristics (for example, whether families consist of couples with or without children, or single parents with children)
- dwelling characteristics
  - tenure type (for example, whether the occupants own or rent the dwelling)
  - household composition (whether the occupants are a family, a lone person or some other grouping)
  - landlord type.



11.22 QuickStats search

QuickStats search
Type in the name of the location you want to study



11.23 QuickStats data for Glenelg, South Australia



11.24 QuickStats data for Australia

Community Profiles

The Community Profile series is a comprehensive statistical snapshot of an area, presented as a Microsoft® Excel® spreadsheet. A number of different profiles have been produced. Of special interest to geographers investigating change over time is the Time Series Profiles, which provides twenty-five tables of data about people, families and dwellings, comparing Census data from 1996, 2001, 2006 and 2011.



11.25 Community Profiles can be downloaded from the ABS website and contain Census data for a particular location.

ACTIVITIES

Investigating

1 Use the ABS's Census data to investigate your local community. In doing so, complete the following tasks.
   - **a** Use the Census QuickStats facility to locate the statistical summary for your local community. Compare your community's data with the data supplied for Australia. Comment on how your community compares with Australia as a whole on each of the social, demographic and economic variables.
   - **b** Use the Community Profile series to investigate how your local community has changed over time in a selected range of Census variables.

2 Use the data you collected in Activity **1** to write a report profiling your local community.

11.9 Comparing communities and neighbourhoods

We can use demographic data to help us compare communities and neighbourhoods. Within Australia there are considerable differences between the demographic characteristics of urban, rural and remote communities.

Using demographic data

The demographic characteristics of a population are features such as the ages, ethnicities and incomes of the people who make up that population. The Australian Bureau of Statistics (ABS) collects Australia's demographic data. As part of this process the ABS conducts a census of all Australian communities every five years. When using ABS data it is important to understand some terms. 'Median' refers to the middle-ranked value in a series. For example, if you wanted to determine the median age of a family of five people, you would use the age of the third-oldest person in the family.

11.26 Community profiles from the 2011 Census

	Oodnadatta, SA	Gold Coast, Qld	Scottsdale, Tas.	Hermannsburg, NT	Melbourne, Vic.	Australia
Demography						
Total population	166	507 642	2461	625	3 999 982	21 507 717
Median age (years)	29	38	43	24	36	37.3
Male (% of total)	48.8	48.9	48.1	45.3	49.2	49.4
Female (% of total)	51.2	51.1	51.9	54.7	50.8	50.6
Percentage under 15 years	31.9	18.6	19.8	32.8	18.4	19.4
Percentage over 65 years	4.2	14.6	21.7	2.9	13.1	14.0
Aboriginal or Torres Strait Islander (%)	68.1	1.3	3.0	86.2	0.5	2.5
Birthplace (%)						
Australia	78.0	65.4	89.6	99.0	63.3	69.8
Other	Greece (2.5) Germany (1.8)	NZ (8.5) UK (5.7)	UK (2.6) NZ (1.1)	… …	UK (3.4) India (2.7) China (2.3)	UK (4.2) NZ (2.2) China (1.5)
Birthplace of parents (%)						
Both parents born overseas	2.1	35.2	7.7	3.6	45.9	34.3
One parent born overseas	7.5	13.6	5.9	2.8	19.2	11.9
Both parents born in Australia	89.4	51.3	86.3	93.6	42.1	53.7

11.26 *(continued)*

	Oodnadatta, SA	Gold Coast, Qld	Scottsdale, Tas.	Hermannsburg, NT	Melbourne, Vic.	Australia
Family composition (%)						
Couple without children	14.3	40.5	46.6	20.5	34.8	37.8
Couple with children	48.6	41.1	39.7	45.3	47.9	44.6
One-parent family	37.1	16.9	12.6	31.6	15.3	15.9
Other family	0.0	1.5	1.0	2.6	2.0	1.7
Employment (%)						
	Farming (45.1) Hotel (9.0) Social services (8.2)	Cafes and restaurants (4.3) Education (3.9) Building and construction (3.3) Hotels and motels (2.9) Supermarkets (2.8)	Log sawing and forestry (19.7) Education (5.0) Trucking (5.0) Supermarkets and stores (4.3)	Local council (40.4) Social services (7.1) Shops (6.1) Education (6.1)	Education (4.1) Cafes and restaurants (3.8) Hospitals (3.3) Legal and accountancy firms (2.4)	
Income of people 15 years and over						
Median total personal weekly income	$333	$570	$409	$269	$519	$577
Median total family weekly income	$483	$1377	$1006	$666	$1576	$1481
Median total household weekly income	$666	$1173	$762	$1238	$1333	$1234
Household income (%)						
Less than $600 gross weekly income	64.3	23.2	39.6	19.0	21.3	23.7%
More than $3000 gross weekly income	0.0	8.3	2.1	5.0	12.3	11.2%

Source: Australian Bureau of Statistics

ACTIVITIES

Knowledge and understanding

1 In your own words, explain the meaning of the term 'demographic characteristics'.

2 Examine the demographic data for Australia. Which community's data most closely resembles the data for Australia as a whole? Why might this be so?

Applying and analysing

3 What are the main demographic differences between the Aboriginal community of Hermannsburg and the other remote community, Oodnadatta?

Geographical skills

4 Use an atlas or internet-based map to locate each of the places included in Table 11.26.

5 Study Table 11.26 and identify the place with the:
- **a** lowest median age
- **b** greatest percentage of the population under the age of 15 years
- **c** highest proportion over the age of 65 years
- **d** lowest proportion of Aboriginal and Torres Strait Islander people
- **e** most ethnically diverse population
- **f** lowest proportion of families where both parents are Australian born
- **g** highest proportion of couple-only households
- **h** highest proportion of single-parent households
- **i** highest and lowest median personal weekly income
- **j** highest and lowest household weekly income.

11.10 In the field: Investigating neighbourhoods

The aim of this fieldwork activity is to investigate your local neighbourhood. You will need to undertake research online and in the field. After you collect your data, you will assess your neighbourhood and the facilities available.

Choosing a neighbourhood

People choose to live in a particular neighbourhood for a variety of reasons. These reasons include:

- attachment to a place
- being close to family and friends
- employment opportunities
- affordability
- life-cycle stage
- lifestyle considerations
- personal safety
- environmental factors, including climate
- educational and healthcare facilities
- culture and ethnicity
- commuting time and public transport options.

Land-use map

A land-use map is a thematic map showing the distribution of different land uses. The steps below explain how to construct a land-use map of your neighbourhood.

Step 1

Access an outline map of your local neighbourhood. Local council websites can usually provide a map. You can also use an online digital map service such as Google Maps. Print a copy.

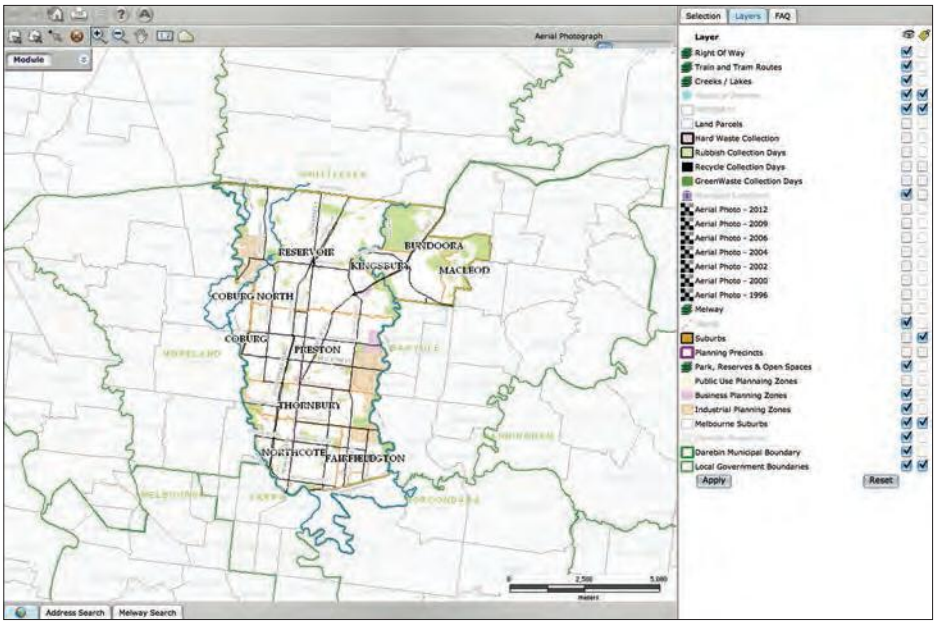
Step 2

Using your outline map, conduct a land-use survey of your local neighbourhood. Make a legend for your map that contains the following land-use categories. Colour-code these land uses on your map. Use Figure 11.27 as a guide.

- Low-density residential
- High-density residential
- Commercial
- Recreational
- Place of worship
- Other
- Medium-density residential
- Transport
- Retail
- Industrial
- Educational
- Bike paths

Step 3

Take digital photographs of the diversity of land uses found in your local neighbourhood. Link these images to your land-use map.



11.27 A map of a neighbourhood on a local council website

A multimedia presentation

Step 1

Use a digital recording device such as a flip camera to capture footage of your local area. Select scenes that are representative of your neighbourhood, such as:

- residential areas
- commercial areas
- educational and healthcare facilities
- religious sites
- transport services
- recreational sites
- special events/festivals/celebrations.

Step 2

Record interviews with members of your community. Ask them to reflect on what it is like to live in your neighbourhood. You may choose to select people who have lived in the area for varying lengths of time. This will help you to determine if things have changed over time—and, if so, in what ways they have changed.

Step 3

Combine your footage into a multimedia presentation by adding a commentary, music and even text to highlight what is especially important in your neighbourhood.

Survey of retail businesses and services

Step 1

Access an outline map of your local neighbourhood, as described earlier under 'Land-use map'. Zoom in on a local retail centre. You may live in a neighbourhood with more than one retail centre; if so, select just one retail centre to survey. Print a copy of the map.

Step 2

Using the list below, conduct an audit of the number and type of retail and service providers found within your local retail centre.

- supermarket
- butcher
- hairdresser
- cafe
- restaurant
- hotel
- fruit shop
- newsagent
- chemist
- takeaway food outlet
- post office
- club
- medical consulting rooms
- service station
- real estate agent
- solicitor's office
- shoe store
- dentist
- bank or credit union
- travel agent
- spa
- clothing store

Step 3

On your map, locate and label the different types of shops and commercial businesses found in your local retail centre. Photos can be taken of examples of each activity. Make a record of any businesses that have closed, or are up for sale or vacant.

Statistical profile

Step 1

Access the QuickStats page on the Australian Bureau of Statistics (ABS) website. To do this, go to the ABS home page and select **Census Data** from the list on the left. On the Data and analysis page, select **QuickStats** from the list on the left. Type the name of your neighbourhood in the QuickStatsSearch box and click **Go** to access Census data related to your neighbourhood (see Figure 11.28).



11.28 Location QuickStats page on the ABS website

Step 2

Use the Census data provided to develop a profile of your local neighbourhood. Include information related to:

- the total number of people
- age
- gender
- place of birth
- languages spoken at home
- marital status
- family type
- employment status and occupation.

Climate profile

Step 1

Go to the Bureau of Meteorology website. On the home page, click **Climate and Past Weather**. Under 'Weather and Climate Data', click **Weather and climate data** to access the Climate Data Online page. You can choose the data you wish to access using either the **Select using Text** (see Figure 11.29) or **Select using Map** (see Figure 11.30) tab.

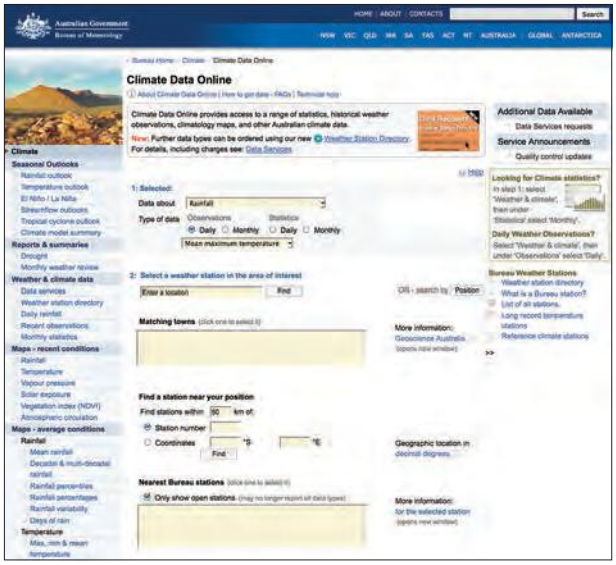
Step 2

Using Select using Text

In section 1 of the tab, select **Weather & climate**. Under 'Statistics', click the **Monthly** button.

In section 2, type the name of the location you want to investigate in the box. Click the **Find** button. Click to select your chosen location from the list. Click the Bureau station closest to your location.

In section 3, click the **Get Data** button.



11.29 Selecting climate data using text

Using Select using map

In the **Data** tab, under 'I would like', select **Climate statistics**.

Under 'Zoom to', type the name of the location you want to investigate in the box. Click the **Search** button. Under 'Select town', click to select your chosen location from the list.

On the map, click the symbol of the weather station closest to your chosen neighbourhood. Click **Monthly climate stats**.



11.30 Selecting climate data using a map

Step 3

Create a climate graph of your local neighbourhood. Use the following statistics:

- mean maximum temperature
- mean minimum temperature
- mean rainfall.

ACTIVITIES

Aim

To investigate the liveability of your local neighbourhood and assess the facilities available.

Method

1. Construct a land-use map of your neighbourhood. Add to your land-use map the photographs you have taken and mount a wall display showing the diversity and location of various land uses in your local neighbourhood.
2. Complete a statistical profile of your local neighbourhood.
3. Audit the retail businesses and services located in your local neighbourhood.
4. Complete a climate profile of your local neighbourhood.

Option 1: A multimedia presentation

Use a digital recording device to record footage of your local area and interview residents.

Option 2: Local history

Investigate the historical background of your local neighbourhood. Include in your response:

- the origin of the name of your local neighbourhood
- Aboriginal and Torres Strait Islander history
- European history.

Option 3: Meeting special needs

Using the data collected in Method steps **1**–**4** above, identify the groups within the local neighbourhood that have special needs (for example, the elderly, the disabled, young children, teenagers). Identify how the needs of one such group are being met or not met in the local neighbourhood.

Evaluation

1. Describe the mix of retail outlets and service providers located in your local neighbourhood centre.
2. Do the facilities provided match the statistical profile of the area, or are there retailing and services missing? Explain your answer.
3. Look at the climate profile of your neighbourhood. Are the types of services provided appropriate for the climate? Explain your answer.
4. Choose five features from the following list of neighbourhood facilities that you would value having in your local neighbourhood.
   - skateboard bowl
   - public housing
   - indoor sports complex
   - church
   - youth club
   - shopping mall
   - nursing home
   - aquatic centre
   - internet cafe
   - restaurant or takeaway food outlet (e.g. McDonald's or KFC)
   - motorway interchange
   - railway station
   - primary school
   - secondary school
   - corner shop
   - factory
   - adventure playground
   - football field
   - cinema complex
   - service station

   a Refer to the rating scale below and rate how close to your home you would be happy to have each of these five features.



   b List those features that you would value in your local neighbourhood but would not want too close to your home. Explain your answer.

   c Suggest three different groups of people in your local neighbourhood who might disagree with your choices. How and why might their views differ?

Conclusion

If you could, would you make any changes to your local neighbourhood? Why, or why not?

11.11 Case study: Australia's 'big' towns

Many of Australia's country towns are known for the so-called 'big things' that are found along the roadways linking them to the rest of the country. Giant models of everything from peanuts to lobsters have been constructed to promote what local people think is special about their town or region.



11.31 Standing an impressive 18 metres tall, the Big Lobster can be found in Kingston SE, South Australia.

Origins

The idea of 'big things' began in the United States of America in the 1920s. As car ownership grew, more and more people went on road trips. Oversized objects were built along roadsides to catch people's attention and to encourage them to stop and spend money.

The first 'big thing' to be built in an Australian country town was the Big Banana at Coffs Harbour, New South Wales, in 1964. A local producer who had a fruit stall on the Pacific Highway wanted something that would make passing motorists take notice, stop and buy his bananas. Having heard of the Big Pineapple in Hawaii, USA, he had the idea of building the Big Banana. It was an immediate hit, and over the last 50 years the Big Banana has grown into one of the surrounding region's most recognised tourist attractions.

The idea takes off

After the success of the Big Banana, there were many imitators, and all kinds of oversized models were built in Australia, such as:

- the Big Mango in Bowen, Queensland
- the Big Potato in Robertson, New South Wales
- the Big Lobster in Kingston SE, South Australia (see Figure 11.31)
- the Big Ned Kelly in Glenrowan, Victoria
- the Big Crocodile in Humpty Doo, Northern Territory.

Changes in small towns

Country towns developed across Australia to serve the needs of rural producers and to make the transport of primary products to markets possible. In recent decades, however, many of these towns have been losing businesses, services and people. Many towns now struggle to survive.

At the same time, tourism has boomed across Australia. As a way to support rural communities, the Federal Government has provided funding for the construction of tourist attractions in rural areas. Most of the 'big things' were built in the 1970s and 1980s to celebrate what a region was famous for. The goal was to encourage travellers to break their journey and boost the local economy. 'Big' towns can be seen as a response to changing economic fortunes.

'Big things' and service stations

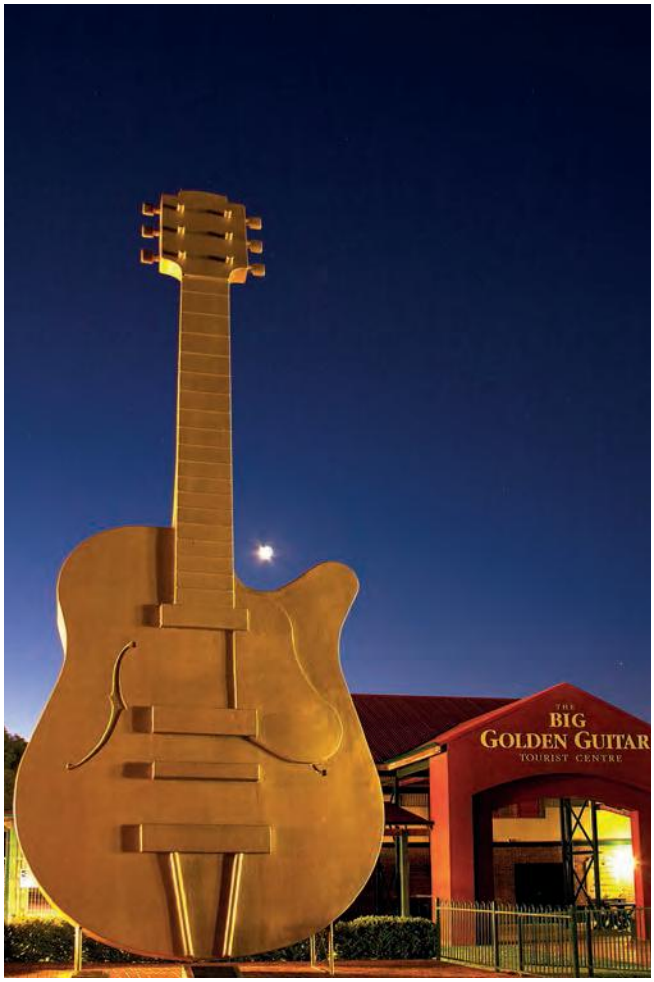
During the 1980s, two brothers embarked on building a 'big thing' empire in New South Wales, based on service stations. The Big Merino at Goulburn was the first of their ventures. It was followed by the Big Prawn at Ballina and the Big Oyster at Taree. The Big Merino is a 15-metre-high concrete structure weighing 96 tonnes. Locals refer to it affectionately as 'Rambo'. When the Hume Highway bypassed Goulburn in 1992, the Big Merino was moved to its present site at a service centre beside the new freeway.

Celebrating big

Australia is a big country and it is now home to more than 150 'big things'. Many objects of local significance are reproduced at larger than life size beside highways running through Australian towns. These include the Big Golden Guitar in Tamworth, New South Wales, and the Golden Gumboot in Tully, Queensland (see Figures 11.32 and 11.33).

With such long distances and hours of travel between towns, these big roadside attractions are a welcome distraction for travellers, who might otherwise hardly notice the towns they drive through. Quite apart from the tourism revenue they generate, the 'big things' have become a quirky part of Australian culture. Many have appeared on postage stamps and in movies. They are now recognised as works of folk art. Some, including the Sunshine Coast's Big Pineapple, have been heritage listed.

11.32 The Big Golden Guitar celebrates Tamworth as the country music capital of Australia.





11.33 The Golden Gumboot at Tully, Queensland, one of the wettest towns in Australia

ACTIVITIES

11.3

Knowledge and understanding

1 Outline how and when the 'big things' idea began in Australia. Where did the idea originate?
2 Explain why 'big things' are mainly found in country towns. Why are they considered important?

Applying and analysing

3 Construct a model or draw a sketch of a 'big thing' that could represent the community you live in or one that you may have visited on holidays or would like to visit one day. Then answer the following questions.
   a Explain why you have chosen this particular 'big thing'.
   b How does it represent your community?
   c Demonstrate how it will be a tourist drawcard for your community.
   d Devise a marketing plan to advertise your 'big thing'.

Review and reflect 3

Activity 1

Improving your local area

a Working in pairs or small groups, choose a teenage-friendly facility you would like to develop in your local neighbourhood, and select a location for it. Suitable facilities could include:
- a skate park
- a new indoor sports and recreational facility
- a swimming pool
- a cinema complex
- a library
- open-air cinemas
- better public transport, e.g. safer train stations or more buses and extended bus routes
- more shops and cafes
- cycle paths
- green open spaces
- a free wi-fi network
- an area for free activities such as music concerts.

b Prepare a multimedia display of your plans. Include the following in your presentation:
- a map of the area with the location shown
- details about what is to be built or developed
- examples of similar facilities elsewhere
- the benefits to the local community (you may want to include the 'costs' of the plan)
- an indication of who is likely to use the facility.

c Outline your social network campaign. Include in your plan:
- the social networks you are going to use
- the people or groups your campaign will target; these could include:
  - the local mayor and councillors
  - the local state and/or federal Member of Parliament
  - community groups
- the message you are going to send to each group or person.

Activity 2

Liveability around the world

Vancouver, shown in Figure R&R3.1, is often rated as the world's most liveable city.



R&R 3.1 Vancouver, Canada

a Select two or three cities from around the world. Ensure you select cities from different continents. Conduct research into the following aspects of liveability for each of the cities you chose:
- law and order
- economics
- environment
- culture
- education
- health care
- infrastructure.

Present your findings in an annotated visual display. Central to your display should be a map of the world with each of the cities you chose marked and labelled on it. Your display can include images, graphs and tables.

b Write a short response comparing and contrasting the liveability of the cities you chose.

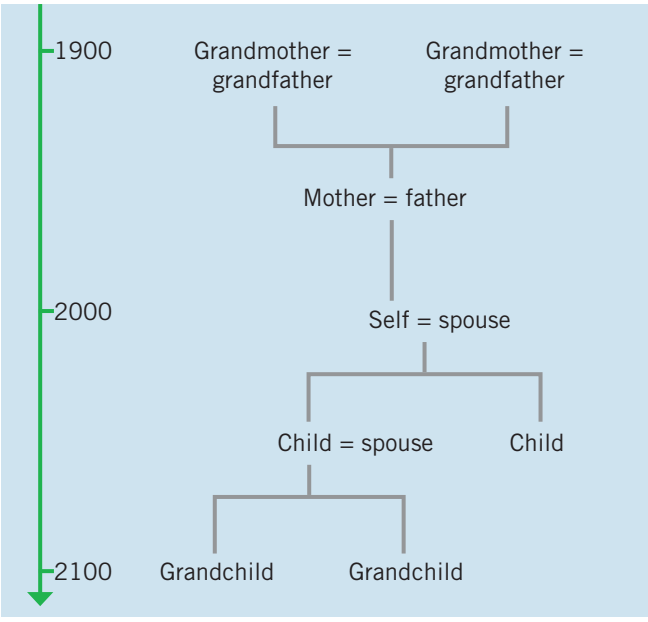
Activity 3

Looking to the future

Geographers are interested in the future, not just the past and the present. They use their geographical knowledge and skills to discover, examine, evaluate and propose possible, probable and preferable futures. We cannot 'study' the future because it does not exist yet. We can, however, make informed predictions about the future. We can do this because of our knowledge of the past and the present.

Figure R&R3.2 shows how generations overlap. Much of our learning about the world we live in is through the interactions we have with others. We can, for example, learn about the past by talking to our grandparents, parents and teachers. We can then use this knowledge to think about what the future might be like.

Figure R&R3.2 also shows how the 'present' can span 200 years of 'lived' experience. Members of a community are linked, through people's life experience, with the events of the past 100 years, and some of those born today may live for another 100 years, thus carrying this knowledge into the future.



R&R 3.2 The family chain

a Using Figure R&R3.2 as a guide, list those things that you can think of that have been passed down from one generation to the next.

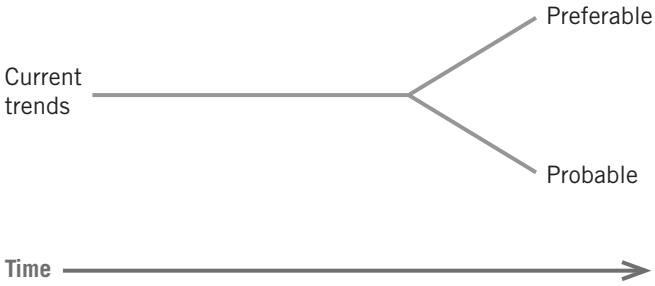
b As a class, brainstorm and list other things that may have been passed between generations.

c Use this information to explore how the local community has changed over the last 100 years, and how it might change over the course of your lifetime. Present this information in a timeline.

Activity 4

Mapping the future

At any point in time, any number of alternative futures are possible. Preferable futures are those futures that could exist under the best of circumstances. Probable futures are those that seem most likely to occur. Timelines are an effective way of exploring probable and preferable futures.



R&R 3.3 Using a timeline to explore probable and preferable futures

Using Figure R&R3.3 as a guide, complete the following tasks.

a Beginning with 'current trends', identify the key elements of the present situation. Examples of current trends are water use, the price of oil, air or water pollution, deforestation and overfishing.

b Fill in the 'probable' timeline by asking what changes are most likely to happen. Your teacher will give you an idea of the period of time you should take into account.

c Fill in the 'preferable' timeline. The question to ask yourself is, 'What would I personally prefer to happen here?'

d Compare your timeline with those developed by others in your class.

Index

A

Aboriginal and Torres Strait Islander people
- city living and 191
- community and 185
- Country attachment and 194–7
- Gerringong and 246
- languages 196
- Natimuk and 252
- Paraburdoo and 261
- population distribution 240
- remote settlements 209
- rock art 197, 252
- water management 112, 157, 162–3
- wild river development and 172–3

accessibility 181, 202, 269, 271
Adelaide 54, 88, 211, 272
aesthetics 181, 183, 190, 200
affordability 183, 200
Afghanistan, population pyramid 235
Africa, water scarcity 93, 139, 142, 150–1
after-dark activities 278
ageing population, Venice 262
age structure changes, Australia 183, 198, 202, 228–9, 232, 234–5, 247, 249
agriculture
- drought and 80, 140, 141
- population distribution and 241
- water and 114, 115

air mass 41, 48
air pressure 59, 63, 94
air quality 193
Alice Springs 54
altitude 44
Amazon River 108
aneroid barometer 59
apartment blocks 215, 218
aqueducts 137, 145
aquifers 101, 110, 112, 113, 138, 144–5, 146, 157, 175
Arabana People 159
ArcGIS Explorer 35
arch dam 145
area references 24–5
artesian bore 112
aspect 19, 27, 43
assembly line production 269, 286
Atlantic Gateway 288
atlas maps 30–1
atmosphere 8
atmospheric pressure 41, 42
Australia
- community changes 226–9
- droughts 94–7
- employment changes 227–8
- mineral and energy resources 245–9
- natural hazards and disasters 65, 79
- population distribution changes 235, 238–9, 240–3
- water resources 112, 115, 117, 119, 154–79
- weather and climate 52–5

Australian Bureau of Statistics (ABS) 290–1, 292–3, 295
Australian content (television) 228
average annual rainfall 156, 159

B

baby boomers 225, 234, 244
Bali, irrigation 130–1
Bangladesh 128, 132
Barangaroo parklands 277, 279
Barmah Forest wetlands 163
Batemans Bay 79
bauxite mining 170
beach cliff 27
beach lifestyle 242
bend measurement 29
Bern 222–3
big dam projects 148–51
'big things' tourist attractions 298–9
'big wet' 84
biodiversity 90
biomass 36
biophysical environment 3, 4, 8
Black Saturday 88
blue water 101, 114
body waste 102, 103
bottled water 115
Bradfield Scheme 160
Brahmaputra River basin, water hotspot 126–7
brine 137, 146
Brisbane 54, 80, 276
- floods 85, 87, 98

Britain, industrial cities 211

British Broadcasting Corporation (BBC) 289
British expatriates, Costa del Sol and 265–6
broadacre farming 225, 253
building codes 98
Bujacali and Karuma 150
Bureau of Meteorology 50, 57, 60, 74, 83, 84, 296
Burkina Faso, water hotspot 125
Burley Griffin, Walter 211
bushfires 65, 66, 67, 88, 96
buttress dam 145

C

Cairns 54
California 145, 282
Canberra 54, 187, 209, 211, 222
Cape York Peninsula 170, 172
carbon dioxide 102, 221
Carlton 229
cartographers 19, 22
car transport 217, 218
case studies 52–5, 84–7, 94–7, 130–1, 132–5, 140–1, 150–1, 152–3, 166–9, 171–3, 222–3, 246–9, 252–5, 260–1, 262–3, 264–7, 286–9, 298–9
catchments 101, 108–9, 166
Census of Population and Housing 269, 290–1, 295–6
central Australia 236
central business district (CBD) 216–17, 277
Central Park (Sydney) 277
centre pivot irrigation 129
change 3
Cheonggyecheon River restoration park 283
Chessell, Duncan 7
children, Gerringong and 248
China 220, 230, 250
  water and 125, 128, 148–9, 150, 151
Chongquing 220
cities 210–11, 212
  enhancement of 276–9
  population distribution 220, 241
  public transport and 216–17
  water and 106, 122, 164
citizenship ceremony 231
city living 184, 185, 199, 208
clean water access 120–3
climate 41, 43–5, 51, 54, 106, 161, 183, 186, 200, 201, 246, 252, 260, 296
climate change 67, 93
clouds 46, 47
clustered settlements 187, 209
coal 116, 257, 258
coal seam gas 259
coalescence 41, 46
coastal cities 236
coastal living 187, 191, 238, 241, 244–5, 246
coffee production, water and 119
cold fronts 56, 68, 69
cold waves 89
colour-coding 294
column graph 69
Commonwealth Scientific and Industrial Research Organisation (CSIRO) 228
community 3, 5, 14–15, 190
community change, Australia 226–9
community gardens 269, 272
community profiles 291, 292–3
community sense 247, 248–9, 254, 271, 272
commuting 251
compact city 217
compound line graphs, energy exports 258
computer-based learning 284, 285
condensation 41, 49, 104
confederation 207, 222
conical mountain 27
connectivity 193
constructed environment 3, 4, 9, 186
consumer products, virtual water and 118
container ship 269, 288
contaminated water 101, 121
continuous resources 3, 10, 11
contour intervals 19, 26
contour lines 19, 26
conurbation 208
convection current 72
convection focus 95
convectional rainfall 41, 47, 49
Coolibah Springs Complex 170–1
Cooper Basin gas fields 258
Costa del Sol 264–7
cotton industry 286
Country attachment, Aboriginal and Torres Strait Islander people and 194–7
country towns, 'big' towns idea 298
creviced rock 110
crime issues 204–5
Cronulla riots 205
crop yield 155, 158
cultural diversity 196, 199, 228, 271
cultural sites 195
culture 9, 183, 190, 191, 192, 228
cumulonimbus clouds 72, 77
cyclones, see tropical cyclones

D

dairying 247
dams 137, 141, 145, 148–51, 157, 164
Dandenong High School (Melbourne) 284–5
Darling River 166
Darwin 54
death rates 234
deep aquifer 137, 145
deforestation 133
demography 15, 181, 187–8, 228, 292–3
dendritic drainage 109
Denmark 284
density 19
desalination 137, 146–7, 161
desertification 63, 90, 137, 142
dew 47
Diamantina River 108
digital photographs 294, 295
digital technologies 34–5, 225, 250
disability 269, 274–5
Disher Creek 168
dispersed settlements 208, 209
distance (maps) 29
distribution 19, 21
Djurite Balug clan 252, 253
Docklands (Melbourne) 272
drainage basin 101, 109
Dreaming 195
drinking water 110, 120
drip irrigation 129, 174
droplets 46, 47
drought 63, 66, 84, 90–7, 98, 113, 117, 140–1, 158, 252
drowned coastline 27
dryland salinity 164
dust storms 96

E

early settlements 210
early warning systems 98
earthquakes 65, 66, 67
eastings 24
ecological footprint 207, 221, 280
ecological sustainability 225, 233
e-commerce 255
economic benefits, wild rivers 173
economic environment 9, 66, 68, 80, 89, 90–1, 138, 167, 238, 271
Economist Intelligence Unit (EIU) liveability survey 192–3
ecosystems 52–3, 166
education level 189, 192, 199
Egypt, irrigation 128
elevated park 284
elevation 19
Elizabeth Quay redevelopment 270
Elizabeth Town 190
El Niño 94–5, 96
embankment dam 145
emergency services 99
emigration 225, 234
employment changes 183, 227–8, 255
endangered species 155, 172
energy resources, Australia 245–9, 258
environment 3, 4, 8, 9, 36, 192
  cities and 221, 277
  liveability and 183
  Murray–Darling Basin and 168
  population changes and 244
  shopping centres and the 280
  water resources and 142, 151
environmental flow 155, 165
environmental impacts 66, 68, 80, 90
environmental quality 200–1
escarpment 27
Ethiopia, water needs 140, 150, 152–3
ethnicity 15, 183, 271
European Cold Wave 89
European settlement 236, 241, 246–7, 253, 261
evaporation 41, 52, 104, 106–7, 108, 110
export income, mineral resources 256
extensive grazing 225, 236

F

family structure, Australia 228–9
famine 92
farmers, drought and 91, 92, 96–7
fertility rates 232
fibre-optic network 225, 226
fieldwork 6
filtration 147
Fitzroy Crossing 161
flash floods 63, 68, 80, 81, 83, 86, 98
flood plains 27, 98
floods 63, 65, 66, 67, 80–3, 86, 98, 99
fly-in, fly-out (FIFO) mining workers 251, 260
food production
  Murray–Darling Basin 167
  virtual water and 118
food relief efforts 140, 141
Foro 153

fossil fuels 225, 257
freezing level 41, 46
Fremantle Festival 15
fresh water 106, 138, 142
frontal rainfall 41, 48
fronts 41, 48, 49, 56
function 15, 209

G

Ganga Action Plan (GAP) 134–5
Ganges River basin 121, 126–7, 132–5
Garwood, Luke 255
Geelong 182, 282
gentrification 269, 288
geographers 3–17
geographic information systems (GIS) 34, 35
Geography 3
geoskills 12–13, 28–9, 50–1, 56–7, 158–9, 234–5, 290–1
geothermal power 36
Gerringong case study 246–9
Glandore 272
global financial crisis, Costa del Sol and 266–7
global positioning systems (GPS) 34, 35
global warming 135, 225, 257
globalisation 225, 226–7, 250
Golden Gumboot (Tully) 299
goods 181, 202
Google Earth 35
Gordon Dam 157
Gorrie, Josh 248
Goulburn Broken Catchment Management Authority 163
government planning 259, 271, 272
Gowrie Creek 86
Grand Inga Project 150, 151
Grantham flash flood 86
gravity feed irrigation 129
grazing 241
Great Artesian Basin 112
Great Dividing Range 112
Great Man-Made River Project 146
green buildings 277, 278, 280–1
green energy 137, 146
green space 193
green water 101, 114
Greenwich 51
grey water 101, 114, 174, 269, 278
grid references 24–5, 32
ground-level photographs 12, 13
groundwater 104, 106, 108, 110–13, 114, 137, 144–5, 157, 164

H

habitat 155, 166, 167
hail 47
Haiti earthquake 66
Hamersley Range 260
hazard control 98–9
Headland Park (Sydney) 279
headwaters 155, 170
health care 192
healthy lifestyles 271
heatwaves 63, 88–9
Hellerup School (Denmark) 284–5
hemispheres 32
heritage 201
hierarchy of settlements 208
High Line linear park (New York) 284
high-density cities 215, 216, 218, 220–1, 242
high-pressure systems 53, 56, 88, 94, 95
historical theme park 262
hobby farm 185
Horn of Africa, drought 140–1
Horsham 253
house price decline, Costa del Sol 267
household type 198
household water 114, 115, 117, 122, 174–5
housing affordability 270
housing density 214–15, 262–3
human activity, environment and 36–7, 103
human impacts, water 81, 105, 167
human remains, Ganges River and 134
human rights 181, 183
humidity 41, 42, 58, 84
Hunter Valley 257
hydro-electricity 36, 137, 145, 149, 151, 157, 167
hydrological cycle 8, 104
hydrological drought 90
hygiene education 121, 123
hyperthermia 63, 88

I

ice caps 106
ice crystals 47
immigration 225, 230–1, 232, 233, 265–6
impervious rock 110
income level 189, 199

index 31
India 111, 132–5, 221
individual water use 174–5
Indonesia, water pollution in 123
Indus River basin, water hotspot 126–7
industrial cities 209, 211, 288
Industrial Revolution 269, 286
industrial wastes, Ganges River and 134
industrial water use 114, 174
infiltration 104, 164
infrastructure 121, 122, 141, 192, 207, 208, 221, 244, 269, 288
inland living 186, 252
inner city living 185, 191, 242
integrated complexes 281
interlocking spurs 27
International Date Line (IDL) 32
internet 35, 226, 250, 254
interstate population movements 242–3
interviewing 295
inundation 63, 82
Ipswich 280, 281
Iraq, water hotspot 124
iron ore exports 261
irrigation 101, 110, 128–9, 142, 157, 160, 164, 169, 174
  Bali and 130–1
isobars 56
isolation, rural centres and 254
Israel, water hotspot 124
Italy 262–3

J

Japan earthquake 67
Japan, population pyramid 235
Jardwadjali People 252
Jerusalem 189
job creation 251, 288

K

Kakadu National Park, rock art 197
Kalahari Desert 143
kangaroos 102
Kati Thanda (Lake Eyre) 159, 164
Kenya, drought 125, 140
Kimberley–Perth Canal 160–1
Kobe 33

L

Lake Eyre (Kati Thanda) 159, 164
Lake Natimuk 252
land degradation 63, 90, 167
landform shading 27
landslide 66
land use patterns 218, 236–7, 294, 295
La Niña 94–5, 96
latitude 32–3, 42, 50
Latrobe Valley 116, 257
layer colouring 26
leaching 155, 164
leakage 174
legend 19, 22, 28, 294
Leigh Creek 209
levee banks 83, 98, 99
Libya, water supply 146
life, water and 103
life expectancy 232, 234
lifestyle 183, 200, 225, 245
lightning 68, 69, 70
linear (ribbon) settlements 209
linear scale 23
liquefied natural gas 258
lithosphere 8
liveability 181, 182–3, 184–5, 192–3, 199
  Bern 222
  enhancement of 268–99
  perceptions of 190–1, 198–9
Liverpool 286, 288
location 19, 202–3
Lockyer Valley, flash flood 86
Lom Pangar 150
London 34, 217
longitude 32–3, 50
low-density cities 214, 216
low-pressure systems 42, 56, 72, 73, 95

M

McMansions 215
malnutrition 137, 141
managed environment 3, 4, 9
  Murray–Darling Basin 168
Manchester, urban renewal 286–9
Manila 122
manufacturing 225, 236, 238
maps 18–39
Marbella 264
marbled frogmouth 170–1, 172
marsupial megafauna 162

master-planned housing estate 207, 214
Media City 287, 289
media reports, crime and 205
medium-density housing 214–15, 218–19
Meking River, water hotspot 125
Melbourne 54, 272, 278, 284
    heatwave 88
    liveability 187, 188
Mercer liveability survey 193
meridians of longitude 19, 32
Merowe 150
metabolic processes 101, 102
meteorology 41, 50, 98
Mexico City, water hotspot 125
Millennium Development Goals 137, 139, 142
mining 173, 185, 237, 238–9, 241, 242, 251, 256–9, 260
Mitchell, Thomas 253
Mitre Rock 252
Mogadishu, rainfall 141
mobile technology 227
Monocle liveability survey 193
monthly climate statistics 51, 296
mountain ranges 44, 53, 108
Mount Arapiles 252, 253, 254
Mount Tom Price 261
Mphanda Nkuwa Dam 150
multicultural society 225, 231
multifunctionality 187, 207, 209
multimedia presentation 295
Mumbai 221
Murray–Darling Basin 84, 108, 160, 162, 163, 165, 166–9
My Family stickers 251

N

Namibia 142
NASA 158, 159
Nati Frinj arts festival 254
Natimuk case study 252–5
National Broadband Network (NBN) 226, 251, 255
National Sea Change Taskforce 244
natural disasters 63, 64–7, 201
natural gas reserves 257, 258
natural hazards 63, 64–7
natural population increase 225, 230
natural resources 3, 10–11
neighbourhoods 3, 14–15, 273, 294–5
net migration 225, 230
New South Wales
    floods 84
    water hotspot 125
New York 284
New Zealand, immigration from 243
Newcastle storm 70
News Corporation 228
night-purging windows 278
Nile River, irrigation 124, 128
nomads 155, 162
non-renewable resource 3, 10, 11, 256
northern Australia, water run-off 156
Northern Hemisphere 43
Northern India, water hotspot 125, 126–7, 128
Northern New South Wales, water and 160
northings 24
North-West Shelf 258
Nourlangie Rock 197
nucleated settlements 209

O

oblique aerial photographs 12, 247
ocean currents 44, 53
ocean hazards 64
Okavango Delta, water hotspot 125
Olary 197
open-cut mines 261
open public spaces provision 271, 277
orientation 22
Orion Springfield shopping centre (Ipswich) 280–1
orographic rainfall 41, 47, 48, 49
outsourcing 225, 250
overcrowding 212
overseas-born Australians 231

P

Pacific Brands 250
Pacific Ocean, water temperatures 94–6
paddy rice irrigation 130–1, 174
Pakistan 125, 126–7, 128
Paraburdoo case study 251, 260–1
parallel drainage 109
parallels of latitude 19, 32
parched areas 155, 158
Pasha Bulker 70
pasture 155, 158
Pearson, Noel 173
perception 181, 198–9, 204
perspective 3, 6
Perth 54, 88, 161, 238, 239, 270
petrol consumption patterns 217

photography 12–13
photosynthesis 101, 102
physical features 30
pie graphs 66
Pilbara 260, 261
Pisolite Hills project 170, 172
pitcher plant 172
pivot irrigation 174
Pixel building (Melbourne) 278
Pixelcrete 278
planned cities 211
plastic bottles 115
police anti-crime programs 204–5
political environment 9, 201
population changes, Australia 230–3, 236–7, 238–9, 240–3
population density 21, 188, 193, 216
population pyramids 234–5
    Gerringong 248
    Venice 262
population replacement rate 221
port cities 209
Port Hinchinbrook 75
Portugal heatwave 88
power supplies 211
precipitation 41, 42, 46–9, 50, 51, 104, 106–7, 108, 110
prevailing winds 44
Prime Meridian 32
public spaces 270, 272
public transport 216–17, 218, 283
    accessibility 183, 222–3, 227, 270, 274, 278
    cities and 216–17
push and pull factors 200

Q

quality of life 181, 190, 268–99
Queensland 74, 183, 242, 256
    floods 84–7
    water grid 160
    water hotspot 125
    wild rivers 171–3
QuickStats 290–1, 295

R

radial drainage 109
railways 218, 222
rain shadow 41, 44
rainfall 31, 41, 44, 45, 46, 48, 50, 51, 53, 60, 72, 74, 81, 90, 156
    East Africa 141
    population distribution and 241
rapid-onset floods 63, 81
Rayner, Michael 98
recreational spaces 190, 200, 282–4
recycling 115
Reel Connections 204
refugees 140
regional centres 184, 242, 253
relative humidity 41, 58
relative location 181, 186
relief 19, 26
religious beliefs 189
remote areas 209, 212, 240
remote sensing (RS) 34
renewable resources 3, 10, 11, 36, 113
replacement rate 207, 221
research scaffold 17
reserves 225, 257
reservoirs 137, 145
resort settlements 209
resource distribution and ownership 11, 259
retail business survey 295
reverse osmosis 137, 146, 147
rice paddies 9
ridge 27
Rio Tinto 261
river basins 155, 166
river red gums 163, 166–7
river regulation, Murray–Darling Basin 168–9
river systems 81, 83, 108, 210
riverside living 187
robotics 227
rock climbing 253, 254
Rouse Hill Town Centre (Sydney) 280
Royal Flying Doctor Service 212
royalties 225, 259
run-off 63, 101, 104, 107, 167
rural communities 185, 198, 199, 207, 208, 209, 212–13, 221, 238, 242, 250
rural homesteads 208
rural schools, Natimuk 255

S

safety awareness 183, 190, 205
safe water 152
Sahel, drought and 93
Salford Quays 287, 289

salinity 113, 164, 165, 168
salt pan 155, 159
saltwater intrusion
Salzburg 210
sand dam 152
sanitation 101, 120, 121, 122, 123, 152
San people 143
satellite images 158–9
scale 3, 19, 22, 23, 50
school design enhancement 284–5
sea attachment, Torres Strait Islander people and 194
sea changers 244
sea temperature 44, 72, 84, 94, 95
sea wall 99
sedentary lifestyle 155, 162
semi-nomadic people 162
sense of place 181, 184–5, 186–9
Seoul, recreational space reclamation 283
services 181, 202
service provision 202–3, 212, 263
settlements 208–9
sewage, Ganges River and 134
sheep grazing 253
Shinjuku 188
shopping centres 275, 280–1
sip well 143
site 181, 186
skateboarding 282
sketch map 31
skilled employment 223
slow-onset floods 63, 81
small town living 184, 250
smart growth strategies 217
Snow, John 34
snow making 105
Snowy Mountains Scheme 145, 165, 167
soaks 155, 162
social characteristics 15
social environment 9
social impacts 66, 80, 92
social needs 182
social networking sites 14, 255
social places 271
socio-economic drought 90
socio-economic status 15
soil type 106
solar energy 8, 36
Somalia, drought and 140
source (map) 22
South Bank (Brisbane) 276
South Korea 283
Southern Hemisphere 43
Southern Oscillation (SOI) Index 94
Spain 124, 264–7
spatial inequalities 181, 183
spatial patterns 16, 181, 187, 193
spatial technologies 34–5, 38–9
special places 200
spiritual significance 133, 194
sporting clubs, Natimuk 255
spot height 19, 26
springs 155, 162
spring tanks 152–3
squatter settlements 221
statistical neighbourhood profiles 295–6
storm surge 63, 73
storms 63, 65, 66, 68–71, 72, 73
straight-line distance 29
street maps 21
streetscapes 271
subak system 131
subsidence 113
subsistence agriculture 137, 140
suburban living 214–15, 218, 242
suburbanisation 207, 218
Sudan, water hotspot 124
Sun 43
supply chains 269, 286
surface hazards 64
surface water 106, 114
surveillance 278
sustainability 3, 10, 157, 175
  shopping centres and 281
Switzerland 222–3
Sydney 54, 182, 217, 277, 279, 280, 281
  desalination plant 146–7

T

technology, impacts of 250–1
telecommunications, changes in 226
telecommuting 251
telework 181, 199
temperature 30, 44, 50, 51, 52, 58
Tennant Creek 182
terrace houses 215
thematic maps 19, 21, 30
thermometer 58
Three Gorges Dam 148–9
thunderstorms 69, 70, 77
thylacine 197
tidal power 36
Time Series Profiles 291

title (map) 22
toilet needs 121, 123
Tokyo 188
Toowoomba flash flood 86
Top Ryde City shopping centre (Sydney) 281
topographic maps 19, 20, 26–7, 37, 190
topography 19, 20, 106, 187
tornadoes 63, 76–9, 98
Torres Strait Islander people 194, 196
total catchment management 165
tourism 247, 298–9
    Costa del Sol 264–5
    Murray–Darling Basin 167
    Venice 262–3
trade winds 94, 95
traffic calming 271
traffic congestion 201, 251, 278
Trafford Park Development Corporation (TPDC) 286, 288
transpiration 104
tree changers 207, 212, 213
trellis drainage 109
Trevorrow, Tom 162
tributary 101, 108
Trio apartments 277
Tripoli 146
Tropical Cyclone Tasha 85
Tropical Cyclone Yasi 65, 67, 73–4
tropical cyclones 63, 65, 66, 67, 72–5, 98
truncated spurs 27
T-shaped settlements 209
tsunamis 66, 67

U

Uganda, drought 140
United Nations 121, 139
United States of America
    'big' towns idea 298
    culture and 228
    irrigation 128
    tornadoes 77–8
    water hotspot 125
uranium 258
urban centres 186, 212–13, 214–15, 218–19
urban consolidation 207, 214
urban design 200
urban–industrial growth 237
urban infill 242
urban renewal 279, 286–9
urban settlement 207, 208
urban sprawl 207, 214, 218
urbanisation 207, 221

V

vaporetti 263
vegetation 106, 158
Venice 262–3
vertical gardens 277
vertical photographs 12
Victoria, floods 82, 84
Vienna 193
virtual water 101, 116, 118–19

W

warm fronts 56
wastewater 114, 139
WaterAid 152
waterborne diseases 121
water buyback 155, 160
water conservation 142
water consumption 114
water contamination 121, 139
water cycle 101, 104–5
water distribution 106–7
water diversion 167
water footprint 101, 116–17
water grid 160
water loss 106
water neutrality 278
water price 174
water quality 90, 138–9
water reclamation 142, 164
water resource management 136–53, 142–3, 154–79, 164–5
    Aboriginal and Torres Strait Islander people 157, 162–3
water restrictions 117, 164
water retention 99
water scarcity 137, 138–9, 142, 160–1, 201
watershed 101, 108
waterspouts 79
water storage 106, 142, 157
water stress 137, 138
water supplies 102–3, 144–7, 156, 237
water table 101, 110, 144, 164–5
water trade 118
water transport 145
water usage 96, 114–15, 116–17, 129, 156, 164, 278, 280

wave power 36
weather and climate 42–5, 58–61, 296
weather maps 21, 56–7
weather-record devices 58
weather-related hazards 64, 66
weather satellites 159
Weeri Lagoon 246, 247
wells 110, 113, 146, 152
Wenlock River 170, 172,
Werri Beach 247, 249
Western Australia 238, 239, 256, 260
wet–dry bulb thermometer 58
wetlands 225, 244
whale hunting 17
wild rivers 155, 171–3
Wilderness Society 170, 173
wildlife, heatwaves and 89
Wimmera 252, 253
wind 56, 59, 68
wind clans 194
wind power 36
wind shear 77
Wodi-Wodi People 246
women, water and 120, 121, 152–3
workforce structure 238
workplace technology 250
World Health Organisation 134
World Heritage site, Bern as 222
world population growth 221
world travel 38
World Vision 123
world water hotspots 124–5
Wright, Timothy 247

Y

Yarra River catchment 108–9
Yorta Yorta People 163
young people
    crime and 204
    disabilities and 274
    lifestyle 191

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